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

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Abstract

Using a representative sample of children all born to unwed parents drawn from the Fragile Families and Child Wellbeing Study and a potential outcome approach to account for self-selection into marriage, we investigate whether marriage after childbearing has a causal effect on early child development. Comparing children with similar background characteristics and parental mate-selection patterns who differ only in terms of whether their parents marry after childbirth, we find that marriage after childbirth significantly increases a child's early cognitive performance but there is no evidence that it affects child asthma risk or child behavioral outcomes.

Keywords: Premarital Childbearing, Child Wellbeing, Marriage, Assortative Mating, Propensity Score Matching

JEL Classification codes: J12, J13, C3.

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1 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 American children born to unmarried 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). The decoupling of marriage and fertility behavior is particularly common among the low-income, less-educated urban population (McLanahan and Sandefur, 1994). Unmarried parents often have fewer resources, and their children tend to display inferior outcomes compared to those raised by two married parents.[1]

Concerned with the rise in out-of-wedlock parenthood and its implications for the children involved, recent policies have geared towards promoting marriage among unmarried parents.[2] However, 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 have lower incentives for assortative mating (Brown, 2004; Rosenzweig, 1999; Garfinkel et al., 2002). Hence, interpreting the outcome differences found in simple comparisons of children born to married *vs.* unmarried parents as benefits of marriage can be misleading, as these differences may largely reflect the more favorable characteristics of married parents.

This study examines whether marriage between the biological parents after childbearing benefits the children involved, using data on a representative sample of children all born to unmarried couples drawn from the Fragile Families and Child Wellbeing Study (FFCWS). The FFCWS is particularly well suited to address this question, as it provides child assessment data and detailed marriage, fertility, and socioeconomic information on both biological parents for a large representative sample of children born outside of marriage. We focus on the effect of marriage among parents who are romantically involved at childbirth on child cognitive ability measured at age three, based on scores from the Peabody Picture

[1] See Ribar (2006) for a recent review of this literature.

[2] For example, President Bush's Personal Responsibility and Welfare Reauthorization Act allocates a significant budget to programs promoting and stabilizing marriage.

Vocabulary Test (PPVT), a widely-used interviewer-administered measure of receptive hearing and verbal ability. In addition, effects of marriage on child health and behavioral outcomes are analyzed.

A significant fraction of children in our sample experience the marriage of their parents. We analyze whether marriage after childbearing affects early developmental outcomes using an empirical strategy centering around a potential outcome framework similar to an experiment where the treatment ("marriage after childbirth") is randomly assigned. We draw on matching methods (e.g., Rosenbaum and Rubin, 1983; Heckman et al., 1998) to identify the treatment effect, exploiting the detailed information on the parents provided in the FFCWS. This approach addresses the selection into marriage by constructing an 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 the outcomes of children whose parents share similar probabilities of marriage but differ only in whether their parents transitioned into marriage within three years after their birth.

The present study also sheds light on the role of typically unobserved factors likely to be important determinants of selection into marriage, including the father's attributes and the degree to which the parents have similar characteristics ("positive assortative matching"). While some studies have examined the determinants of (marital) union formation among the population of single mothers (e.g., Aassve, 2003), relatively little is know about the factors influencing the transition into marriage and the role of similarities in traits between unmarried biological parents.This is partly due to the lack of survey data on men who father children out-of-wedlock.[3]

Confronted with the "missing fathers problem," studies typically account for selection into marriage by controlling for the characteristics of the resident parent only (usually the mother) and implicitly assume that unmarried couples are strongly (positively) assortatively matched as it is the case for married parents. To the extent that the effect of parents' marriage on child wellbeing reflects the characteristics of both parents as well as the quality of the match, differences in the assortative mating patterns between unmarried parents and couples who marry before having children could lead to omitted variables

[3]Finding a representative sample of men who fathered children out-of-wedlock is extraordinarily difficult in large U.S. representative surveys: it has been estimated that more than half are missing (Garfinkel et al., 1998).

bias in the estimated effect of marriage after childbearing. The present study addresses this concern and investigates the role of parental match quality in marriage formation, utilizing the detailed information on the biological parents and their relationship available in the FFCWS.

Much of the existing evidence on the effects of family structure and child outcome stems from studies using data on school-age children and adolescents. Since unmarried families tend to be less stable and short-lived (e.g., Bumpass and Lu, 2000), previous findings may be more characteristic of children in relatively stable unmarried families. The present work seeks to identify the impact of marital transitions within the first three years after childbirth, thus drawing from the experiences and conditions of a broader (potentially more representative) segment of the population of unmarried families. The results suggest that parental marriage during the first three years after childbirth significantly increases child cognitive ability: children whose parents marry after childbirth score about four points ($1/4th$ of a standard deviation) higher on the PPVT than if their parents *had remained unmarried*. However, we find no evidence that marriage reduces the child's risk of developing asthma or behavioral problems.

2 Background

Benefits of Marriage

There are several reasons to expect a link between marriage and child wellbeing, all are related to either resource availability or allocation of resources. We will begin by considering mechanisms related to resource availability. First, marriage may involve the transition from a one to a two person household, boosting the resource endowments (e.g., time and skill) of the family. Second, couples can take advantage of economies of scale in household production (e.g., sharing the apartment). Third, couples can realize gains from specialization and exchange in the presence of comparative advantages, allowing them to produce more household public goods such as "child quality". Fourth, the two-parent household can pool individuals' financial resources and realize gains from exploiting risk-sharing opportunities (Becker, 1991). Fifth, individuals may become more productive as part of a family due to social learning (Waite and Gallagher, 2000). Finally, non-resident parents lack the ability to monitor the use of their transfers to the family, potentially resulting in suboptimal investments made toward their children (Willis, 1999).

