Open access • Journal Article • DOI:10.1111/J.1465-7295.2010.00248.X

Should we get married? The effect of parents' marriage on out-of-wedlock children. — Source link

Shirley H. Liu, Frank Heiland

Institutions: University of Miami, Florida State University

Published on: 01 Jan 2012 - Economic Inquiry (Econ Inq)

Topics: Fragile Families and Child Wellbeing Study and Child development

Should We Get Married? The Effect of Parents'
Marriage on Out-of-Wedlock Children

Shirley H. Liu
and
Frank Heiland*

JEL Classification codes: J12, J13, C3.

Should We Get Married? The Effect of Parents' Marriage on Out-of-Wedlock Children

Using a representative sample of children all born to unwed parents drawn from the Fragile Families and Child Wellbeing Study (FFCWS), we investigate whether marriage after childbirth has a causal effect on early child cognitive ability, using a treatment outcome approach to account for self-selection into marriage. Comparing children with similar background characteristics and parental mate-selection patterns who differ only in terms of whether their parents marry after childbirth, marriage between unwed biological parents leads to a four point increase in their child's Peabody Picture Vocabulary Test (PPVT) score at age three relative to children whose parents remain unmarried.

Shirley H. Liu
University of Miami
Coral Gables, FL

Frank Heiland
Florida State University
Tallahassee, FL

I. INTRODUCTION

While marriage remains the foundation of family life in the U.S., the traditional process of family formation, specifically marriage before having children, has been dwindling. The proportion of children born to unwed parents has increased dramatically over the past three decades, from 12% in 1970 to nearly one-third of all births today (Sigle-Rushton and McLanahan, 2002*b*). The decoupling of marriage and fertility behavior is particularly common among the low-income, less-educated urban population (Sigle-Rushton and McLanahan, 2002*a*; Manning and Brown, 2003; McLanahan and Sandefur, 1994). Unmarried parents tend to have fewer resources, and children raised by unwed parents tend to display inferior outcomes compared to those raised by two married parents.[1]

Concerned over the rise of out-of-wedlock parenthood and its implications on children involved, recent policies have geared toward promoting marriage among unmarried parents.[2] However, very little is known about the potential benefits of marriage *after childbirth*. Couples who have children out-of-wedlock are known to be selectively different from those who marry before having children. Unmarried parents tend to be of lower socioeconomic standing, face poorer prospects in the marriage market, and may be less assortatively matched (Brown, 2004; Osborne and McLanahan, 2004; Nock, 1998; Rosenzweig, 1999; Jaffe and Chacon-Puignau, 1995; Garfinkel et al., 2002). Hence, interpreting differences in child outcomes found in cross sectional comparisons between children born to married *vs.* unmarried parents as benefits of marriage could be misleading, as these differences may largely reflect the advantages of married parents rather than the intrinsic benefits of marriage.

This study examines whether marriage after having children has a causal effect on child cognitive ability, using data on a representative sample of children all born to unmarried parents drawn from the Fragile Families and Child Wellbeing Study (FFCWS). In this sample, a significant percentage of children born out-of-wedlock experience the marriage of their (biological) parents. To determine whether marriage after having children has a causal effect on child cognitive development, our empirical strategy centers around a treatment outcome framework similar to an experiment where the treatment ("marriage after childbirth") is randomly assigned. We draw on matching methods (Rubin, 1979; Rosenbaum and Rubin, 1983; Heckman and Hotz, 1989; Heckman et al., 1997, 1998) to identify the treatment effect (marriage), exploiting the full information provided by the rich set of parental characteristics in the FFCWS. Our approach addresses the selection into marriage by constructing the appropriate comparison group for children whose parents marry after childbirth. We first estimate the probability of marriage among unwed parents with a newborn, then compare cognitive outcomes of children whose parents share similar probabilities of marriage.

The treatment outcome framework is a (semi) nonparametric method that does not impose functional form assumptions on the relationship between the treatment ("marriage") and the outcome in question, allowing for the separate identification of the treatment effects for the treated. In comparison, the linearity assumption of the conventional regression approach permits data from all observations to be combined into one estimate, generating a complex average of the treatment effect on the treated ("effect of marriage on children whose parents marry"), and the treatment effect on children whose parents are unlikely to ever marry. The validity of such estimates is suspect when the combining function operates over children born to couples with very different characteristics (i.e., when unmarried couples with substantially different characteristics from those who marry are used to estimate the counterfactual). We investigate potential differential marriage effects by comparing estimates from treatment outcome models to least squares results.

In the estimation, we utilize information on the unwed biological father that is rarely available in large representative datasets. The extent to which children benefit from their parents transitioning into marriage may depend on each parent's characteristics ("traits") and how well these traits are matched ("positive assortative mating"). While some studies examine the determinants of (marital) union formation among single mothers (Furstenberg et al., 1987; Graefe and Lichter, 2002; Aassve, 2003), the factors influencing marriage and the patterns of assortative mating between unmarried biological parents are considerably less well understood.[3] This is mainly due to the lack of information on men who father children out-of-wedlock.[4] Confronted with the "missing fathers problem", studies typically account for selection into marriage by controlling for the characteristics of the resident parent (usually the mother) and assume that the mating patterns of unmarried parents are similar to those of married parents (Astone and McLanahan, 1991; Wu, 1996; Painter and Levine, 2000).[5] To the extent that the effect of parents' marriage on child wellbeing reflects the characteristics both parents as well as the quality of their match, existing estimates of the effect of marriage among unwed parents may be biased.[6]

Data from the FFCWS is used to estimate the effect of marriage on child ability among out-of-wedlock children. The FFCWS provides child assessment data and detailed marriage, fertility, and socioeconomic information on both biological parents of a large representative sample of children born outside of marriage. We focus on the effect of marriage among parents who are romantically involved (cohabiting or visiting[7]) at birth on child cognitive ability measured at age three, based on scores from the Peabody Picture Vocabulary Test (PPVT), a widely-used interviewer-administered measure of receptive hearing and verbal ability. Much of the existing evidence on the effects of family structure and child outcome stems from studies using data on the wellbeing of school-age children and adolescents. Since unmarried families tend to be less stable and hence more short-lived (Bumpass and Lu, 2000; Manning et al., 2004), these findings may be characteristic of stable unmarried families only. Hence, by focusing on marital transitions within a short period after childbirth, our sample may be more representative of the overall population of unmarried families. We find that children whose parents marry after childbirth score about four points ($1/4th$ of a standard deviation) higher on the PPVT at age three, compared to children of persistently unmarried parents with similar observable characteristics.

II. BACKGROUND

While there exists an extensive body of research on the relationship between family structure and child wellbeing, the effect of marriage between unwed biological parents on child outcomes has received little attention. This section provides the conceptual and empirical background for analyzing the effects of marriage on child wellbeing, with special emphasis on how marriage between the biological parents may benefit children born out-of-wedlock. We draw on the theoretical literature on family formation and resource allocation (Becker, 1965, 1973, 1991; Manser and Brown, 1980; McElroy and Horney, 1981; Weiss and Willis, 1997; Willis, 1999; Ribar, 2004) and stress the importance of family resources (time and money) and endowments (caregivers' ability) in the production of family public goods such as child quality.

Benefits to Marriage

Financial resources are key determinants of child wellbeing (Blau, 1999), allowing parents to purchase goods and services important for child development. Economic resources are complemented by parenting resources—the services provided by the parents using their time and childrearing ability (McLanahan and Sandefur, 1994). Interaction with the child fosters child development by providing support, stimulation, and control (Maccoby and Martin, 1983). For healthy child development, both time and material resources are needed (Coleman, 1988). Time and income are substitutable to a certain extent as money can buy childcare services and working in the labor market increases available financial resources.

By forming a union, the availability of family resources can increase through several mechanisms (Becker, 1991; Michael, 1973; Shaw, 1987; Drewianka, 2004). First, individuals can realize gains from specialization and exchange in the presence of comparative advantages: Households of married or cohabiting parents may divide responsibilities across partners according to their individual capacities.[8] Specialization of partners' time is economically efficient as it exploits comparative advantages of each person in the production of goods that both enjoy (such as "child quality"). Second, individuals may realize economies of scale in household production (e.g., sharing the apartment). Third, the two-parent household can pool individuals' resources and realize gains from exploiting risk-sharing opportunities.[9] Fourth, individuals may become more productive as part of a family due to social learning. While these benefits apply to married couples and potentially to cohabitors as well, additional institutional factors that enhance resource availability such as tax laws and insurance coverage, are often exclusive to married couples.

Non-marital arrangements lack the rights and responsibilities granted by the legal bond of marriage (Hamilton, 1999; Lundberg and Pollak, 1995). The marriage contract ensures that there is some compensation for sacrifices made on behalf of the family, thereby encouraging specialization and more defined parental roles (Brown, 2004). Furthermore, marriage provides an environment that fosters the allocation of resources towards children since responsibilities and agreements are more easily enforced under family law and the cost of divorce reduces the risk of union dissolution.[10] For example, in the absence of a marriage contract, the father's incentive to invest in child quality may be low since he faces greater uncertainty regarding the extent to which he will enjoy the benefits of these investments in the future.[11] Moreover, given the greater difficulties for a non-resident father to monitor the effective use of his monetary transfers to the mother on behalf of the child, the father may make suboptimal child investments (Willis and Haaga, 1996; Willis, 1999).

Consistent with the resource hypotheses, Brown (2002) finds that the availability of economic resources differ markedly across family arrangements, with children residing in mother-only or cohabiting-parents households being more likely to live in poverty, compared to children in married two-parent families. McLanahan (1985) shows that differences in income explain up to half the differences in child wellbeing. Hofferth (2001) estimates that among children under age 13, those living with single mothers spent 12 to 14 fewer hours with their parents per week compared to children living with married parents.[12] In addition, Waite and Gallagher (2000) find some evidence that living together may induce a stabilizing effect on the partners, which can increase resources as a result of greater productivity at home and in the labor market.

While children in either married or cohabiting families may enjoy resources provided by two resident parents, there is evidence that cohabitors do not pool their incomes (Winkler, 1997; Bauman, 1999; Kenney, 2004; Lerman, 2002; Oropesa et al., 2003). Bauman (1999) finds that income of a cohabiting partner does less to amend the economic hardship than that of a spouse. Single-parent and cohabiting families are found to spend smaller shares of their budget on child-related goods, such as education (Ziol-Guest et al., 2004; DeLeire and Kalil, 2005). Parenting resources may also suffer in cohabiting unions. Brown (2002) finds that cohabiting mothers are more likely to be psychologically distressed than married mothers and suggests that this difference stems from the greater uncertainty regarding the future of the union.

This paper focuses on the effect of marriage between the biological parents on child wellbeing. The amount of resources allocated to the child may depend on whether or not the partner is biologically related to the child. Hamilton's kin selection model (1964), posits that genetic relatedness is a key determinant of parental transfers. Biological parents may make greater investments in their children than non-biological parents for several reasons. First, biological parents may be more emotionally attached to the child and feel more responsible for the child's wellbeing. Second, the returns from child investments may be higher for a biological parent. The father, for example, may be more involved if the child is his own since the child can continue his family lineage and ascertain future intergenerational transfers (Case et al., 2000). Third, the biological father may be required by law to pay child support regardless of his relationship status with the mother.[13,14]

Selection into Marriage

Following the previous discussion, a transition towards marriage is expected to increase the availability of resources and paternal investments in children. However, unwed parents who later marry may be substantially different from parents who remained unmarried. Most existing studies measure the benefits of marriage by comparing the wellbeing of out-of-wedlock children to children born within marriage, and seldom accounts for the role of selection into marriage. In examining the effect of marriage on child outcomes, potential differences in the characteristics and mate selection patterns between parents who marry and those who remained unmarried, need to be addressed.

Economic theories of marriage posit that individuals optimally select a mate to exploit the benefits of marriage discussed in the previous section, subject to marriage market conditions and individual endowments (Becker, 1973; Lam, 1988; Manser and Brown, 1980; McElroy and Horney, 1981; Pollak, 1995). As a result, union formation tends to be non-random. Lam (1988) shows that couples tend to be positively assortatively matched to exploit marital gains through joint production of household public goods and negatively assortatively matched in the presence of gains to specialization: Spouses are typically found to be similar in age, race, education, and other socioeconomic characteristics (Epstein and Guttman, 1984; Mare, 1991; Oppenheimer, 1988; Rockewell, 1976).