Consistent with greater availability of material resources in marital unions, Brown (2002) finds that children residing in mother-only or cohabiting-parents households are more likely to live in poverty compared to children in married two-parent families. The differences in income may explain up to half of the differences in child wellbeing (McLanahan, 1985). Single parents may also be unable to perform the multiple roles and tasks required for childrearing. 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. The challenge of juggling multiple responsibilities can result in heightened stress levels and insufficient childrearing practices among single parents (Thomson et al., 1994). Conflicts over visitation may also encumber parenting effectiveness (e.g., Brown, 2004).

The potential benefits of marriage for resource availability discussed above are closely tied to the two-person household (e.g., economies of scale) and hence may extend to cohabiting unions as well. However, there are a number of institutional factors—including financial benefits and incentives to invest in children provided by the marriage and tax code—that are exclusive to marital unions (e.g., Hamilton, 1999). For example, the legal bond of marriage ensures that there is compensation for individuals' sacrifices made on behalf of the family, thereby encouraging partners to take advantage of specialization gains and pooling of financial resources, and foster more defined parental roles (e.g., Brown, 2004). Consistent with the incentives provided by these institutional differences, cohabitors have been found to be less likely to pool their incomes (e.g., Winkler, 1997) and single-parent and cohabiting families tend to allocate a smaller share of their budget towards child-related goods, such as education (Ziol-Guest et al., 2004; DeLeire and Kalil, 2005). 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. Social norms and family traditions affecting the intergenerational transfer of resources may also benefit marital unions more. For instance, Eggebeen (2005) finds that cohabiting couples are less likely than married couples to receive help from their parents.

This paper focuses on the effect of marriage between the biological parents on child wellbeing. 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 biological father may be more involved since the child can continue his family lineage and ascertain future intergenerational transfers (Case and McLanahan, 2000). Third, the biological father may be required by law to pay child support regardless of his relationship status with the mother.[4]

Selection into Marriage

Economic theories of marriage argue that individuals optimally select a mate to exploit the gains to marriage, subject to marriage market conditions and individual endowments (Becker, 1973; Lam, 1988; McElroy and Horney, 1981). Lam (1988) shows that individuals have an incentive to be positively assortatively matched with a partner when the production of household (public) goods requires the inputs of both partners ("joint production") and negatively assortatively matched in the presence of gains to specialization. Consistent with the importance of jointly produced goods in modern households (e.g., family activities), spouses are typically found to be similar in key attributes including age, race, education, and other socioeconomic characteristics (Epstein and Guttman, 1984).

However, little is known about the characteristics and mating patterns of couples who marry *after* having children. Willis (1999) argues that unmarried parents should have less favorable characteristics and be less (positively) assortatively matched than married parents. Consistent with this hypothesis, married parents have been found to be of higher socioeconomic status than unwed parents (Brown, 2004), and unmarried couples tend to be less (positively) assortatively matched (Garfinkel et al., 2002). As argued in Brown and Booth (1996), these differences in attributes may be a symptom of lower

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

relationship quality, with adverse effects on children, and may contribute to the greater instability found among unmarried parents relative to married parents.

Non-random selection into marriage complicates the estimation of the marriage effect. Simple comparisons of child outcomes by marital status can be misleading if couples who get married are different from those who remain unmarried in ways that also affect child investments. Given the limited understanding of the determinants of marriage among out-of-wedlock parents, the direction and magnitude of the potential selection bias in the estimated marriage effect is a priori ambiguous. For example, if couples with characteristics that benefit child development are also more likely to get married, 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, child wellbeing may be adversely affected as these parents face greater difficulties in realizing gains to specialization or coordinating the production of child quality.

3 Statistical Model and Estimation Strategy

Conceptual Model

Consider a (romantically involved) couple *i* that has a child out-of-wedlock. The interrelation of child outcomes, parental investments in children, and parents' marital status may be formalized as :

$$C_i = \beta M_i + \gamma X_i + \varepsilon_i \quad (1)$$

$$M_i = \delta X_i + \nu_i \quad (2)$$

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. Characteristics of couple *i* that influence their child investment and marital decisions are captured in X_i. Unobservables affecting C_i and M_i are captured by ε_i and ν_i, respectively.

The effect of marriage on child wellbeing is captured by β. However, estimating Eq. (1) directly may yield a biased estimate of β if M_i and ε_i are statistically dependent. This dependence can arise from two sources (Rosenbaum and Rubin, 1983; Heckman and Robb, 1985): first, couples' characteristics (child investments) may be correlated with unmeasured child endowments, i.e., X_i and ε_i are correlated; and second, bias may arise due to unobservable factors that affect both the child outcomes and the couple's marital status, i.e., correlation between ε_i and ν_i. The existence of either source of bias would likely show that children of married parents to have different outcomes from their peers whose parents remained unmarried, independent of any true causal effect of marriage on child outcomes.

Selection bias can arise in regression analysis as these estimators employ data from all observations to be combined into one estimate of the marriage effect. If parents who marry tend to differ markedly from parents who remained unmarried, the validity of the estimate would be suspect since the combining functions operate over very different families. Specifically, the marriage effect is identified by comparing the average outcome of children whose parents married to those with parents who did not. In the presence of any characteristics that affect the couples' decision to marry as well as child well-being, the resulting estimate will reflect both the "true" effect of parents' marriage on children whose parents married *and* effects of factors that influenced the parents' decision to marry in the first place.

This study builds on the potential outcome approach to investigate the effect of parents' marriage after childbearing on child outcomes. The relationship between parents' marriage and child outcomes is formulated in a framework similar to a social experiment in which the treatment is randomly assigned. In the present context, the "treatment" – parents' marriage – is defined in terms of the potential outcomes for children whose parents married (treated). We draw on matching methods (Rosenbaum and Rubin, 1983; Heckman and Robb, 1985) to construct the counterfactual outcomes for the treated in the absence of treatment, by matching the treated with controls (children whose parents remained unmarried) who share identical characteristics that rule selection into treatment. While our methodology addresses selection on observables but does not readily extend to selection on unobservables,[5] we rely

[5]The instrumental variables 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 of marriage if few people are close to the margin where these restrictions matter; (2) even if these policies have measurable effects on marriage, Ribar (2006) points out that they might only be enacted in areas with particular socioeconomic characteristics or

on the richness of the FFCWS to reduce selection bias generated by unobservables. The advantage of FFCWS is that it contains detailed information on both biological parents and their romantic involvement previously unavailable for out-of-wedlock children in large representative datasets, allowing us to account for many important determinants of marriage.

Potential Outcome Approach

Let the "treatment" be the marriage between the parents of child i after his/er birth: $M_i = 1$ denotes the "treatment group" (children whose parents marry), and $M_i = 0$ denotes the "control group" (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, $C_i = M_i C_i(1) + (1 - M_i) C_i(0)$ is the observed outcome of child i. The individual treatment effect, $\beta_i = C_i(1) - C_i(0)$, is unobserved since either $C_i(1)$ or $C_i(0)$ is missing.

Standard parametric methods (e.g. OLS) estimates the average treatment effect (ATE) by taking the average outcome difference between the treatment groups: $\beta_{OLS} = E[C_i(1)|M_i = 1] - E[C_i(0)|M_i = 0]$, the average of the treatment effect on the treated and the treatment effect on the controls. If many parents who remained unmarried are unlikely to ever marry, the ATE may not be particularly illuminating in answering how parents' marriage has affected children whose parents transitioned into marriage. An alternative is to focus on the average treatment effect on the treated (ATET):

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

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 observe the outcomes of children of married parents, and thus able to construct the first

as a result of concerns about local marriage and wellbeing trends; and (3) Card (1999) points 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.

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 to obtain information on the counterfactual outcome. Random assignment of couples into treatment would solve this problem but infeasible in this context. In this non-experimental setting, replacing $E[C_i(0)|M_i = 1]$ directly with $E[C_i(0)|M_i = 0]$ is inappropriate since union formation is likely non-random and many untreated may have characteristics that differ substantially from the treated.

Matching

Statistical matching is a way to construct a sample counterpart for the counterfactual outcomes of the treated had they not received treatment. Matching estimators can be devised to reconstruct the condition of an experiment by stratifying the sample with respect to covariates X_i that rule selection into treatment. Selection bias is eliminated provided all variables in X_i are measured and balanced (comparable) between the two treatment groups within each stratum. In this case, each stratum represents a separate randomized experiment and simple outcome difference between the treated and controls provide an unbiased estimate of the treatment effect.

Conditional Independence Assumption (CIA). An identifying assumption of the matching method is that all relevant outcome differences between the matched treated and controls are captured in their observed characteristics. The CIA requires that, conditional on observables X, the distribution of potential outcomes of the treated in the absence of treatment to be the same as the outcome distribution of the controls. Hence, conditional on X, the outcomes of children whose parents remained unmarried are what the outcomes of children of married parents *would have been* if their parents had remained unmarried.[6] The conditional response of the treated under no treatment can thus be estimated by the conditional mean response of the matched untreated.

[6] Moreover, it assumes that there are untreated units for each x: $Pr(M_i = 0 \mid X_i = x) > 0$ for all x. This implies that individuals are matched only over the common support region of X_i where the treated and untreated overlap.

Average Treatment Effect for the Treated (ATET). Following the CIA, the ATET can be computed as:

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

To estimate the ATET, one is to first take the outcome difference between the two treatment groups conditional on X, then average over the distribution of the observables in the treated population.

Conditioning on X within a finite sample can be problematic if the vector of observables is of high dimension, as the number of matching cells increases exponentially with the number of covariates in X. Rosenbaum and Rubin (1983) proposed using the *propensity score*, i.e. the conditional probability of selection into 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 same propensity score have the same distribution of X: $X_i \perp M_i \mid p(X_i)$ (known as the *balancing property* of the propensity score). 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, thus reducing the dimensionality problem into a single variable $p(X_i)$.

Matching treated and untreated units using their estimated propensity scores and placing them into one block (i.e., observations with propensity scores falling within a specific range) means that selection into treatment within each block is random and the probability of receiving treatment within this block 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 ATET at that value of $p(X_i)$.

Kernel Matching Estimators. Since $p(X_i)$ 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 (see Becker and Ichino, 2002).

Kernel matching matches all treated observations with a weighted average of all controls with weights that are inversely proportional to the distance between the propensity scores of the treated and controls, with the *Gaussian kernel* assigning weights that follows a normal distribution, and the *Epanechinikov kernel* following a triangular distribution. In *radius* matching (uniform kernel), each treated is matched only with controls whose propensity score fall within a predefined neighborhood ("radius") of its propensity score. All matches within this radius are assigned the same weight. If the dimension of the neighborhood is defined to be very small, it is possible that some treated units are not matched because the neighborhood does not contain any control units. Conversely, the smaller the size of the neighborhood the better the quality of the matches.

There are tradeoffs between the quantity and quality of the matches among these estimators but none is a priori superior. Relative to radius matching, Gaussian and Epanechinikov matching tend to produce higher quantity of matches; however, match quality may be poorer since treated units are potentially matched with distant controls. Nevertheless, their joint consideration offers a way to assess the robustness of our results.[7]

4 Data and Descriptive Evidence

Our study sample consists of 958 children born to romantically-involved unmarried parents drawn from the FFCWS. The FFCWS collected data on a cohort of $4,898$ births across 16 U.S. cities between 1998 to 2000. The weighted sample is representative of births in large U.S. cities in 1999. 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 again 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 PPVT is ad-

[7]Due to the small sample size, we employ matching with replacement. Matching with replacement reduces bias but increase the variance.

ministered to the child by the interviewer. The PPVT has been shown to be predictive of subsequent intellectual ability and achievement (Dunn and Dunn, 1981).