The characteristics and mate selection patterns of unwed parents who later marry have received relatively little attention. Willis (1999) argues that theoretically, unmarried parents should have less favorable characteristics and be less assortatively matched than married parents.[15] Consistent with these hypotheses, married parents are found to be of higher socioeconomic status than unwed parents (Weiss and Willis, 1997; Sigle-Rushton and McLanahan, 2002*a*; Brown, 2004; Osborne and McLanahan, 2004; Osborne, 2005), and unmarried couples tend to be less (positively) assortatively matched (Jaffe and Chacon-Puignau, 1995; Garfinkel et al., 2002). As in Brown and Booth (1996), these differences in attributes and mating pattern likely contribute to the lower relationship quality and greater instability found among cohabiting and visiting parents compared to married parents.

Given that selection into marriage is non-random complicates the estimation of the marriage effect. Simple comparisons of child outcomes by marital status can be misleading if couples who get married are substantially different from those who remain unmarried in ways that also affect child investments. For example, if couples with characteristics that benefit child development are also more likely to get married, compared to those who remain unmarried, the benefits of marriage may be overstated. Conversely, if couples with poorer traits are more likely to get married after childbearing, a negative association between marriage and child wellbeing may arise. For instance, the social stigma of non-marital childbearing may induce some poorly-matched or -endowed couples to marry. In turn, the development of their children may suffer as these parents may face greater difficulties in specializing and coordinating the production of child quality. Given the limited understanding of the determinants of marriage among out-of-wedlock parents, the direction and magnitude of the potential selection biases in the estimates of the marriage effect remain unclear.

III. STATISTICAL MODEL AND ESTIMATION STRATEGY

In this section, we present a conceptual model of child investments and marriage for couples who experienced a premarital birth. We then introduce the potential outcome approach and our estimation strategy, namely the propensity score matching method.

Conceptual Model

Consider a couple i who have a child out-of-wedlock. The model of parental investments in their child and the process of marriage formation following childbirth can be formalized as follows:

$$C_i = \beta M_i + \gamma X_i + \varepsilon_i \tag{1}$$

$$M_i = \delta X_i + \nu_i \tag{2}$$

where C_i denotes the observed child outcome of couple i; M_i is equals to (1) if the couple marries after childbirth and (0) otherwise. The vector X_i includes characteristics of couple i that influence their child investment and marital decisions. In this setting, child quality is determined by parental marital status, observable characteristics X_i, and unmeasured factors ε_i. A couple's decision of whether to marry depends on their observed characteristics X_i and unobserved factors ν_i.

If marriage is exogenous to a couple's child investment decisions, then ordinary least squares regression of the effect of marriage on child outcomes yields an unbiased estimate of the effect of parents' marriage after childbirth (β in (1)). However, a couple's child investment behavior might be endogenous to whether the couple transitions into marriage, i.e. if there is dependence between marital status M_i and the error term ε_i. Correlation between M_i and ε_i can arise for one of two not necessarily mutually exclusive reasons (Rosenbaum and Rubin, 1983; Heckman and Robb, 1985): (a) dependence between X_i and ε_i ("*selection on observables*"); and (*b*) dependence between ε_i and ν_i ("*selection on unobservables*").

Our methodology addresses the selection on observables using propensity score matching (PSM).[16] The FFCWS enables us to construct measures of the biological parents' attributes and how assortatively matched they are. The PSM method matches children based on these factors (and other characteristics), thereby reducing potential bias induced by self-selection into marriage.[17]

Potential Outcome Approach

Using the terminology of the evaluation literature, consider the "treatment" to be the marriage between the biological parents of child i after his/er birth: $M_i = 1$ denotes the "treatment group" (i.e. children whose parents marry after childbirth), and $M_i = 0$ denotes the "control group" (i.e. children whose parents remain unmarried). Let $C_i(1)$ denote the potential outcome of child i under the treatment state ($M_i = 1$), and $C_i(0)$ the potential child outcome if the same child i receives no treatment ($M_i = 0$). Thus, $C_i = M_iC_i(1) + (1 - M_i)C_i(0)$ is the observed outcome of child i. The individual treatment effect is $\beta_i = C_i(1) - C_i(0)$, which is unobserved since either $C_i(1)$ or $C_i(0)$ is missing. Alternatively, one might focus on the average effect of treatment on the treated ("effect of parents' marriage on children whose parents marry after childbirth"), i.e. the ATET henceforth:

$$\beta_{M_i=1} = E(\beta_i|M_i = 1) = E[C_i(1)|M_i = 1] - E[C_i(0)|M_i = 1] \quad (3)$$

which is the difference between the expected outcome of a child whose parents marry, and the expected outcome of the same child if his/er parents were to remain unmarried.

While we do observe the outcomes of children whose parents marry, and are thus able to construct the first expectation $E[C_i(1)|M_i = 1]$, we cannot identify the counterfactual expectation $E[C_i(0)|M_i = 1]$ without invoking further assumptions. To overcome this problem, one has to rely on children whose parents remain unmarried ($C_i(0)$), the comparison group, to obtain information on the counterfactual outcome. Replacing $E[C_i(0)|M_i = 1]$ with $E[C_i(0)|M_i = 0]$ is inappropriate since the treated and untreated might differ in their characteristics determining the outcome. An ideal randomized experiment would solve this problem because random assignment of couples into treatment ensures that potential outcomes are independent of treatment status. In this hypothetical case, the treatment effect could be consistently estimated by the difference between the means of the observed outcomes in the treatment and the control groups. In our context where union formation is expected to be non-random we will devise suitable matching estimators.

Matching

Statistical matching is a way to construct a correct sample counterpart for the counterfactual outcomes of the treated had they not been treated. Since data on the counterfactual for the treated group is unavailable, matching estimators can be devised to reconstruct the condition of an experiment by stratifying the sample of treated and untreated children with respect to the covariates X_i that rule both the selection into treatment and the outcome under study. Selection bias is eliminated provided all variables in X_i are measured and balanced between the two groups. In this case, each stratum represents a separate randomized experiment and simple outcome differences between the treated and control groups provide an unbiased estimate of the treatment effect.

Conditional Independence Assumption (CIA). An identifying assumption of the matching method is that the relevant outcome differences between any two children are captured in their observed characteristics, called the "Conditional Independence Assumption". It requires that, conditional on observables X_i, the distribution of potential outcomes of children whose parents marry if they had remained unmarried to be the same as the outcome distribution of children with persistently unmarried parents. Hence, the outcomes of children whose parents remained unmarried are what the outcomes of children whose parents married *would have been* if their parents had remained unmarried (conditional on X_i).[18] Moreover, it assumes that there are untreated individuals for each x.[19] It follows that $E[C_i(0) \mid X_i, M_i = 1] = E[C_i(0) \mid X_i, M_i = 0]$.The conditional response of the *treated* under no treatment for a given X can thus be estimated by the conditional mean response of the untreated under no treatment.[20]

Average Treatment Effect for the Treated (ATET). Following the CIA, the average treatment effect on the treated can be computed as follows:

$$\begin{aligned}
\beta_{|M_i=1} &= E[C_i(1) \mid M_i = 1] - E[C_i(0) \mid M_i = 1] \qquad (4)\\
&= E_X[E[C_i(1) \mid X_i, M_i = 1] - E[C_i(0) \mid X_i, M_i = 1] \mid M_i = 1]\\
&= E_X[E[C_i(1) \mid X_i, M_i = 1] - E[C_i(0) \mid X_i, M_i = 0] \mid M_i = 1]\\
&= E_X[E[C_i \mid X_i, M_i = 1] - E[C_i \mid X_i, M_i = 0] \mid M_i = 1]
\end{aligned}$$

To estimate the average treatment effect on the treated, one is to first take the outcome difference between the two treatment groups conditional on X_i, then average over the distribution of the observables in the treated population.[21]

Conditioning on X within a finite sample can be problematic if the vector of observables is of high dimension. The number of matching cells increases exponentially as the number of covariates in X increases. Rubin (1979) and Rosenbaum and Rubin (1983) suggest the use of the *propensity score*, i.e. the conditional probability of participating in the treatment $p(X_i) = Pr(M_i = 1 \mid X_i = x) = E(M_i \mid X_i)$, to stratify the sample. They showed that by definition the treated and the non-treated with the sample propensity score have the same distribution of X: $X_i \perp M_i \mid p(X_i)$.[22] Furthermore, if $C_i(0) \perp M_i \mid X_i$, then $C_i(0) \perp M_i \mid p(X_i)$. This implies that matching can be performed on $p(X_i)$ alone, which is more parsimonious than the full set of interactions needed to match treated and untreated based on X, thus reducing the dimensionality problem into a single variable $p(X_i)$.

Matching treated and untreated couples with the sample propensity scores and placing them into one cell (i.e., observations with propensity scores falling within a specific range) means that the decision of whether to participate or not is random within each cell and the probability of participation in this cell equals the propensity score. Consequently, the difference between the treated and the untreated average outcomes at any value of $p(X_i)$ is an unbiased estimate of the average treatment effect for the treated at that value of $p(X_i)$. Therefore, an unbiased estimate of the ATET can be obtained conditioning on $p(X_i)$, which is equal to exact matching on $p(X_i)$: $\beta_{|M_i=1} = E_{p(X)}[(E(C_i \mid M_i = 1, p(X_i)) - E(C_i \mid M_i = 0, p(X_i))) \mid M_i = 1]$.

The implementation of this framework has several challenges. First, the propensity score itself needs to be estimated. Second, since it is a continuous variable, the probability of finding an exact match is theoretically zero. Therefore, a certain distance between the treated and untreated has to be accepted. Several matching procedures have been proposed to solve this problem (Becker and Ichino, 2002). To estimate the ATET, this study employs *Kernel* estimators.[23,24] We refer to the Technical Appendix for a discussion of these estimators. There are tradeoffs between the quantity and quality of the matches among these estimators but none is a priori superior. However, their joint consideration offers a way to assess the robustness of our results.

IV. DATA and DESCRIPTIVE EVIDENCE

Our study sample consists of 958 children born to parents who were unmarried but romantically involved at childbirth drawn from the Fragile Families and Child Wellbeing Study (FFCWS). The FFCWS collected data on a cohort of 4,898 births in 75 hospitals in 16 large cities (with population of 200,000 or more) across the U.S. between 1998 to 2000. The weighted sample is representative of all births in large U.S. cities in 1999.[25] The FFCWS is unique as it provides information on a large set of children born to unmarried parents in various living arrangements and relationship structures. Within the original cohort, 3,600 were born to unmarried parents. Both biological parents were interviewed at the time of childbirth, when the child reaches age one, and then at age three. Areas such as parent-parent and parent-child relationships, socioeconomic activities, and child development are covered.

At the three-year follow-up, the FFCWS collects data from a random subsample of the core respondents ($n = 2,368$) on various domains of the child's environment, called the "36-Month In-Home Longitudinal Study of Pre-School Aged Children". As part of the In-Home survey, the Peabody Picture Vocabulary Test (PPVT) is administered to the child by the interviewer. The PPVT is a well-documented and widely-used measure of verbal ability and early scholastic aptitude, and has been shown to be predictive of subsequent intellectual ability and achievement (Dunn and Dunn, 1981).[26]

Our study sample is selected as follows. First, given that the child outcome measures are available only through the 36-Month In-Home survey, children not part of the random subsample selected for the survey ($2,530$ cases) are excluded. Second, we focus on children born to unmarried biological parents who were at least romantically involved at childbirth (i.e., either in cohabiting or visiting unions), therefore children born to parents who were either married (508 cases) or not romantically involved (221 cases) upon childbirth are excluded ($N = 1,639$ remains).[27] Third, to keep track of the history of parental relationship transitions, parental relationship status must be identified in all three waves: Biological parents whose relationship status cannot be identified at baseline (349 cases), one-year follow-up (141 cases), or the three-year follow-up (69 cases) are dropped. Fourth, we cross check the marriage date (available since the one-year follow-up) with parents' reported marital status at childbirth. Observations in which the reported marriage date contradicts the reported marital status of the parents at childbirth are dropped (6 cases). An additional 23 cases are dropped due to missing information on important socioeconomic and demographic characteristics.[28] In the resulting sample, consisting of $1,051$ children all born to unmarried parents, 19% experienced the marriage of their biological parents by age three [weighted = 24%].