Sample Selection

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 survey ($2,530$ cases) are excluded. Second, we focus on children born to unmarried biological parents who were romantically involved at childbirth (i.e., either in cohabiting or visiting[8] unions): children born to married parents (508 cases) or not romantically involved parents (221 cases) are excluded. Third, to keep track of the history of parental relationship transitions, biological parents whose relationship status cannot be ascertained 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 marriage date contradicts with the reported marital status of the parents at childbirth are dropped (six cases). Another 23 cases are dropped due to missing information on important socioeconomic and demographic characteristics.[9] The resulting sample consists of $1,051$ children all born out-of-wedlock. Finally, we construct the "matched sample" by estimating the propensity score of selection into treatment within this sample. 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 of 958 children.[10]

Sample Descriptives

Table 1 presents summary statistics of the measures used in this study. Sample descriptives are first presented for the entire sample (columns 1 and 2), and columns 3 and 4 present the variable means for the treated and control groups, respectively. The main outcome measure is child cognitive ability,

[8]The FFCWS asks the parents to report their romantic involvement and living arrangements. "Visiting" parents refers to couples who are romantically involved but living separately.

[9]Our results are robust to the exclusion of these observations (available upon request).

[10]Our results are robust to the exclusion of observations outside of the common support region (available upon request).

measured by the child's standardized PPVT score administered at age three.[11] The mean PPVT score in our sample is 84.9. Relative to peers whose parents remained unmarried, children whose parents marry within three years after childbirth display significantly higher cognitive ability at age three.

Among children with parents who transition into marriage within three years after childbirth (20% of the sample): (1) 81% had cohabiting parents at birth, and (2) approximately half of their parents got married within the first year after childbirth (not shown). Among parents who remained unmarried by wave three (not shown), 53% remain romantically involved in either cohabiting or visiting relationships. Among parents who are no longer romantically involved with each other at wave three, 139 (38%) mothers report to be romantically involved with new partners.

Who Gets Married? Parents who marry after childbirth differ markedly from parents who remained unmarried (henceforth "persistently unmarried") in various dimensions: on average, they tend to be older, more educated, more likely to participate in the labor market, have higher earnings and household income. Unmarried parents who transitioned into marriage after childbearing also tend to be less assortatively matched relative to those who remained unmarried: they are more likely to differ in racial backgrounds, and the mother tends to be more educated than the father. While the descriptive assortative mating patterns are not statistically different by treatment status, they may be correlated with other characteristics of the partners which will to be addressed in a multivariate setting in the next section.

Parents who marry are more likely to have known their partner for less than six months prior to pregnancy, compared to persistently unmarried parents. These fathers are also less likely to have suggested abortion during pregnancy. Proposing abortion during pregnancy may indicate whether the pregnancy was planned; however, it may also reflect the father's attitudes towards abortion and marriage. Consistent with Thornton et al. (1992), we find that mothers who marry their child's father after childbirth are more likely to be Catholic and participate in religious activities frequently. This evidence is consistent with the proposition that for many parents who are potentially against abortion and/or face higher social stigma of raising children out-of-wedlock, an unintended pregnancy may provide a strong incentive to marry even if the quality of the partners' match is poor and/or uncertain.

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

5 Estimation Results

Estimating the Propensity Score of Marriage

The first step in implementing the matching method is to estimate the propensity score for selection into treatment under study, $p(X_i) = p(M_i = 1|X_i)$. The propensity score is defined as the probability of the parents transitioning into marriage within three years after childbirth. We estimate this process using a probit noting that other probability models yield similar results.

One issue is what covariates to include in the probit. We rely on the proposition by Rosenbaum and Rubin (1983), which asserts that conditional on the propensity score, the covariates are mean-independent of assignment into treatment, so that for observations with the same propensity score, the distribution of covariates should be the same across the treatment and control groups. Conditioning on the propensity score, each observation has the same probability of assignment into treatment, as in a randomized experiment. Following the algorithm proposed by Dehejia and Wahba (1999), for any given specification (we begin by including the simplest set of controls), observations are grouped into blocks defined by the estimated propensity score and check whether we succeed in balancing the covariates between the treated and controls within each block. If we are unable to find a partition structure in which the covariates are balanced, indicating that the specification does not fully capture the differences between the treated and controls , additional covariates are included until this condition is satisfied.

Parents' marriage decision may respond to children's favorable characteristics. For example, two well-documented regularities are the greater risk of divorce following the birth of a female child or a child with poor health (Lundberg et al., 2007; Reichman et al., 2004). Furthermore, unmarried parents in relatively stable relationships (cohabitors and couples with multiple children together) may be more likely to marry than new couples. In our simplest probit specification, we control for child gender, birth order, whether the child is of low birth weight (< 88 ozs),[12] and parents' baseline relationship status (cohabiting *vs.* visiting). Successively we add household income, mothers socioeconomic and demo-

[12]This is consistent with the definition of low birth weight in the medical literature.

graphic characteristics, and father's characteristics, respectively. Including additional covariates in X improves the fit of the propensity score model (pseudo R^2 increases from 0.075 to 0.165), but significant differences in covariate means between the treated and control groups remain, which constitutes a well-defined criterion for rejecting these more parsimonious specifications.

The covariate means are finally balanced when we additionally include parental assortative mating patterns and relationship characteristics.[13] Table 2 presents results of the balancing test between the treatment and control groups both before (column 1) and after stratifying the sample into blocks based on their estimated propensity scores (columns 2- 7). As expected, the treated and control groups differ substantially prior to matching. Post-matching (condition on the propensity score), however, the characteristics of the matched controls within each block resemble closely to that of the treated group, as the covariate means between the treated and control units within each block are statistically equivalent, showing that the balancing condition is satisfied.