Finally, we estimate the propensity score of selection into treatment (i.e., the probability of parents' marrying within three years since childbirth) within this sample of $1,051$ children. To ensure sufficient overlap of the propensity scores between the treatment and control groups, observations with propensity scores falling outside of the common support region are excluded from the analysis (six treated and 87 controls), resulting in the final sample size of 958 children.

Sample Descriptives

Table 1 presents summary statistics of the measures used in this study. Sample descriptives are first presented for the entire sample (Columns 2 and 3). Columns 4 and 5 present variable means for children whose parents marry within three years after childbirth, and children whose parents remained unmarried, respectively. About 64% of the children were born to cohabiting parents, while the remaining were born to visiting parents. Among children with parents who transition into marriage within three years after childbirth (20% of the sample), 81% (19%) had cohabiting (visiting) parents at birth.[29] Among biological parents who remained unmarried after three years since childbirth, 53% remain romantically involved with each other in either cohabiting or visiting relationships at wave 3. For parents who are no longer romantically involved at wave 3, 38% of the mothers and 27% of the fathers have entered into romantic relationships with new partners (results not shown).

Child cognitive ability is measured by the child's standardized PPVT test score administered at age three.[30] The mean PPVT score in our sample is 84.9 (S.D. = 16). Children whose parents marry within three years since childbirth display significantly higher cognitive ability at age three, with an average PPVT score of 87.4, compared to 84.3 among children whose parents remained unmarried.

Who Gets Married?

Parents who marry after childbirth are better off in many dimensions compared to parents who remained unmarried (henceforth "persistently unmarried")[31]: They are older, more educated, more likely to participate in the labor market, have higher earnings and household income. White and Hispanic mothers are more likely to marry their children's fathers, compared to black mothers.

Table 2 summarizes the differences in (positive) assortative mating patterns between unmarried parents who marry after childbirth, and persistently unmarried parents. We examine disparities between the partners' traits, such as age, education, race/ethnicity, and labor income. Overall, the age difference between the partners is larger for parents who marry than among persistently unmarried parents. There is also greater variation in the partners' age difference among parents who marry. The prevalence of unions in which the mother is older than her partner are similar across the two groups (about 20%). Mixed-race unions are more common among those who marry.[32]

Married mothers tend to be more educated than their partners:[33] About 29% of the mothers who marry the child's father after childbirth is more educated than the father (compared to 27% of persistently unmarried parents). The prevalence of less assortment by labor earnings is similar among parents who marry after childbirth and those who remained persistently unmarried.[34] However, its distribution varies markedly across the two subsamples: Among mothers who earn more than their partners, those who marry tend to have lower labor income compared to mothers who are persistently unmarried. This implies that among children whose parents are less assorted by earnings (i.e., unions in which the mother has higher earnings than the father), those whose parents subsequently marry may face greater economic disadvantages, compared to their counterparts whose parents remained unmarried.

Finally, we examine the differences in relationship characteristics between parents who marry after childbirth and persistently unmarried parents. Parents who marry are more likely to have rushed into marriage, given that they tend to have known each other for less than six months prior to pregnancy, compared to persistently unmarried parents (15% *vs.* 11%). Consistent with Carlson et al. (2004), we also find that mothers who marry their child's father after childbirth are also more likely to be catholic and attend religious activities frequently. The incidence of the father suggesting abortion during pregnancy is lower among children whose parents marry compared to those with persistently unmarried parents. The father suggesting abortion during pregnancy may be a signal of whether the pregnancy was planned, but also be correlated with the father's attitudes towards abortion and marriage. For fathers who are against abortion, an unintended pregnancy may provide a strong incentive to marry, even if the quality of the match between him and the mother is poor and/or uncertain.

V. Estimation Results

In a standard parametric framework (i.e., OLS), the average cognitive outcomes of children whose parents marry (treatment group) are compared to the average outcomes of children whose parents remained unmarried (control group). The linearity assumption permits data on all observations to be combined into one estimate, but the validity of the estimate is suspect when the average outcome is taken over observations with very different characteristics (Levine and Painter, 2003). Thus, the results tend to be sensitive to the choice of functional form. In addition, the estimation procedures create estimates that are complex averages of the typical treatment effect on the treated and the controls.[35] Propensity score matching (PSM) methods relax the linearity assumption. By matching each treated observation with controls who are share similar observable characteristics, the differences in their outcomes are taken as driven by their treatment status only. In this setting, the estimated marriage effect is the average of the typical effect of treatment on the treated only, rather than the average of the treatment effects on the treated and the controls.

Estimation results using conventional OLS regressions and propensity score matching are presented in this section. Note that if the linearity assumption holds, then OLS and matching should produce very similar results. However, if the effect of marriage on children whose parents marry differ substantially from the average effect of marriage on children of persistently unmarried parents, then PSM yields the unbiased estimate of the causal effect of marriage on child outcomes.

If the characteristics of parents who marry differ substantially from parents who remained unmarried, then we would expect the parametric (OLS) and semi-nonparametric (PSM) estimates to differ. Following the discussion in Section 2.2, if better-off parents are more likely to marry, OLS would overstate the effect of marriage. Conversely, if disadvantaged parents are more likely to marry, then the OLS results would understate the marriage effect, suggesting that the benefits of marriage are larger among children whose parents marry than the average out-of-wedlock child.

Ordinary Least Squares Estimates

Table 3 presents the OLS estimates of the effect of parents' marriage after childbirth on children's PPVT score at age three. The results using six model specifications are presented. The "Baseline Model" shows the gross difference in the PPVT test scores between children whose parents marry, and children of persistently unmarried parents. On average, children whose parents marry score 3.073 points higher on the PPVT ($1/5th$ of a standard deviation) compared to children whose parents remained unmarried. As shown in Model 1, the marriage effect is robust to a set of basic controls including relationship status at birth, child gender, low birth weight, and state of residence at childbirth.

As mentioned earlier, information on men who father children outside of marriage are largely unavailable in existing large datasets. As a result, studies examining the effect of family structure on children typically resort to only controlling for the mother's characteristics to account for parental influences. By doing so, these studies implicitly assume that the traits between the unwed partners are highly correlated, similar to that of married couples. This assumption may be inappropriate if unmarried parents differ substantially in their choices of mates compared to married couples. To illustrate the importance of accounting for both parents' characteristics and their patterns of assortative mating in analyzing the effect of family structure on child wellbeing, Model 3, 4, and 5 each additionally controlling for mother's characteristics, father's characteristics, and more detailed parental characteristics including similarities in traits (mating patterns) and proxies for relationship quality.

Holding basic family and child characteristics, and household income constant, Model 3 additionally controls for mother's characteristics. Differences in mothers' characteristics account for 12% of the differences in the cognitive outcomes at age three between children whose parents marry and children whose parents remained unmarried. If parents match assortatively (i.e., the partners' traits are highly correlated), additionally controlling for father's characteristics should have little effect on the estimated marriage effect. Model 4 shows that adding controls for the biological father's attributes appears to weaken the marriage effect. Holding both parents' characteristics constant, children whose parents marry after childbirth have PPVT scores of 2.38 points higher ($1/7th$ of a standard deviation) than their counterparts whose parents remained unmarried. Adding more detail on the couple—including mating patterns and other potential proxies for relationship quality—tends to further improve the fit and reduce the marriage effect (see Model 5).

Matching Estimates

Propensity score matching is a way to obtain estimates of the causal (unbiased) effect of marriage on child outcomes. The bias is reduced when the comparison of outcomes is performed using treated and control units with similar observable characteristics. To understand the potential bias introduced through self-selection into marriage, the differences in the characteristics between the treated and the control groups need to be highlighted. The descriptive evidence and OLS estimates highlight the importance of both parents' traits and their relationship-specific characteristics (such as assortative mating patterns) in explaining the differences in child outcomes. To that end, we match the treated and control units based on measures of parents' match quality and relationship-specific characteristics, as well as each parent's socioeconomic and demographic characteristics. Therefore, we first illustrate the factors affecting a couple's propensity to marry, namely the propensity score estimates. Then, the matching estimates are presented.

Estimating the Propensity Score of Marriage. The first step in implementing the matching method is to estimate the propensity score for the treatment ("marriage") under study. Parents' propensity to marry is defined as a function of each parents' socioeconomic and demographic characteristics, child-specific characteristics observed at childbirth, and measures of union match quality.[36] We account for parental relationship status at childbirth when estimating the propensity score, since the majority of the parents who transition into marriage were cohabitors at the time of childbirth (81%), while the remaining were in visiting relationships.

Table 4 presents probit estimates of the propensity score of selection into treatment, i.e. the probability of transitioning into marriage among unmarried biological parents with a newborn.[37] Compared to persistently unmarried parents (holding everything else constant), unwed mothers who marry their children's fathers after childbirth (*i*) are (positively) assortatively matched in terms of their age, race/ethnic backgrounds, and labor incomes, but less (positively) assortatively matched by their educational backgrounds: Unions in which the male is less-educated than the female are more likely to transition into marriage;[38] (*ii*) are significantly more likely to have known their children's fathers for less than six months prior to pregnancy; and (*iii*) attend religious activities frequently (at least a few times a week).

Weiss and Willis (1997) find that the lack of (positive) assortative mating, in particular with respect to education, contributes to martial instability. Given our finding that parents who marry after childbirth are less positively assortatively matched by education may suggest higher relationship instability among these unions. In addition, couples who marry appear to have been together for less time prior to pregnancy, which may suggest that they transitioned into marriage faster then planned (perhaps succumbing to social/religious pressures in the presence of an unplanned pregnancy), while having only limited information about their partners and the potential quality of their match upon marriage.

Main Findings. Table 5 presents the propensity score matching estimates of the effect of parents' marriage after childbirth on child PPVT score at age three.[39] The effect of marriage on children whose parents marry ("average treatment effect on the treated") based on the Epanechnikov, Gaussian, and uniform kernel (radius) estimators are reported, respectively. To assess the sensitivity of the estimates to the choice of bandwidth (or radius), we report results using different bandwidths (or radiuses). These and additional results from robustness checks are discussed in detail in the Technical Appendix (Sections 2 and 3).

The matching estimates confirm the direction of the marriage effect suggested by the parametric results reported in Model 5 of Table 3: Parents' marriage after childbirth has a significant positive effect on child cognitive ability at age three. Specifically, the matching estimates show that children whose parents marry after childbirth, on average, score 3.5 to 4.4 points ($\approx$ between $1/5th$ to $1/4th$ of a standard deviation) higher on the PPVT than to children whose parents remained unmarried. Simple correlations that we obtained from the Young Adults from the National Longitudinal Survey of Youth (Cohort 1979) suggest that a four point increase in the PPVT score at age three may raise the odds of graduating from high school by as much as two percentage points.

We note that the matching estimates, which are based on comparing outcomes of children who experienced marriage to similar children whose parents remained unmarried, tend to be larger in magnitude than the parametric estimates.[40] This indicates that the effect of marriage on out-of-wedlock children's cognitive development is heterogeneous. The latter is consistent with parents who choose to marry after having an out-of-wedlock birth being selectively different from persistently unmarried parents. As discussed above, we observe that the couples that transition into marriage tend to be different from those that remain unmarried. In particular, the model comparison suggests that children of parents who are less well acquainted and less well assortatively matched—and who thus are potentially less able to provide a stable family environment in the absence of the legal bond of marriage—may enjoy greater benefits to marriage.

In general marriage may be beneficial for children for a number of reasons as discussed above (see Section 2). Benefits to marriage may reflect gains in resources, economies of scale or specialization in household activities. It is unlikely that the matching estimates reflect gains of marriage through resource pooling and/or specialization, since married parents are matched with unmarried parents who share similar household incomes and multiple dimensions of partners' differentials in traits. The differences in child outcomes may reflect the extent that married and cohabiting parents enjoy economies of scale in joint production, which are more limited for visiting parents. Consistent with the idea that economies of scale partly explain the benefits of marriage, subsample analysis of children born to cohabiting parents only ($N = 640$) shows smaller marriage effects (results available upon request).

In addition, potential differences in the quantity and/or quality of investments made in children between married and unmarried families may also contribute to the estimated differences in child outcomes. It has been found that compared to families with married parents, (holding family income constant), cohabiting and single-parent families devote smaller shares of the family budget to their children (Ziol-Guest et al., 2004; DeLeire and Kalil, 2005), spent less time with their children (Carlson and McLanahan, 2001; Hofferth and Anderson, 2003), and face greater difficulties in monitoring and disciplining children (Bulcroft et al., 1998; Brown, 2002). Finally, while unmarried parenthood is less stigmatized today, it still does not benefit fully from legal and social recognition (Durst, 1997; Mahoney, 2002). Hence, in the absence of a legal arrangement ("marriage"), lower incentives to allocate resources towards the child combined with greater difficulties in coordinating and monitoring investments, may translate into suboptimal child investments being made.

VI. CONCLUSION

The dramatic rise in out-of-wedlock childbearing and concerns over the potential adverse effects of non-traditional arrangements between the parents on child wellbeing have prompted policies aimed at encouraging marriage among unwed parents. The belief that the welfare of out-of-wedlock children is better protected if their parents get married is founded (at least in part) on evidence showing that children of unwed parents tend to exhibit inferior outcomes, compared to children born to married parents. However, couples who have children before *vs.* after marriage are selectively different, hence the differences in child outcomes across the two types of families do not directly speak of the potential benefits of marriage for children who are born out-of-wedlock.

This study addresses the question of whether marriage after childbearing benefits the children involved, using a representative sample of children all born to unwed parents. Adopting the treatment outcome framework to account for parental self-selection into marriage, we find evidence of a causal effect of parents' marriage on the cognitive development of children whose parents marry within three years after childbirth. Compared to children of unmarried parents who share similar background characteristics and mate-selection patterns, children whose parents marry score about four points higher on the Peabody Picture Vocabulary Test at age three, which may translate into up to two percentage points greater odds of the child eventually receiving a high school degree.

While our findings support the idea that marriage after childbearing benefits the children involved, the results also suggests that such benefits do not necessarily apply for all children born out-of-wedlock. We find that parents who marry after having children are selectively different from persistently unmarried parents, and, in particular, that those couple who can realize the largest benefits from marriage for their child are also more likely to get married. While it is well documented that couples who marry before having children are more socioeconomically advantaged and assortatively matched compared to unwed parents, we find evidence that among unwed couples with children, those who are relatively less well acquainted and potentially more poorly matched are more likely to transition into marriage within three years after the child's birth. Their children may face larger gains from marriage through economies of scale in joint production, and the legal bond of marriage may generate additional incentives to allocate a greater share of the available resources towards their children.

Our finding that the benefits to marriage for the child are greater among families where the parents are more likely to get married is consistent with economic theories of out-of-wedlock childbearing by Willis (1999) and gains to marriage as in Becker (1973; 1974) and Weiss and Willis (1997). Unmarried parents tend to be less well matched than parents who have children within marriage since the incentive for assortative mating is lower in the absence of specialization. Conditional on having a child, unmarried couples who see higher gains to marriage (relative to the alternative of staying unmarried) will be more likely to get married, while couples who see little gains to getting married remain single.[41] Hence, programs to promote marriage provide incentives that are likely in addition to private incentives that are aligned with this objective and marital behavior consistent with the child's interest.

While further research into the mechanisms through which parents' marriage benefits out-of-wedlock children is needed, our findings provide some evidence that even after ruling out potential gains through resource pooling and specialization, children benefit from having married parents as they can exploit economies of scale through joint production. In addition, marriage may induce parents to allocate a greater fraction of family resources towards their children. However, because we do not directly observe potential differences in the intra-household production and allocation of inputs for children across married and unmarried families, we cannot distinguish whether the marital gains found is attributable to either one (or both) of these two channels. If the gains are due to economies of scale, encouraging unwed parents to establish a joint household, which improves input-production efficiencies, should be endorsed. If the lack of legal protection lessens the incentives to invest in children (perhaps due to the lack of guarantees that their resources will be used optimally, or that they will be able to enjoy the returns of their investments), extending legal protection and responsibility to unmarried biological parents (in particular fathers) may aid the allocation of resources towards out-of-wedlock children.

Although we find that out-of wedlock children benefit from the marriage of their parents, the parents are also found to be less well assortatively matched, which has been associated with relationship instability and higher risk of dissolution. Given that parental separation/divorce have been found to negatively affect child outcomes, the adverse effects of parental relationship dissolution in the long run may eventually outweigh the positive effect of marriage in the short run. Because the time span covered by FFCWS is relatively short and these children are young, we cannot readily explore to what extent marital dissolution would offset the observed marital benefits. Given our focus on children born out-of-wedlock, the findings presented here do not readily speak to whether the large differences in child outcomes typically found between children born to married *vs.* unmarried parents should be interpreted as causal effects of marriage. We note that, although the FFCWS includes children born to married parents, an application of the potential outcome approach to assess the effect of marriage between children born to married *vs.* unmarried parents is infeasible since information on these parents before childbirth is very limited.

REFERENCES

Aassve, A. "The Impact of Economic Resources on Premarital Childbearing and Subsequent Marriage among Young American Women." *Demography,* 40(1), 2003, 105–26.

Astone, N.M., and S.S. McLanahan. "Family Structure, Parental Practices and High School Completion." *American Sociological Review,* 56(3), 1991, 309–20.

Bauman, K.J. "Shifting Family Definitions: The Effect of Cohabitation and Other Nonfamily Household Relationships on Measures of Poverty." *Demography,* 36(3), 1999, 315–25.

Becker, G.S. "A Theory of the Allocation of Time." *Economic Journal,* 75(299), 1965, 493–517.

Becker, G.S. "A Theory of Marriage: Part I." *Journal of Political Economy,* 81(4), 1973, 813–46.

Becker, G.S. "A Theory of Marriage: Part II." *Journal of Political Economy,* 82(2), 1974, S11–S26.

Becker, G.S. *A Treatise on the Family.* (Enl. Ed.) Cambridge, MA: Harvard University Press, 1991.

Becker, S.O., and A. Ichino. "Estimation of Average Treatment Effects Based on Propensity Scores." *The Stata Journal,* 2(4), 2002, 358–77.

Blau, D.M. "The Effect of Child Care Characteristics on Child Development." *Journal of Human Resources,* 34(4), 1999, 786–822.

Brown, S. "Child Well-Being in Cohabiting Families," in: *Just Living Together: Implications of Cohabitation on Families, Children, and Social Policy,* edited by Booth, A., and A. Crouter. Manwah, NJ: Lawrenc Erlbaum Associates, 2002, 173–87.

Brown, S. "Family Structure and Child Well-Being: The Significance of Parental Cohabitation." *Journal of Marriage and The Family,* 66(2), 2004, 351–67.

Brown, S., and A. Booth. "Cohabitation versus Marriage: A Comparison of Relationship Quality." *Journal of Marriage and the Family,* 58(3), 1996, 668–79.

Bulcroft, R., D. Carmody, and K. Bulcroft. "Family Structure and Patterns of Independence Giving to Adolescents." *Journal of Family Issues,* 19(4), 1998, 404–35.

Bumpass, L., and H.H. Lu. "Trends in Cohabitation and Implications for Children's Family Contexts in the United States." *Population Studies,* 54(1), 2000, 29–41.

Card, D. "The Causal Effect of Education on Earnings," in *Handbook of Labor Economics,* Vol. 3, Part 1, edited by O. Ashenfelter and D. Card. Amsterdam: Elsevier Science, 1999, 1801–63.

Carlson, M., and S. McLanahan. "Shared Parenting in Fragile Families." Paper presented at the Biennial Meetings of the Society for Research in Child Development, Minneapolis, M.N., 2001.

Carlson, M., S. McLanahan, and P. England. "Union Formation in Fragile Families." *Demography,* 41(2), 2004, 237–61.

Case, A., I. Lin, and S. McLanahan. "How Hungry is the Selfish Gene?" *Economic Journal,* 110(466), 2000, 781–804.

Cherlin, A.J., J. Griffith, and J. McCarthy. "A Note on Maritally-Disrupted Men's Reports of Child Support in the June 1980 Current Population Survey." *Demography,* 20(3), 1983, 385–89.

Cherlin, A.J. *Marriage, Divorce, Remarriage,* (Rev. and Enl. Ed.). Cambridge, MA: Harvard University Press, 1992.

Coleman, J. "Social Capital in the Creation of Human Capital." *American Journal of Sociology,* 94, 1988, S95–S120.

Dehejia, R., and S. Wahba. "Causal Effect in Nonexperimental Studies: Reevaluation of the Evaluation of Training Programs." *Journal of the American Statistical Association,* 94(488), 1999, 1053–62.

DeLeire, T., and A. Kalil. "How Do Cohabiting Couples with Children Spend Their Money?" *Journal of Marriage and the Family,* 67(2), 2005, 286–95.

Drewianka, S. "How Will Reforms of Marital Institutions Influence Marital Commitment? A Theoretical Analysis." *Review of Economics of the Household,* 2(3), 2004, 303–23.

Dunn, M.L., and L. Dunn. *Peabody Picture Vocabulary Test—Revised (PPVT-R).* Circle Pines, MN: American Guidance Service, 1981.

Durst, R. "Ties that Bind: Drafting Enforceable Cohabitation Agreements." *New Jersey Law Journal,* 147, 1997, S13–S14.

Epstein, E., and R. Guttman. "Mate Selection in Man: Evidence, Theory, and Outcome." *Social Biology,* 31, 1984, 243–78.

Furstenberg, F.F., Jr., J. Brooks-Gunn, and S.P. Morgan. *Adolescent Mothers in Later Life,* Cambridge, UK: Cambridge University Press, 1987.

Garfinkel, I., and D. Oellerich. "Noncustodial Fathers' Ability to Pay Child Support." *Demography,* 26(2), 1989, 219–33.

Garfinkel, I., S.S. McLanahan, and T.L. Hanson. "A Patchwork Portrait of Nonresident Fathers," in *Fathers Under Fire,* edited by I. Garfinkel, S. McLanahan, D. Meyer, and J. Seltzer. New York: Russell Sage Foundation, 1998, 31–60.

Garfinkel, I., D. Glei, and S.S. McLanahan. "Assortative Mating among Unmarried Parents: Implications for Ability to Pay Child Support." *Journal of Population Economics,* 15(3), 2002, 417–32.

Garfinkel, I. and S.S. McLanahan. "Strengthening Fragile Families," in *One Percent for the Kids: New Policies, Brighter Futures for America's Children,* edited by I. Sawhill. Washington D.C.: Brookings Institution, 2003, 76–92.

Graefe, D.R., and D.T. Lichter. "Life Course Transitions of American Children: Parental Cohabitation, Marriage, and Single Motherhood." *Demography,* 36(2), 1999, 205–17.

Graef, D.R., and D.T. Lichter. "Marriage Among Unwed Mothers: Whites, Blacks, and Hispanics Compared." *Perspectives on Sexual and Reproductive Health,* 34(6), 2002, 286–93.

Hamilton, W.D. "The Genetical Evolution to Social Behavior." *Journal of Theoretical Biology,* 7(1), 1964, 1–52.

Hamilton, G. "Property Rights and Transaction Costs in Marriage: Evidence from Prenuptial Contracts." *Journal of Economic History*, 59(1), 1999, 68–103.

Heckman, J.J., and R. Robb Jr. "Alternative methods for evaluating the impact of interventions: An overview." *Journal of Econometrics,* 30(1), 1985, 239–67.

Heckman, J.J., and V.J. Hotz. "Choosing Among Alternative Nonexperimental Methods for Estimating the Impact of Social Programs: The Case of Manpower Training." *Journal of The American Statistical Association,* 84, 1989, 862–80.

Heckman J.J., H. Ichimura, and P. Todd. "Matching as an Econometric Evaluation Estimator: Evidence from Evaluating a Job Training Programme." *Review of Economic Studies,* 64(4), 1997, 605–54.