Matching based on the full set of covariates results in a sample of 958 observations with propensity scores falling within the region of common support $[0.02025512, 0.77094784]$.[14] Figure 1 illustrates the diagnostic value of the propensity score within the common support. The figure shows that the treated and controls are comparable as there is sufficient overlap in their propensity scores 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.

Table 3 presents the probit estimates of the propensity score for the fully-specified model. Compared to persistently unmarried mothers (holding everything else constant), unwed mothers who marry their child's father after childbirth are significantly more likely to be more educated than the father. Weiss and Willis (1997) finds that the lack of positive assortative mating with respect to education, contributes to martial instability. The results also show that parents who marry after childbirth are

[13] Details of the balancing tests based on more parsimonious specifications and additional sensitivity analysis regarding the CIA assumption are available upon request.

[14] The lower bound of the common support is defined by the minimum propensity score within the treated group, and the upper bound is defined by the maximum propensity score of the control group.

more likely to have known each other for less than six months prior to pregnancy, to have been cohabiting at childbirth and to attend religious activities often (mother). These findings are consistent with the idea that among couples who have children out-of-wedlock, those who potentially face higher social barriers to raising children out-of-wedlock are more likely to transition into marriage, even though they may be less well-matched (assortatively).

Effect of Parents' Marriage after Childbearing on Child Cognitive Ability

Table 4 presents the estimated effect of parents' marriage after childbirth on child cognitive ability at age three measured by the PPVT score. We first report the OLS estimates: column 1 shows the unadjusted mean difference in the PPVT score between the (unmatched) treatment groups (i.e., OLS regression without any controls), and column 2 reports the mean outcome difference between the (unmatched) treatment groups after adjusting for the full set of controls. The PSM estimates based on the Gaussian, Epanechnikov, and uniform (radius) kernel matching estimators are reported in columns 3 - 7, respectively. To assess the sensitivity of the matching estimates to the choice of bandwidth (or radius), we report results using different bandwidths (or radii).[15]

On average, out-of-wedlock children whose parents marry score 3.073 points higher on the PPVT than their peers with persistently unmarried parents. Differences in observable parental and child characteristics partially explain the outcome differences between the treated and controls: the marriage effect estimated by the OLS is reduced to 2.158 after controlling for the full set of covariates, but remains statistically significant. While the matching estimates confirm the direction of the marriage effect implied by the parametric results, they suggest that parents' marriage increases the child's PPVT score by 3.5 to 4.4 points ($\approx 1/4th$ of a standard deviation) relative to *if the parents had remained unmarried*. Simple correlations we obtained based on a cohort of 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 high school graduation by two percentage points.

Selection into marriage partially explains the differences in child outcomes between out-of-wedlock

[15] Details on the choice of bandwidth are available upon request.

children whose parents later marry and those who do not. We note that the matching estimates are larger in magnitude and statistically different from the parametric estimates, indicating that the parametric estimate may be biased towards zero. This is consistent with economic theory of marriage (Becker, 1973, 1974): couples who can realize larger gains to marriage are more likely to marry, those who see little gains will remain unmarried.

Recall that many parents who transitioned into marriage exhibit characteristics that may not be conducive for a healthy marriage and potentially face higher risk of union dissolution. Becker et al. (1977) argues that as the union becomes less stable, fewer investments in the relationship or other public goods, such as children, are made. The finding that, on average, the outcome difference between a given treated child and a child in the control group who does not (necessarily) share similar disadvantages is smaller (OLS) than the outcome difference between the same treated child and a control child who does share these disadvantages (PSM) implies that at least for some children in the treated group, in particular those whose parents exhibit these disadvantaged characteristics, having their parents get married yields greater benefits relative to others in the treated group.

As discussed above, marriage may foster child wellbeing for a number of reasons including greater time and skill endowments, economies of scale, specialization, and greater incentives to allocate resources towards children. Differences in parental time and skill endowments are less plausible explanations, since we match children of married parents with children of unmarried parents who are similar regarding their relationship status at childbirth, levels of education, household income, labor force participation, and differentials in parents' traits. Given that some of these potential benefits to marriage should extend to cohabiting parents as well (e.g., economies of scale), we re-estimated the models excluding children whose parents do not co-reside at age three. The results indicate smaller cognitive outcome differences between the treated and controls with cohabiting parents, as shown in the bottom panel of Table 4. This pattern is consistent with the idea that the estimated benefits to marriage partly reflect resource gains that accrue when forming a two-parent household.

This subsample analysis results in a significantly reduced sample and increased standard errors of the marriage coefficients, causing the estimated marriage effects to be no longer statistically significant while remaining positive with a magnitude of about 2 points. Outcome differences between children of married *vs.* cohabiting parents may be attributable to the institutional and socio-cultural benefits of marriage. While unmarried parenthood is less stigmatized today, it still does not enjoy the same legal and social recognition as childrearing within marriage (Durst, 1997; Mahoney, 2002). Without the marriage contract parents face fewer incentives to take advantage of gains to specialization and to allocate resources towards a child. Consistent with this, compared to families with married parents, cohabiting and single-parent families tend to devote a smaller share of the family budget to their children (Ziol-Guest et al., 2004; DeLeire and Kalil, 2005), spent less time with their children (Hofferth and Anderson, 2003), and face greater difficulties in monitoring and disciplining them (Brown, 2002). Moreover, Nock (1995) and Brown and Booth (1996) find that cohabiting couples tend to be less happy and less committed to their relationships than married couples.