Heckman J.J., H. Ichimura, and P. Todd. "Matching as an Econometric Evaluation Estimator." *Review of Economic Studies,* 65(2), 1998, 261–94.

Heckman, J.J., R.J. LaLonde, and J.A. Smith. "The Economics and Econometrics of Active Labor Market Programs," in *Handbook of Labor Economics,* Vol. 3A, edited by O. Ashenfelter and D. Card. Amsterdam: Elsevier Science, 1999, 1865-2097.

Heiland, F., and S.H. Liu. "Family Structure and Wellbeing of Out-of-Wedlock Children: The Significance of the Biological Parents' Relationship." *Demographic Research,* 15(4), 2006, 61–104.

Hofferth, S.L. "Women's Employment and Care of Children in the United States," in: *Women's Employment in a Comparative Perspective,* edited by T. Van der Lippe and L. Van Dijk. New York: Aldine de Gruyter, 2001, 151–74.

Hofferth, S.L., and K. Anderson. "Are All Dads Equal? Biology versus Marriage as a Basis for Paternal Investment." *Journal of Marriage and the Family,* 65(1), 2003, 213–32.

Imbens, G. "Nonparametric Estimation of Average Treatment Effects Under Exogeneity: A Review." *Review of Economics and Statistics,* 86(1), 2004, 4–29.

Jaffe, K., and G. Chacon-Puignau. "Assortative Mating: Sex Differences in Mate Selection for Married and Unmarried Couples." *Human Biology,* 67(1), 1995, 111–20.

Kenney, C. "Cohabiting Couple, Filing Jointly? Resource Pooling and U.S. Poverty Policies." *Family Relations,* 53(2), 2004, 237–47.

Lam, D. "Marriage Markets and Assortative Mating with Household Public Goods: Theoretical Results and Empirical Implications." *Journal of Human Resources,* 23(4), 1988, 462–87.

Lechner, M. "A Note on the Common Support Problem in Applied Evaluation Studies." Discussion Paper 2001-01, Department of Economics, University of St. Gallen, 2001.

Lerman, R. "How do Marriage, Cohabitation, and Single Parenthood Affect the Material Wellbeing of Families with Children?" Urban Institute Working Paper, Washington D.C., 2002.

Levine, D.I., and G. Painter. "The Schooling Costs of Teenage Out-of-Wedlock Childbearing: Analysis with a Within-School Propensity-Score-Matching Estimator." *Review of Economics and Statistics,* 85(4), 2003, 884–900.

Lundberg, S., and R.A. Pollak. "Bargaining and Distribution in Marriage." *Journal of Economic Perspectives,* 10(4), 1995, 139–58.

Maccoby, E.E., and J.A. Martin. "Socialization in the Context of the Family: ParentChild Interaction," in *Handbook of Child Psychology: Socialization, Personality, and Social Development,* Vol. 4., edited by P.H. Mussen and E. M. Hetherington. New York: Wiley, 1983, 1–101.

Mahoney, M. "The Economic Rights and Responsibilities of Unmarried Cohabitants," in *Just Living Together: Implications of Cohabitation on Families, Children, and Social Policy,* edited by A. Booth and A. Crouter. Mahwah, N.J.: Lawrence Erlbaum, 2002, 247–54.

Manser, M., and M. Brown. "Marriage and Household Decision-Making: A Bargaining Analysis." *International Economic Review,* 21(1), 1980, 31–44.

Manning, W., and S. Brown. "Children's Economic Well-Being in Cohabiting Parent Families." Center for Family and Demographic Research Working Paper No. 03-05, 2003.

Manning, W., P. Smock, and D. Majumbar. "The Relative Stability of Cohabiting and Marital Unions for Children." *Population Research and Policy Review,* 23(2), 2004, 135–59.

Mare, R. "Five Decades of Educational Assortative Mating." *American Sociological Review,* 56(1), 1991, 15–32.

McElroy, M.B., and M.J Horney. "Nash-Bargained Household Decisions: Toward a Generalization of the Theory of Demand." *International Economic Review,* 22(2), 1981, 333–49.

McElroy, M.B. "The Empirical Content of Nash-Bargained Household Behavior." *Journal of Human Resources,* 25(4), 1990, 559–83.

McLanahan, S. "Family Structure and the Reproduction of Poverty." *American Journal of Sociology,* 90(4), 1985, 873–901.

McLanahan, S., and G. Sandefur. *Growing Up with a Single Parent: What Hurts, What Helps.* Cambridge, MA: Harvard University Press, 1994.

Meyer, D.R., and S. Garasky. "Custodial Fathers: Myths, Realities, and Child Support Policy." *Journal of Marriage and the Family,* 55(1), 1993, 73–89.

Michael, R.T. "Education in Nonmarket Production." *Journal of Political Economy,* 81(2), 1973, 306–27.

Miller, C., I. Garfinkel, and S. McLanahan. "Child Support in the U.S.: Can Fathers Afford to Pay More?" *Review of Income and Wealth,* 43(3), 1997, 261–81.

Nock, S. "The Consequences of Premarital Fatherhood." *American Sociological Review,* 63(2), 1998, 250–63.

Oppenheimer, V.K. "A Theory of Marriage Timing." *American Journal of Sociology,* 94(3), 1988, 563–91.

Oropesa, R., N. Landale, and T. Kenkre. "Income Allocation in Marital and Cohabiting Unions: The Case of Mainland Puerto Ricans." *Journal of Marriage and Family,* 65(4), 2003, 910–26.

Osborne, C., S. McLanahan, and J. Brooks-Gunn. "Young Children's Behavioral Problems in Married and Cohabiting Families." Center for Research on Child Well-Being Working Paper No. 03-09-FF, 2003.

Osborne, C., and S. McLanahan. "The Effects of Partnership Instability on Parenting and Young Children's Health and Behavior." Center for Research on Child Well-Being Working Paper No. 04-16-FF, 2004.

Osborne, C. "Marriage following the Birth of a Child of Cohabiting and Visiting Parents." *Journal of Marriage and The Family,* 67(1), 2005, 14–26.

Painter, G., and D.I. Levine. "Family Structure and Youth's Outcomes." *Journal of Human Resources,* 35(3), 2000, 525–49.

Paull, G., I. Walker, and Y. Zhu. "Child Support Reform: Some Analysis of the 1999 White Paper." *Fiscal Studies,* 21(1), 2000, 105–40.

Pollak, R.A. "A Transaction Cost Approach to Families and Households." *Journal of Economic Literature,* 23(2), 1995, 581–608.

Reichman, N., I. Garfinkel, S. McLanahan, and J. Teitler. "The Fragile Families: Sample and Design." *Children and Youth Services Review,* 23(4/5), 2001, 303–26.

Ribar, D.C. "What Do Social Scientists know About the Benefits of Marriage? A Review of Quantitative Methodologies." IZA Discussion Paper No. 998, 2004.

Rockwell, R. "Historical Trends and Variations in Educational Homogamy." *Journal of Marriage and the Family,* 38(1), 1976, 83–95.

Rosenbaum, P.R., and D.B. Rubin. "The Central Role of the Propensity Score in Observational Studies for Causal Effects." *Biometrika*, 70(1), 1983, 41–55.

Rosenzweig, M.R. "Welfare, Marital Prospects, and Nonmarital Childbearing." *Journal of Political Economy,* 107(6), 1999, S3–S32.

Rubin, D.B. "Using Multivariate Matched Sampling and Regression Adjustment to Control Bias in Observation Studies." *Journal of the American Statistical Association,* 74(366), 1979, 318–28.

Shaw, K. "The Quit Propensity of Married Men." *Journal of Labor Economics,* 5(4), 1987, 533–60.

Sigle-Rushton, W., and S. McLanahan. "For Richer or Poorer: Marriage as Poverty Alleviation in the United States?" *Population,* 57(3), 2002a, 509–28.

Sigle-Rushton, W., and S. McLanahan. "The Living Arrangements of New Unmarried Mothers." *Demography,* 39(3), 2002b, 415–33.

Silverman, B.W. *Density Estimation,* London: Chapman and Hall, 1986.

Sorenson, E. "A National Profile of Nonresident Fathers and Their Ability to Pay Child Support." *Journal of Marriage and the Family,* 59(4), 1997, 785–97.

Thomson, E., T.L. Hanson, and S. McLanahan. "Family Structure and Child Wellbeing: Economic Resources vs. Parental Behaviors." *Social Forces,* 73(1), 1994, 221–42.

Waite, L.J. and M. Gallagher. *The Case for Marriage: Why People are Happier, Healthier, and Better Off Financially.* New York: Broadway Books, 2000.

Washington, J., and H. Craig. "Performances of At-Risk, African American Preschoolers on the Peabody Picture Vocabulary Test-III." *Language, Speech, and Hearing Services in Schools*, 30(1), 1999, 75-82.

Weiss, Y., and R.J. Willis. "Match Quality, New Information, and Marital Dissolution." *Journal of Labor Economics,* 15(1), 1997, S293–S329.

Willis, R.J., and J.G. Haaga. "Economic Approaches to Understanding Nonmarital Fertility." *Population and Development Review,* 22, 1996, 67–86.

Willis, R.J. "A Theory of Out-of-Wedlock Childbearing." *Journal of Political Economy,* 107(6), 1999, S33–S64.

Winkler, A. "Economics Decision-Making by Cohabitors: Findings Regarding Income Pooling." *Applied Economics,* 29(8), 1997, 1079–90.

Wu, L.L. "Effects of Family Instability, Income, and Income Instability on the Risk of a Premarital Birth." *American Sociological Review,* 61(3), 1996, 386–406.

Ziol-Guest, K., K. Kalil, and T. Deleire. "Expenditure Decisions in Single-Parent Households." in *Family Investments in Children: Resources and Parenting Behavior that Promote Success,* edited K. Kalil and T. Deleire. Mahwah, NJ: Erlbaum, 2004, 181–208.

Captions:

Figure 1: Box Plot of the Propensity Score Overlap

Appendix Figure 1: Distribution of the Estimated Propensity Score

Appendix Figure 2: Box Plot of the Propensity Score (Relaxing the Common Support Condition)

Footnotes.

*Shirley H. Liu acknowledges financial support through the James W. McLamore Summer Awards in Business and the Social Sciences from the University of Miami. Helpful comments were received from Philip Robins, David Ribar, Gregory Acs, Andrew Cherlin, Elaina Rose, Scott Drewianka, Kristin Mammen, Joseph Sabia, Thomas Kniesner, Oscar Mitnik, Carlos Flores, Steffen Reinhold, and Al Holtmann.

Authors: Liu: Assistant Professor, Department of Economics, University of Miami, P.O. Box 248126, Coral Gables, FL 33124-6550. Phone 1-305-284-4738, Fax 1-305-284-6550, E-mail s.liu2@miami.edu. Heiland: Assistant Professor, Department of Economics and Center for Demography and Population Health, Florida State University, Tallahassee, FL 32306. Phone 1-850-644-7083, Fax 1-850-644-4535, E-mail fheiland@fsu.edu.

1. See Ribar (2004) for a sweeping review of this literature.

2. E.g., President Bush's Personal Responsibility and Welfare Reauthorization Act allocates a significant budget to programs promoting and stabilizing marriage. See Garfinkel et al. (2003) for a discussion.

3. Two recent studies use FFCWS to examine the determinants of marriage among unmarried parents. Carlson et al. (2004) examines the determinants of marriage between unwed parents within one year after childbirth; and Osborne (2005) explores differences in the determinants of marriage between cohabiting and single parents. However, neither study explores assortative mating patterns among these parents.

4. Finding a representative sample of nonresident fathers has proved extraordinarily difficult. In U.S. nationally representative surveys (e.g., CPS, NSFH, and SIPP), it has been estimated that more than one fifth and perhaps as many as one-half of nonresident fathers are "missing," i.e., not identified as fathers (Cherlin et al., 1983; Garfinkel et al., 1998; Sorenson, 1997). The problem is especially pronounced men who fathered children outside of marriage, more than half appear to be missing. Although longitudinal studies of divorced fathers offer a more complete picture, even these suffer from non-inclusion and non-response bias (Garfinkel et al., 1998).

5. This assumption is frequently made in estimating the potential economic contributions of nonresident fathers for their children (E.g., Garfinkel et al., 1998; Garfinkel and Oellerich, 1989; Miller et al., 1997; Sorenson, 1997; Paull et al., 2000).

6. Two recent studies examine the effects of parental relationship structure on early child outcomes using the FFCWS. Heiland and Liu (2006) examines how different types of parental relationship transitions affect child health and behavioral outcomes at age one; and Osborne et al. (2003) compares child behavioral outcomes at age three between persistently-married, cohabit then subsequently married, and persistently cohabiting parents. Neither study explicitly accounts for selection into marriage.

7. "Visiting" relationships refers to couples who are romantically involved but living separately.

8. The benefits of specialization may be greater for married couples than for cohabiting couples, since

specialization is riskier for women without a legal commitment.

9. Following Becker (1991), the pooling of all resources arises if the dominant decision-maker is altruistic or if the partners have the same objectives. However, if these assumptions are relaxed (e.g., McElroy, 1990; Manser and Brown, 1980; McElroy and Horney, 1981), one person's resources cannot be treated as common household income.

10. The extent to which available resources are allocated towards specific public goods depends on preferences and individual bargaining power. The latter reflects the opportunities a partner has outside the union (McElroy, 1990; Manser and Brown, 1980; McElroy and Horney, 1981).

11. The same applies for children in father-only households. Note that while the number of households with custodial fathers is on the rise (Meyer and Garasky, 1993), they remain the exception.

12. Single parents may be unable to perform the multiple roles and tasks required for childrearing, which can result in heightened stress levels and insufficient monitoring, demands, and warmth in their childrearing practices (Cherlin, 1992; Thomson et al., 1994; Wu, 1996). Brown (2004) suggests that conflicts over visitation may also encumber parenting effectiveness.

13. The Family Support Act of 1988 requires states to establish legal paternity for all births, apply child support formulas based on a father's resources, establish stronger collection procedures.

14. If a child is born out-of-wedlock and the father disputes paternity, the court determines paternity via DNA testing.

15. Becker (1973, 1974, 1991) showed that when (*i*) there are as many men as women, and/or (*ii*) women are in excess supply and lack the economic resources to bear children out-of-wedlock, an equilibrium assignment of matches between men and women occurs as all couples assortatively match to maximize the total gains across all possible matches, and all children will be born within marriage. Willis (1999) showed that when women are in excess supply and are economically self-reliant, another equilibrium in the marriage market exists: Women from the lower economic strata—those with incomes (traits) sufficient for childrearing but not to attract a high-income male to enter into marriage—would bear children out-of-wedlock. Some unmarried men can father these children at a low cost, as they are not expected to play an important role in childrearing.

16. The Instrumental Variables (IV) strategy provides an alternative to account for selection into marriage. However, finding a suitable instrument for marriage is difficult. State and local marriage restrictions have been used as instruments for marriage but are problematic for several reasons: (1) state and local marriage restrictions may not detect any effects on marriage if few people are close to the margin where these restrictions matter; (2) even if these policies have measurable effects on marriage, Ribar (2004) points out that they might only be enacted in areas with particular socioeconomic characteristics or as a result of concerns about local marriage and wellbeing trends; and (3) Card (1999) and Heckman et al. (1999) point out that instruments can also fail when there are differences across people in the effects of an event, like marriage, which subsequently affect people's decision-making. Consider the case in which there is exogenous variation in marriage restrictions across areas. In areas with burdensome restrictions, only people who foresee large gains to marriage will marry, while in areas with few

restrictions, even people who foresee smaller gains will marry. In this case, the size of the marriage effect varies systematically with the otherwise exogenous costs of marriage.

17. The unusually rich data on the determinants of marriage available in the FFCWS may also help to limit the extent of selection on unobservables. Potential bias from selection on unobservables is reduced to the extent that the X_i are proxying for unmeasured factors.

18. This rules out possible unobservables affecting both $C_i(0)$ and M_i. Our analysis utilizes the detailed individual and couple relationship characteristics available in the FFCWS to specify the marriage matching functions.

19. More specifically: $Pr(M_i = 0 \mid X_i = x) > 0$ for all x. This implies that individuals are matched only over the common support region of X_i where the treated and untreated group overlap.

20. This is simply to replace the unobserved outcomes of the treated had they not been treated with the outcomes of the untreated with the same X_i characteristics.

21. The regression equivalent of this procedure requires the inclusion of all the possible interactions between the observables X_i. Regression and matching approaches differ in the weighting schemes used to average estimates at different values.

22. This is the so-called *balancing property* of the propensity score.

23. Various methods exist to implement matching estimates, all based on the same strategy of pairing individuals but with different techniques for pairing or different weights given to counterfactual individuals. This study implements three derivatives of kernel matching: Uniform (i.e. radius), Epanechnikov and Gaussian kernels.

24. Matching can be done with or without replacement of the control units. Matching with replacement reduces bias but increase the variance. Here we use matching with replacement.

25. See Reichman et al. (2001) for a detailed descriptive of the study design and sampling methods.

26. Since the PPVT is based on receptive hearing of standard American English vocabulary, its cultural fairness has been debated. For example, see Washington and Craig (1999). Our analysis allows for racial and ethnic differences in verbal ability using information on both parents' race and ethnicity.

27. The reasons for non-involvement may be plentiful (e.g., separation, surrogacy, etc.), and cannot be identified in the data. The process of marriage and child investments among non-involved parents likely differs in fundamental ways from romantically involved parents, warranting an approach that models these processes separately, a task beyond the scope of this paper.

28. To ensure that exclusions of these observations do not result in a selected sample (i.e., if the tendency of under-reporting is correlated with the treatment), we construct missing indicators for each of these covariates and conduct t-tests of means for each of the missing indicators between the treated and control groups. None of the t-tests show significant differences in the prevalence of under-reporting across the two groups (results are available upon request).

29. This is consistent with Osborne (2005) who finds that cohabiting mothers are more likely to marry within one year after childbirth than mothers who were in visiting relationships at childbirth.

30. The PPVT scores are normalized against a national population with a mean of 100 and a variance of 15 points.

31. This is consistent with earlier findings by Carlson et al. (2004) using the FFCWS: Unwed parents of higher socioeconomic status are more likely to marry within one year after childbirth.

32. This is consistent with Osborne (2005), who finds that FFCWS parents who are of different racial backgrounds are more likely to marry within one year after childbirth.

33. The FFCWS provides information on the highest *level* of education attained. "More educated" refers to strictly higher *level* of educational attainment.

34. The statistics on labor earnings exclude unions in which at least one partner does not work.

35. This means that the average treatment effect on the treated (ATET) is assumed to be equivalent to the average treatment effect on the controls (ATEC).

36. The covariates X_i used in estimating the propensity score are identical to the fully-specified model (Model 5) in Table 3.

37. Estimating the propensity score using a logit model produces very similar results.

38. Graefe and Lichter (1999) use data from the National Longitudinal Survey of Youth (1979 Cohort) to examine women's propensity to marry after experiencing a premarital birth. They find a positive relationship between a woman's education and her likelihood of subsequently entering into marriage. However, their study does not examine potential disparities between the partners' education levels.

39. Following the algorithm proposed by Dehejia and Wahba (1999), observations are grouped into blocks defined based on the estimated propensity score and then the balancing property is tested within each block to ensure that the observables are sufficiently similar between the treated and controls within each block. Once the balance is achieved, the distributions of covariates X among the treated and control groups should be identical within each block. (For details of the test of the balancing property within each block, see Appendix Table 1). Figure 1 shows the box plot of the estimated propensity score within each block. The figure reveals that there is good overlap in terms of the propensity score within each block, while in the extreme bins there is only limited overlap. This can be expected since the number of treated units increases and the number of control units decreases at high values of the propensity score. Note that this does not generate bias in the estimates as long as the balancing property is satisfied.

40. Three of the five matching estimates are statistically different from the OLS at the 5% significance level or better.

41. For example, conditional on already having a child with a poorly matched partner, a mother may realize higher gains to getting married to the child's father (relative to staying unmarried) if (1) her

bargaining power within the relationship may be enhanced and more resources will be allocated towards her children within marriage, which may not be available/enforceable in the absence of a marital agreement, and (2) her outside option of attracting a better match as a single mother is low.

Abbreviations:

ATEC: Average Treatment Effect on the Controls
ATET: Average Treatment Effect on the Treated
CIA: Conditional Independence Assumption
CPS: Current Population Survey
DNA: Deoxyribonucleic Acid
FFCWS: Fragile Families and Child Wellbeing Study
IV: Instrumental Variables
NLSY: National Longitudinal Survey of Youth
NSFH: National Survey of Families and Households
OLS: Ordinary Least Squares
PPVT: Peabody Picture Vocabulary Test
PSM: Propensity Score Matching
SIPP: Survey of Income and Program Participation

TABLE 1
Sample Descriptives

	Sample Mean	[S.D.]	Parents' Marital Status (3 Years after Childbirth) **Married**	**Unmarried**
			(Mean)	(Mean)
Dependent Variable				
Child PPVT Score (Age 3)	84.91	[15.74]	87.37	84.30*
Parents' Relationship at Childbirth				
Cohabiting	0.637	[0.481]	0.813	0.597*
Visiting	0.363	[0.481]	0.187	0.403*
Child Characteristics				
Child is of low birth weight ($<$ 88 oz)	0.099	[0.298]	0.081	0.103
Child is female	0.469	[0.499]	0.490	0.464
Child's birth order (mother):				
- 1^{st}	0.342	[0.474]	0.323	0.345
- 2^{nd}	0.329	[0.470]	0.333	0.328
- 3^{rd} or higher	0.304	[0.460]	0.328	0.299
Parent's Demographic Characteristics				
Mother's age $<$ 20 at childbirth	0.242	[0.428]	0.177	0.257*
Father's age $<$ 20 at childbirth	0.119	[0.324]	0.063	0.132*
Mother's race/ethnicity:				
- white	0.156	[0.363]	0.214	0.143*
- black	0.575	[0.495]	0.367	0.623*
- Hispanic	0.243	[0.429]	0.388	0.210*
- other	0.025	[0.156]	0.031	0.023
Father's race/ethnicity:				
- white	0.115	[0.319]	0.192	0.097*
- black	0.615	[0.487]	0.414	0.661*
- Hispanic	0.238	[0.426]	0.369	0.208*
- other	0.032	[0.177]	0.025	0.034
Mother is foreign-born	0.058	[0.234]	0.116	0.045*
Father is foreign-born	0.179	[0.383]	0.192	0.176
Child's Household Income				
Income less than $10,000	0.219	[0.414]	0.137	0.239*
Income between $10,000 and $24,999	0.348	[0.477]	0.355	0.347
Income at least $25,000	0.433	[0.496]	0.508	0.415*
N	958		192	766

(Continued)

TABLE 1
Sample Descriptives

	Sample Mean	[S.D.]	Parents' Marital Status (3 Years after Childbirth) **Married**	**Unmarried**
			(Mean)	(Mean)
Parents' Education				
Mother's education:				
- high school diploma / GED	0.370	[0.483]	0.318	0.382^{+}
- some college	0.245	[0.430]	0.303	0.231^{*}
- bachelor & beyond	0.027	[0.161]	0.045	0.022
Father's education:				
- high school diploma / GED	0.385	[0.487]	0.333	0.397^{+}
- some college	0.224	[0.417]	0.242	0.219
- bachelor & beyond	0.024	[0.152]	0.076	0.012^{*}
Parents' Labor Market Activities				
Mother works	0.188	[0.391]	0.222	0.181
Mother's weekly hours of work	35.11	[9.065]	36.36	34.75
Mother's annual labor income:				
- less than $10,000	0.407	[0.493]	0.303	0.433
- between $10,000 and $24,999	0.467	[0.500]	0.545	0.448
- at least $25,000	0.126	[0.333]	0.152	0.119
Father works	0.824	[0.381]	0.909	0.804^{*}
Father's weekly hours of work	43.74	[11.29]	44.53	43.52
Father's annual labor income:				
- less than $10,000	0.295	[0.457]	0.242	0.311^{+}
- between $10,000 and $24,999	0.463	[0.499]	0.466	0.462
- at least $25,000	0.242	[0.429]	0.292	0.227
N	958		192	766

Notes: * Sample means between "children whose parents marry after childbirth" and "children whose parents remained unmarried" is statistically significantly different at the 5% level. $^{+}$ 10% level.