Finally, among mothers who are no longer romantically involved with the child's biological father three years after childbirth (47% of the control group), seven report to be married and 53 to be cohabiting with new partners when the child reaches age three (not shown). Although stepparents potentially contribute to children both in terms of their time and financial resources, some evidence indicates that non-biological parents tend to be less involved with stepchildren as compared to biological parents (Hofferth and Anderson, 2003) — and may in some cases disrupt relations with the absent parent (Amato, 1998). Indeed, Hofferth (2004) finds that even after accounting for differences in socioeconomic situations between these family types, children raised in stepparent families appear to fare just about as poorly as children raised in single-parent families, and worse than children living with their married biological parents. While sub-sample analysis is not warranted due to the small sample size, previous findings would suggest that additionally accounting for the presence of a stepparent would do little to amend the differences in child outcomes found in the present study.

Child Health and Behavioral Outcomes

Asthma is the most common chronic illness affecting children, with symptoms formulated since infancy.[16] Genetic predispositions combined with exposure to environmental toxins and poor health investments are common risk factors for asthma onset (Neidell, 2004). Psychological stress is also known to aggravate asthma, and the relationship between stressful life events and asthma onset has been well established among the adult population (e.g., Kilpel*ä*inen et al., 2002). Recent research point to stress experienced by a caretaker as an independent factor contributing to child asthma (Wright et al., 2002). Stressful life events, such as parental relationship conflicts, have been found to be associated with asthma onset in infants, mainly through the mother's coping abilities that translate into her parenting ineffectiveness (Klinnert et al., 1994). We categorize a child as to have asthma ($Y_i = 1$) if his/er mother reports that her child has asthma or has had asthma attacks (or she was ever informed by a health care professional that the child has asthma).[17]

Early childhood behavior outcomes are operationalized using maternal reports of aggressive behavior,[18] attention deficit hyperactivity disorder (ADHD), oppositional defiant disorder (ODD), and an instrument of prosocial behavior ("Express subscale") taken from the Adaptive Social Behavioral Inventory (ASBI).[19] Both ADHD and ODD are considered clinical scales: ADHD, a neurobehavioral disorder characterized by pervasive inattention and/or hyperactivity-impulsivity resulting in significant functional impairment; and ODD, a psychiatric disorder that is characterized by aggressiveness and a tendency to purposefully bother and irritate others.[20]

Appendix Table 1 presents a detailed list of items used to construct the behavioral scales and the

[16] Source: "Asthma in Children Fact Sheet," American Lung Association, 2004.

[17] This is consistent with the standard definition of childhood asthma ("America's Children: Key National Indicators of Well-Being, 2001," Federal Interagency Forum on Child and Family Statistics, Washington D.C.: U.S. Printing Office).

[18] Aggressive behavior is a subscale taken from the Child Behavior Checklist 2-3 (CBCL, Achenbach, 1992). The CBCL is well established for use with children under age five, and has been shown to effectively identify children who are referred to mental health services (Achenbach, 1992).

[19] The ASBI was developed to assess multiple components of social competence in young children (Hogan et al., 1992). The full ASBI scale includes 30 items to evaluate three dimensions of social competence in children, labeled "Express," "Comply," and "Disrupt." These three subscales correspond to prosocial, internalizing, and externalizing behaviors found in children. The FFCWS, however, only provides information on a subset of the items included in the "Express" dimension (henceforth the ASBI express subscale).

[20] Source: National Center on Birth Defects and Developmental Disabilities, 2005.

associated Cronbach's alpha.[21] Mothers were asked to rate the child with respect to each of these items with 0 = (not true), 1 = (somewhat or sometimes true), and 2 = (very true or often true). The Cronbach's alphas reveal that the item scales used to measure each of the underlying behavioral outcomes are quite reliable within our sample. For instance, an α of 0.880 implies the correlation between the set of items included and the underlying factor measuring aggressive behavior is $\sqrt{\alpha} \approx 0.938$.

We define the behavioral outcome variables as follows: for aggressive behavior, ADHD, and ODD, sum scale scores are standardized and we use a cut-off of t-scores greater than or equal to 63. This cut-off point demarcates emotional and behavioral problems at or above the 90^{th} percentile in the population of children as a whole and represents borderline clinical range (Achenbach and Rescorla, 2000). About 10% of the children in our sample meet the criterion for aggressive disorder, 10% for ADHD, and 9% for ODD at the borderline clinical cut-off (not shown). To measure the child's competence in prosocial (expressive) behavior, mother's mean response to the listed items is used.

Table 5 presents the estimated effects of parents' marriage after childbearing on child asthma and behavioral outcomes measured at age three. We find that children whose parents marry are 1% - 3% less likely to develop asthma/asthma attack by age three compared to children of persistently unmarried parents; however these estimates are not statistically significantly different from zero at conventional levels. Consistent with Heiland and Liu (2006), we find no evidence that marriage following childbirth affects child behavioral outcomes, as none of these estimates are statistically different from zero. One possible cause for the absence of effects using these outcomes is measurement error. There may be systematic reporting bias in the mother's evaluation of her child's health and behavioral problems. Brown (2002) finds that cohabiting mothers are more likely to report more mental health problems than married mothers, and poor maternal mental health may increase a mother's likelihood of perceiving more behavioral problems in her children (Friedlander et al., 1986). A recent study by Meadows et al. (2007), however, finds that mother's appraisals of many of these child behavioral outcomes correspond closely with independent observer assessments.

[21] The Cronbach's alpha assesses the reliability of a summative rating scale composed of variables specified. The reliability α is defined as the square of the correlation between the measured scale and the underlying factor.

Additional analysis supports the idea that marriage is particularly beneficial for child (verbal) cognitive development. While mothers who marry after childbirth in the FFCWS read to their children about as frequently as persistently unmarried mothers, children of married mothers tend to have more reading materials at home (specifically children's books) than their peers in unmarried families (p-value = 0.018). Married mothers also possess better verbal abilities as indicated by their higher PPVT scores (see Table 1). This suggests that the quality of verbal stimulation that children receive within marriage may be better. On the other hand, there is no evidence that married and unmarried parents differ significantly with respect to behaviors that are known to impede child health and behavioral development.[22] Specifically, we find that married and unmarried parents in our sample display similar prevalence of smoking and are equally likely to discipline their children using physical or negative verbal (including yelling, cursing, and threatening) punishment.

6 Conclusion

Using a recent, large representative sample of children all born to unmarried parents, this study examines how marriage between the biological parents within three years after childbirth affects child cognitive, health, and behavioral outcomes at age three. Adopting a potential outcome approach to account for parental self-selection into marriage, we compare outcomes between children who share similar parental background characteristics and assortative mating patterns and differ only in terms of whether their parents marry or not. While we find no evidence of an effect of marriage on the child's risk of developing asthma or behavioral problems, marriage is found to enhance child cognitive ability. Parenting behavior and the quality of child investments may help explain these results: while we find no evidence that married and unmarried parents differ significantly with respect to behaviors that are known to hinder child health and behavioral development, our evidence points to married mothers providing higher-quality verbal stimulation important for child cognitive development.

The analysis contributes to a better understanding of the complex relationship between family for-

[22] Smoking in the household and aggressive verbal or physical punishment has been shown to adversely affect child health (e.g., increase asthma risk) and behavioral development, respectively (e.g., Weitzman et al., 1990; Hao and Matsueda, 2006).

mation and child development among the growing population of unmarried couples with children. It also sheds light on the characteristics and mating patterns of unmarried parents. Among unmarried parents, we find that those couples who potentially face a greater stigma of out-of-wedlock childrearing and those who are less similar in terms of their educational attainments are more likely to transition into marriage after childbirth. The latter result is interesting since married couples in general tend to be (positively) assortatively matched by education (e.g., Pencavel, 1998). Our analysis also provides some evidence that those out-of-wedlock children whose parents get married enjoy particularly large gains from marriage. Marriage being especially beneficial for children with parents of different education levels is consistent with the idea that the marital bond facilitates specialization, especially for these couples. By ensuring compensation for sacrifices made on behalf of the family (e.g., via alimony rights), marriage provides those fathers with relatively low education—and hence low earnings power—with a greater incentive to contribute time towards the production of family public goods (e.g., by taking on more childcare responsibilities), thereby allowing their more educated spouses to allocate their time more efficiently between market and home production.

We find that out-of-wedlock children's cognitive development benefits from their biological parents marriage. While more research on the mechanisms through which marriage benefits these children is needed, our findings are consistent with the greater availability of time and material resources in two-parent households playing an important role in explaining the outcome differences. All else equal, marriage of the biological parents may increase family resources and child investments beyond the levels of cohabiting unions. The lack of full legal and social recognition of cohabiting parenthood may lessen their incentives to take advantage of opportunities to specialize in market vs. home production and to allocate time and material resources towards children. Evidence of cohabiting parents devoting smaller shares of the family budget on children and spending less time with them (Ziol-Guest et al, 2004; DeLeire and Kalil, 2005; Hofferth and Anderson, 2003), and evidence that cohabiting relationships tend to last longer once they are granted the same alimony rights (Lafortune, 2007) support this interpretation.

We note that while the matching approach adopted here addresses selection effects driven by differences in observable characteristics between married and unmarried parents, it is possible that there remain important unobservables that we do not account for. For instance, although we account for assortative mating patterns in terms of age, race, education, and labor market activities, couples' compatibility in less tangible dimensions such as social views, maturity, and marital expectations may also have important implications on whether they transition into marriage and how their children will be raised (e.g., Waller and McLanahan, 2005). Furthermore, marriage may depend on transitory in addition to permanent or pre-childbirth family characteristics. Studies focusing on the low-income population often found that both partners' education and earnings are important determinants of whether a couple can afford to marry (Sweeney, 2002). Hence, improvements in the couples' socioeconomic status are likely to increase their odds of marriage and positively influence child development as well.

The analysis also contributes to the ongoing debate concerning the merits of encouraging marriage among unwed parents. Our findings on child cognitive development are consistent with the idea that out-of-wedlock children benefit from their parents establishing a joint household and entering marriage. However, it is important to recognize that parents of out-of-wedlock children who get married may not have characteristics conducive for a stable relationship over the long-haul. Our finding that the parents of out-of-wedlock children who get married within three years after child birth tend to be less (positively) assortatively matched than couples who do not get married raises the concern that these marriages will face high rates of marital instability (e.g., Weiss and Willis, 1997). The early child cognitive developmental gain from marriage that we document here may, in turn, be offset by the adverse effects of divorce. As additional waves of the FFCWS will become available over the next years, it may be feasible to investigate the longer-term effects of marriage on child development.

Lastly, we note that our findings 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. Although the FFCWS includes a subsample of 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 pre-marital information on parents who were married at baseline is very limited.

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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
Parents of different race/ethnicity	0.145	[0.011]	0.156	0.142
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
Parents' Assortative Mating Patterns & Relationship Characteristics				
Father is younger than mother	0.196	[0.013]	0.196	0.196
Father and mother of different race / ethnicity	0.146	[0.011]	0.158	0.142
Father is less educated than mother	0.274	[0.014]	0.292	0.270
Father's labor income is less than mother's	0.102	[0.023]	0.103	0.102
Parents' known each other $<$ 6 mons before preg.	0.121	[0.011]	0.146	0.115
Father suggested abortion during pregnancy	0.146	[0.011]	0.109	0.155^{+}
Mother is catholic	0.253	[0.014]	0.328	0.234^{*}
Mother attends religious activities frequently	0.168	[0.012]	0.229	0.153^{*}
Other Characteristics				
Mother prenatal smoking (if at all)	0.240	[0.014]	0.250	0.238
Mother prenatal drinking (if at all)	0.077	[0.009]	0.057	0.082
Mother's PPVT score (Yr 3)	88.92	[0.358]	90.91	88.43^{*}
Maternal grandmother's education ($>$ H.S.)	0.224	[0.014]	0.220	0.225
N	958		192	766