TABLE 2

Assortative Mating Patterns and Relationship Quality among Unmarried Biological Parents

	Marital Status 3 Years After Childbirth	
	Married	Unmarried
Age		
Father is younger than mother	19.57	19.57
Mean age difference[b]	2.880	2.539
Standard deviation of age difference[b]	5.220	4.936
Race / Ethnicity		
Mother and father of different race / ethnicity	15.79	14.25
Education		
Mother is more educated than father	29.17	27.01
Labor Income		
Mother's annual labor income exceeds father's labor income	2.43	2.24
Mother's annual labor income is between $10,000 and $24,999	62.50	45.83
Mother's annual labor income is at least $25,000	37.50	54.17
Other Characteristics		
Parents' have known each other for less than 6 months before pregnancy	14.58	11.49
Father suggested abortion during pregnancy	10.94	15.54^{+}
Mother is catholic	32.81	23.24^{*}
Mother attends religious activities frequently	22.92	15.27^{*}
N	192	766

Notes: [a] Percentages reported. [b] "Age Difference" is defined as "father's age − mother's age at childbirth". * Sample means between "parents who marry after childbirth" and "parents who remained unmarried" are statistically significantly different at the * 5% level, and + 10% level.

TABLE 3

Effect of Parents' Marriage after Childbirth on Child PPVT Score at Age 3 (OLS)

	Baseline Model	(1)	(2)	(3)	(4)	(5)
Parents married (by age 3)	**3.073***	**3.085***	**2.961***	**2.603***	**2.375***	**2.158**$^{+}$
	[1.277]	[1.263]	[1.250]	[1.176]	[1.205]	[1.224]
Basic controls		Yes	Yes	Yes	Yes	Yes
Child's household income			Yes	Yes	Yes	Yes
Mother's characteristics				Yes	Yes	Yes
Father's characteristics					Yes	Yes
Relationship characteristics						Yes
R^2	0.006	0.080	0.092	0.164	0.173	0.221
N	985	985	985	985	985	985

Notes: [a] Robust standard errors reported in brackets [-]. [b] Statistical significance reported: $*$ = 5% level, and $+$ = 10% level. [c] Sets of controls (not included unless indicated): "Basic controls" include parents' relationship status at childbirth, child gender, low birth weight, birth order, and mother's state of residence at childbirth; "Mother's/Father's characteristics" include age < 20, race/ethnicity, foreign-born, education, working, weekly hours of work, and labor income; "Relationship characteristics" includes father is younger than mother, both parents are white, both parents are Hispanic, both parents are of other race/ethnicity, mother is white (not father), mother is black (not father), mother is Hispanic (not father), mother is of other race/ethnicity (not father), mother is foreign-born (not father), father is foreign-born (not mother), both parents are foreign-born, father is less educated than mother, father is more educated than mother, length of time parents' had known each other before pregnancy, father suggested abortion during pregnancy, mother's PPVT score, mother is catholic, mother has no religious affiliation, mother attends religious activities frequently, prenatal smoking (mother), prenatal drinking (mother), mother works (not father), father works (not mother), both parents work, each parents' hours of work per week, mother's labor income exceeds father's, and maternal grandmother's education.

TABLE 4
Probit Estimates of the Propensity Score

	Coefficient	Robust Standard Error	$P > \|z\|$
Child is of low birth weight (< 88 oz)	−0.036	0.180	[0.840]
Child is female	0.022	0.103	[0.831]
Child's birth order (mother):			
- (Ref: 1^{st})			
- 2^{nd}	0.138	0.131	[0.294]
- 3^{rd} or higher	0.182	0.147	[0.217]
Mother's age < 20	−0.208	0.153	[0.171]
Father's age < 20	−0.192	0.210	[0.361]
Father is younger than mother	−0.058	0.140	[0.678]
Parents' race/ethnicity:			
- (Ref: both black)			
- both white	0.236	0.193	[0.222]
- both Hispanic	0.602	0.198	[0.002]
- both other	0.049	0.571	[0.931]
- mother is white, father is non-white	−0.033	0.250	[0.894]
- mother is black, father is non-black	−0.617	0.530	[0.244]
- mother is Hispanic, father is non-Hispanic	−0.460	0.255	[0.071]
- mother is other, father is non-other	0.199	0.659	[0.763]
Parents' region of birth:			
- (Ref: both U.S.)			
- mother is foreign-born, father is not	0.264	0.374	[0.481]
- father is foreign-born, mother is not	0.108	0.178	[0.543]
- both parents are foreign-born	0.489	0.266	[0.066]
Mother's education:			
- (Ref: less than HS)			
- H.S. diploma / GED	−0.399	0.210	[0.057]
- some college	−0.588	0.342	[0.086]
- bachelor & beyond	−0.857	0.553	[0.121]
Father's education:			
- (Ref: less than HS)			
- H.S. diploma / GED	0.291	0.203	[0.152]
- some college	0.509	0.341	[0.135]
- bachelor & beyond	1.917	0.554	[0.001]

(Continued)

TABLE 4
Probit Estimates of the Propensity Score

	Coefficient	Robust Standard Error	$P > \|z\|$
Father's education relative to mother's:			
- (Ref: same)			
- less	0.463	0.236	[0.050]
- more	−0.335	0.230	[0.145]
Child's household income:			
- (Ref: less than $10,000)			
- between $10,000 and $24,999	0.010	0.163	[0.950]
- at least $25,000	−0.020	0.170	[0.904]
Parents' labor force participation:			
- (Ref: neither parents work)			
- both parents work	−0.356	0.513	[0.488]
- only mother works	−0.137	0.622	[0.825]
- only father works	0.062	0.216	[0.775]
Mother's weekly hours of work	0.013	0.013	[0.311]
Father's weekly hours of work	0.007	0.003	[0.042]
Mother's labor income exceeds father's	−0.087	0.391	[0.824]
Length of parents' relationship before pregnancy:			
- (Ref: more than 2 years)			
- less than 6 months	0.354	0.163	[0.030]
- 6 months to 1 year	−0.202	0.171	[0.238]
- 1 to 2 years	0.113	0.129	[0.378]
Mother is catholic	−0.190	0.153	[0.212]
Mother has no religious affiliation	−0.005	0.160	[0.973]
Mother attends religious activities frequently	0.472	0.136	[0.001]
Father suggested abortion during pregnancy	−0.045	0.154	[0.770]
Maternal grandmother attained more than a high school education	0.125	0.135	[0.354]
Prenatal smoking (mother)	0.248	0.132	[0.060]
Prenatal drinking (mother)	−0.464	0.206	[0.024]
Parents in visiting relationship at childbirth	−0.486	0.128	[0.000]
Mother's PPVT score (Year 3)	0.015	0.006	[0.006]
Constant	−3.139	0.569	[0.000]
Log Likelihood $= -420$			
Pseudo $R^2 = 0.174$			
$N = 958$ (Treated = 192; Control = 766)			

Notes: [a] Additional controls for "mother's state of residence at childbirth" (14 state dummies) omitted here. [b] Region of Common Support $\in [0.02025512, 0.77094784]$.

FIGURE 1

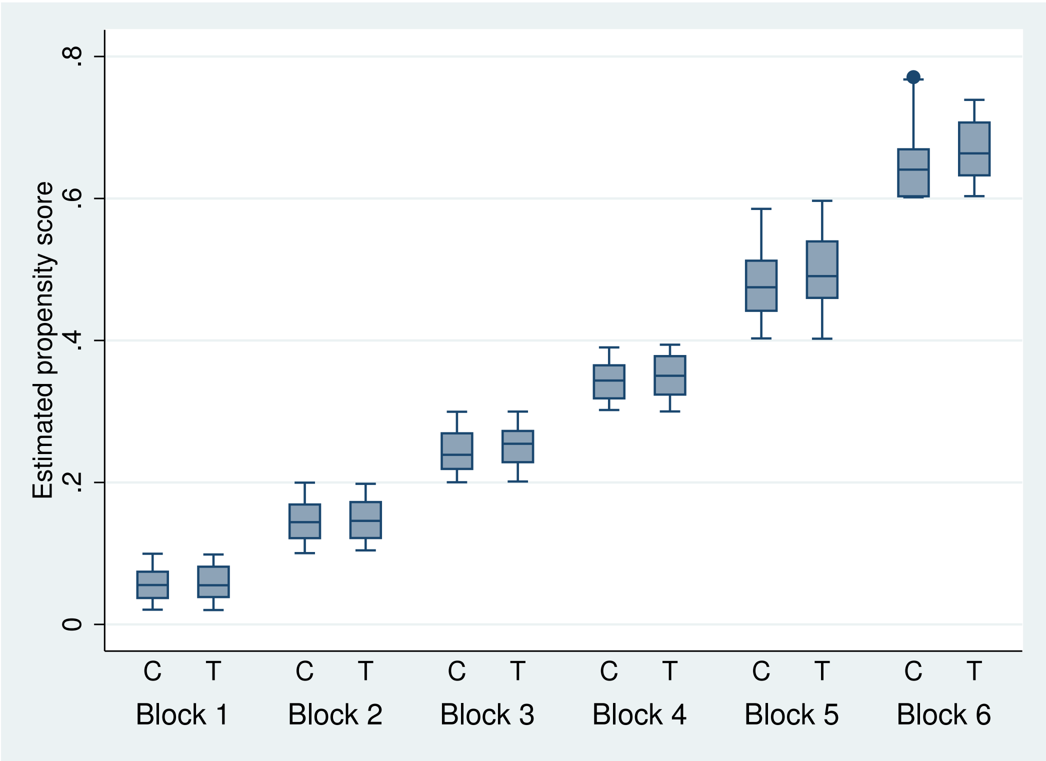

Estimated propensity score
0
.2
.4
.6
.8
C
T
Block 1
Block 2
Block 3
Block 4
Block 5
Block 6

TABLE 5

Effect of Parents' Marriage after Childbirth on Child PPVT Score at Age 3 (PSM)

	Matching Estimate	S.E.	*N* Treated	*N* Controls	% Matched Treated
Epanechnikov Kernel					
Bandwidth = 0.01	**3.500***	1.717	192	766	100
Bandwidth = 0.005	**4.366***	1.791	192	766	100
Gaussian Kernel	**3.610***	1.830	192	766	100
Radius					
Radius = 0.01	**3.524***	1.404	189	765	98
Radius = 0.005	**3.914***	1.487	182	697	95
N Treated (Total)= 192					
N Controls (Total)= 766					

Notes: [a] Standard errors are obtained by bootstrap with 500 replications. [b] Propensity score is re-estimated at each replication of the bootstrap procedure to account for the uncertainty associated with the estimation of the propensity score; [c] Estimated propensity score in region of common support $[0.02025512, 0.77094784]$, which is defined by the minimum estimated propensity score within the treatment group, and the maximum estimated propensity score within the control group; [d] The propensity score is estimated using a probit model with the same five sets of controls as employed in Model (5) in Table 3 (refer to the notes in Table 3 and the explanation in the text for details); [e] Refer to Appendix Table 1 for details of tests of the "balancing properties" between the treated and controls with respect to each covariate.

TECHNICAL APPENDIX

Matching Estimators

Let T and C be the set of treated and untreated individuals, respectively. The observed outcome of a treated individual be denoted Y_i^T, and Y_j^C denotes the observed outcome of an individual in the control group. Let $C(i)$ be the set of control individuals matched to the treated individual i with an estimated propensity score p_i.

In general, the *Kernel matching* matched all treated observations with a weighted average of all control observations with weights that are inversely proportional to the distance between the propensity scores of treated and controls. The *kernel matching estimator* is given by:

$$\tau^k = (1/N^T)\sum_{i\in T}[Y_i^T - [(\sum_{j\in C} Y_j^C K((p_j - p_i)/h_n))/(\sum_{k\in C} Y_j^C K((p_k - p_i)/h_n))]]$$

where $K(\cdot)$ is a kernel function and h_n is a bandwidth parameter. In this study we consider three matching estimators, namely *Uniform* (also known as the "radius" matching estimator), *Epanechinikov*, and *Gaussian* kernels, each uses a specific kernel function:

- **Epanechinikov:** $K(u) = (3/4)(1-u)^2$ for $|u| < 1$, and 0 otherwise
- **Gaussian:** $K(u) = (1/\sqrt{2\pi})exp[-u^2/2]$ for all u
- **Uniform (Radius):** $K(u) = 1/2$ for $|u| < 1$ and 0 otherwise

Under the standard conditions on the bandwidth and kernel,

$$\sum_{j\in C} Y_j^C K((p_j - p_i)/h_n)/\sum_{k\in C} Y_j^C K((p_k - p_i)/h_n)$$

is a consistent estimator of the counterfactual outcome Y_{0i}.

Choosing the Bandwidth

Silverman's rule-of-thumb (1986) may be used to select the optimal bandwidth:

$$\widehat{h} = 1.06 \times Min\{\widehat{\sigma}, R/1.34\} \times n^{-\frac{1}{5}}$$

where $\widehat{\sigma}$ = sample standard deviation, R = interquartile range (75^{th}-quantile $-$ 25^{th}-quantile), and n = sample size. The method is based on the assumption that the underlying distribution of X (the propensity score) is normally distributed. The rule-of-thumb will give reasonable results for all distributions that are unimodal, fairly symmetric and do not have fat tails. However, the rule-of-thumb may not be applicable in our case as the distribution of the estimated propensity score is far from normal (see Appendix Figure 1). As a result, the bandwidth suggested by the rule-of-thumb may be far from optimal. If the choice of bandwidth is too large, the treated and their matches tend to differ more on observable characteristics. As a result, the matching estimates tend to converge to that produced by the OLS. Our matching estimates using the bandwidth suggested by the rule-of-thumb ($\widehat{h} \approx 0.040$) is very close to the OLS estimates. Hence, we choose smaller bandwidth(s) (0.010 and 0.005) to ensure closer matches between the treated and controls are used in the estimation.

Robustness Analysis

Relaxing the Common Support Condition. Our estimates are based on observations with propensity scores falling within the common support, to ensure that there are sufficient overlap between the treated and control units to enhance comparability, which may improve the quality of our estimates. A potential drawback of imposing the common support restriction is that high quality matches may be lost at the boundaries of the common support and the sample may be considerably reduced. Hence imposing the common support restrictions is not necessarily better (Lechner 2001). Imposing the common support condition results in 87 control and 6 treated units being dropped from our main analysis. To ensure that our estimates are sensitive to the inclusion of these observations, we relax the common support condition and re-estimate the ATET using all $1,051$ observations.

Appendix Figure 2 presents the box plot of the propensity score overlap for this sample. For treated individuals with high propensity scores (Block 7), there are no suitable controls (no overlap). In this case, treated observations with high propensity scores are potentially matched with control observations that are substantially different. This is particularly problematic for matching estimators that place positive weights on these "poor matches", such as the Gaussian kernel.[42] Overall, with the exception of the Gaussian kernel estimate, the ATET estimates obtained by relaxing the common support condition are similar to our main results (results available upon request).

Assessing the Conditional Independence Assumption. An identifying assumption of the matching method, namely CIA, requires that conditional on the observables, the distribution of the potential outcomes of the treated group in the absence of treatment is identical to the outcome distribution of the controls. Yet since the data are uninformative about the distribution of potential outcomes for the treated group in the absence of treatment, they cannot directly reject the CIA. Imbens (2004) proposes an indirect way of assessing its plausibility, relying on estimating a causal effect that is known to be zero. Specifically, the test involves estimating the causal effect of the treatment on a lagged outcome, with its value determined prior to the treatment itself. If it is not zero, this implies that the underlying conditional distribution of the potential outcomes of the treated under no treatment is not comparable to control outcomes.[43]

We estimate the "causal" effect of parents' marriage after childbirth on the child's birth weight. A child's birth weight is realized before the treatment can take place, and potentially correlated with the child's subsequent development. All of our matching estimates show that parents' marriage has no effect on child birth weight (results available upon request).

APPENDIX TABLE 1

Test of Balancing Properties between the Control and Treatment Group (Two-Sample T-Test of Means): T-statistics Reported

Range of the Propensity Score	Block 1 [0.020, 0.100]	Block 2 [0.100, 0.200]	Block 3 [0.200, 0.300]	Block 4 [0.300, 0.400]	Block 5 [0.400, 0.600]	Block 6 [0.600, 0.771]
N Treated	19	37	38	47	38	13
N Controls	286	223	134	75	38	10
	Two-Sample Test of Means: Significance Level $= 0.01$ $\lvert T \rvert$ **Statistic**					
Propensity Score	0.557	0.565	1.541	1.376	1.222	0.528
Child is of low birth weight ($<$ 88 oz)	0.042	1.471	0.293	1.454	1.021	0.186
Child is female	0.253	1.144	1.346	0.185	0.453	1.125
Child birth order (mother):						
- (Ref: 1^{st})						
- 2^{nd}	0.260	2.146	0.451	0.849	1.194	1.326
- 3^{rd} or higher	0.528	0.621	0.937	0.606	1.217	0.636
Mother's age ($<$ 20)	0.345	0.894	1.146	0.066	0.585	0.000
Father's age ($<$ 20)	0.478	0.254	1.072	0.186	1.021	0.000
Father is younger than mother	0.194	0.012	0.033	0.673	0.000	1.181
Parents' Race/Ethnicity:						
- (Ref: Both parents are black)						
- Both parents are white	1.223	0.470	1.076	0.703	1.526	1.181
- Both parents are Hispanic	0.718	0.052	1.395	1.070	0.230	0.762
- Both parents are of "other" race/ethnicity	1.565	0.884	1.207	0.790	0.000	1.148
- Mother $=$ white, Father $\neq$ non-white	0.869	0.562	0.445	0.686	0.583	1.288
- Mother $=$ black, Father $\neq$ non-black	0.737	0.619	0.000	0.000	0.000	0.000
- Mother $=$ Hispanic, Father $\neq$ non-Hispanic	0.222	0.246	1.189	0.588	0.000	1.288
- Mother $=$ other, Father $\neq$ other	0.447	1.099	0.927	0.790	1.434	1.148
Parents' Region of Birth:						
- (Ref: Both parents are born in U.S.)						
- Mother is foreign-born (not Father)	0.365	0.619	0.927	1.010	1.021	0.872
- Father is foreign-born (not Mother)	1.065	1.048	0.062	0.234	2.010	1.655
- Both parents are foreign-born	0.257	1.355	0.114	0.330	0.351	0.283
Child household income: (Ref: $<$ \$10,000)						
- between \$10,000 to \$24,999	0.825	0.236	0.071	0.751	0.944	1.678
- More than \$25,000	0.251	0.124	0.651	0.185	0.453	0.072
Parents' Educational Backgrounds:						
- (Ref: Mother's education: Less than HS)						

(Continued)

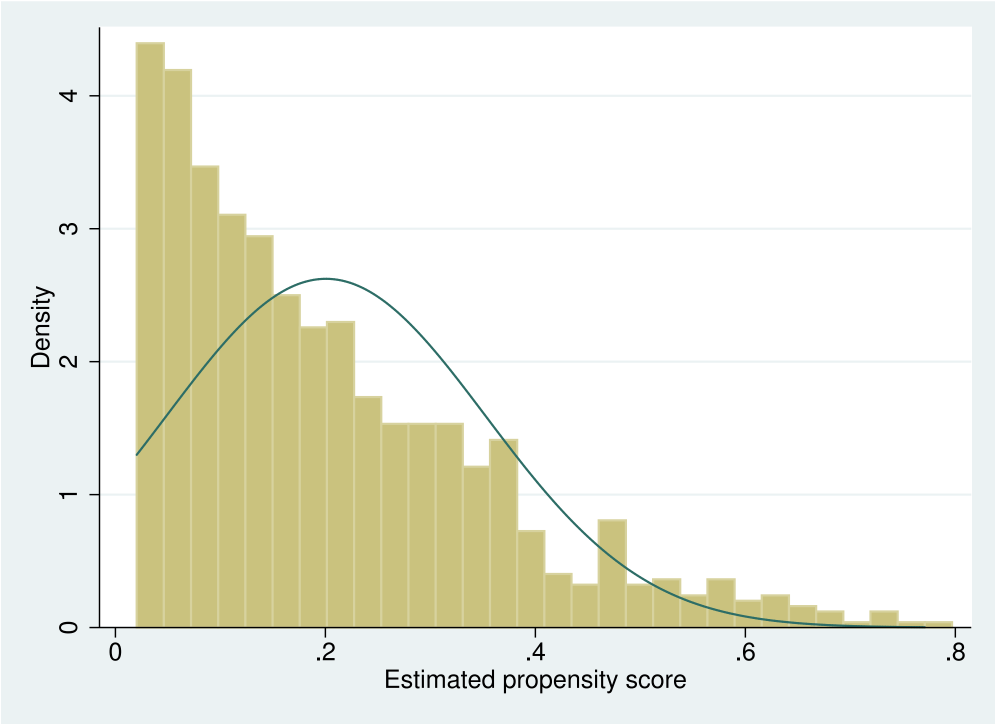
APPENDIX TABLE 1

Test of Balancing Properties between the Control and Treatment Group (Two-Sample T-Test of Means): T-statistics Reported

	Block 1	Block 2	Block 3	Block 4	Block 5	Block 6
	Two-Sample Test of Means: Significance Level $= 0.01$ $\lvert T \rvert$ **Statistic**					
- Mother's education: H.S. diploma / GED	1.359	0.750	1.576	0.406	0.788	0.170
- Mother's education: some college	0.298	0.600	2.452	1.056	0.712	1.338
- Mother's education: bachelor and beyond	0.580	0.372	0.114	0.561	0.583	1.288
- Father's education: H.S. diploma / GED	1.327	1.009	1.296	0.197	1.176	0.844
- Father's education: some college	0.150	0.694	0.211	1.204	0.534	1.148
- Father's education: bachelor and beyond	0.000	0.000	0.754	1.010	0.844	0.762
Mother's education relative to father's:						
- (Ref: Same)						
- Father is less educated than Mother	0.918	1.537	2.330	0.758	1.720	0.818
- Father is more educated than Mother	0.111	0.247	0.392	0.703	0.762	0.442
Parents' labor force participation:						
- (Ref: Neither parents work)						
- Both parents work	1.013	0.201	0.695	0.619	0.285	1.181
- Only Mother works	0.613	0.708	0.754	0.000	0.583	0.000
- Only Father works	1.199	0.389	0.634	0.543	0.000	1.181
Mother's weekly hours of work	0.387	0.316	0.785	0.731	0.029	1.131
Father's weekly hours of work	0.630	1.448	0.939	1.196	0.547	2.813
Mother's labor inc. $>$ Father's labor inc.	0.636	0.708	0.141	0.476	0.000	0.872
Length of parents' relationship prior to preg.						
- (Ref: $>$ 2 yrs)						
- $\leq$ 6 months	0.480	0.767	0.990	0.352	0.556	1.288
- 6 months $\sim$ 1 year	0.369	1.135	0.904	1.457	1.434	0.872
- 1 year $\sim$ 2 years	1.034	0.501	0.367	1.031	0.253	0.561
Mother is catholic	0.498	0.317	0.392	1.195	0.000	1.510
Mother has no religious affiliation	0.006	1.255	1.757	0.124	0.322	0.186
Mother attends religious activities (at least few times a week)	0.690	0.533	1.578	0.747	0.740	0.175
Father suggested abortion during pregnancy	1.002	1.438	0.014	0.351	0.392	0.000
Maternal grandmother's education (some college and beyond)	1.065	0.678	0.404	0.007	0.556	0.277
Prenatal smoking (mother)	1.551	0.753	2.020	0.624	0.556	0.818
Prenatal drinking (mother)	0.728	0.642	1.280	0.061	0.000	0.000
Parents in visiting relationship (baseline)	1.223	1.826	1.499	0.330	0.000	0.796
Mother's PPVT score (Measured at Year 3)	0.786	0.169	0.163	0.703	0.804	0.481

Notes: [a] $\lvert T \rvert$ statistics of the two-sample test of means for "mother's state of residence at baseline" (14 indicators) not reported here (available upon request).

APPENDIX FIGURE 1



APPENDIX FIGURE 2