Notes: * Sample mean 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

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

	Pre-Matching	Post-Matching					
		Block 1	Block 2	Block 3	Block 4	Block 5	Block 6
N Treated	192	19	37	38	47	38	13
N Controls	766	286	223	134	75	38	10
Range of the Propensity Score	$[0.02, 0.77]$	$[0.02, 0.10]$	$[0.10, 0.20]$	$[0.20, 0.30]$	$[0.30, 0.40]$	$[0.40, 0.60]$	$[0.60, 0.77]$
		Two-Sample Test of Means: Significance Level $= 0.01$ $\|T\|$ **Statistic**					
Propensity Score	12.41	0.557	0.565	1.541	1.376	1.222	0.528
Child is of low birth weight	0.616	0.042	1.471	0.293	1.454	1.021	0.186
Child is female	0.454	0.253	1.144	1.346	0.185	0.453	1.125
Child birth order (mother):							
- (Ref: 1^{st})							
- 2^{nd}	0.261	0.260	2.146	0.451	0.849	1.194	1.326
- 3^{rd} or higher	0.781	0.528	0.621	0.937	0.606	1.217	0.636
Mother's age (< 20)	1.419	0.345	0.894	1.146	0.066	0.585	0.000
Father's age (< 20)	1.857	0.478	0.254	1.072	0.186	1.021	0.000
Father is younger than mother	0.016	0.194	0.012	0.033	0.673	0.000	1.181
Parents' Race/Ethnicity:							
- (Ref: Both parents black)							
- Both parents white	1.718	1.223	0.470	1.076	0.703	1.526	1.181
- Both parents Hispanic	4.286	0.718	0.052	1.395	1.070	0.230	0.762
- Both parents of "other" race	0.206	1.565	0.884	1.207	0.790	0.000	1.148
- Mother white, Father non-white	0.394	0.869	0.562	0.445	0.686	0.583	1.288
- Mother black, Father non-black	1.019	0.737	0.619	0.000	0.000	0.000	0.000
- Mother Hisp., Father non-Hisp.	0.639	0.222	0.246	1.189	0.588	0.000	1.288
- Mother other, Father non-other	0.362	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 foreign-born (not Father)	0.973	0.365	0.619	0.927	1.010	1.021	0.872
- Father foreign-born (not Mother)	1.277	1.065	1.048	0.062	0.234	2.010	1.655
- Both parents are foreign-born	3.235	0.257	1.355	0.114	0.330	0.351	0.283
Child household income:							
- (Ref: $< \$10,000$)							
- between $\$10,000$ to $\$24,999$	0.425	0.825	0.236	0.071	0.751	0.944	1.678
- More than $\$25,000$	1.418	0.251	0.124	0.651	0.185	0.453	0.072

(Continued)

TABLE 2

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

	Pre-Matching	Post-Matching					
		Block 1	Block 2	Block 3	Block 4	Block 5	Block 6
Parents' Educational Backgrounds:							
- (Ref: Mother's education: Less than HS)							
- Mother's education: H.S. diploma / GED	1.562	1.359	0.750	1.576	0.406	0.788	0.170
- Mother's education: some college	1.490	0.298	0.600	2.452	1.056	0.712	1.338
- Mother's education: bachelor and beyond	0.614	0.580	0.372	0.114	0.561	0.583	1.288
- Father's education: H.S. diploma / GED	1.319	1.327	1.009	1.296	0.197	1.176	0.844
- Father's education: some college	0.363	0.150	0.694	0.211	1.204	0.534	1.148
- Father's education: bachelor and beyond	3.399	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	0.669	0.918	1.537	2.330	0.758	1.720	0.818
- Father is more educated than Mother	0.202	0.111	0.247	0.392	0.703	0.762	0.442
Parents' labor force participation:							
- (Ref: Neither parents work)							
- Both parents work	0.776	1.013	0.201	0.695	0.619	0.285	1.181
- Only Mother works	0.249	0.613	0.708	0.754	0.000	0.583	0.000
- Only Father works	1.120	1.199	0.389	0.634	0.543	0.000	1.181
Mother's weekly hours of work	0.790	0.387	0.316	0.785	0.731	0.029	1.131
Father's weekly hours of work	3.441	0.630	1.448	0.939	1.196	0.547	2.813
Mother's labor inc. $>$ Father's labor inc.	0.233	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	1.175	0.480	0.767	0.990	0.352	0.556	1.288
- 6 months to 1 year	1.431	0.369	1.135	0.904	1.457	1.434	0.872
- 1 year to 2 years	0.999	1.034	0.501	0.367	1.031	0.253	0.561
Mother is catholic	2.742	0.498	0.317	0.392	1.195	0.000	1.510
Mother has no religious affiliation	0.417	0.006	1.255	1.757	0.124	0.322	0.186
Mother attends religious activities (at least few times a week)	2.538	0.690	0.533	1.578	0.747	0.740	0.175
Father suggested abortion during pregnancy	1.613	1.002	1.438	0.014	0.351	0.392	0.000
Maternal grandmother's education (some college and beyond)	0.096	1.065	0.678	0.404	0.007	0.556	0.277
Prenatal smoking (mother)	0.359	1.551	0.753	2.020	0.624	0.556	0.818
Prenatal drinking (mother)	1.158	0.728	0.642	1.280	0.061	0.000	0.000
Parents in visiting relationship (baseline)	4.361	1.223	1.826	1.499	0.330	0.000	0.796
Mother's PPVT score (Measured at Year 3)	0.741	0.786	0.169	0.163	0.703	0.804	0.481

Notes: ^{a} $|T|$ statistics of the two-sample test of means for "mother's state of residence at baseline" (14 indicators) not reported here (available upon request).

Figure 1: Box Plot of the Estimated Propensity Score for the Treated Units (T) and the Control Units (C) within the Common Support Region

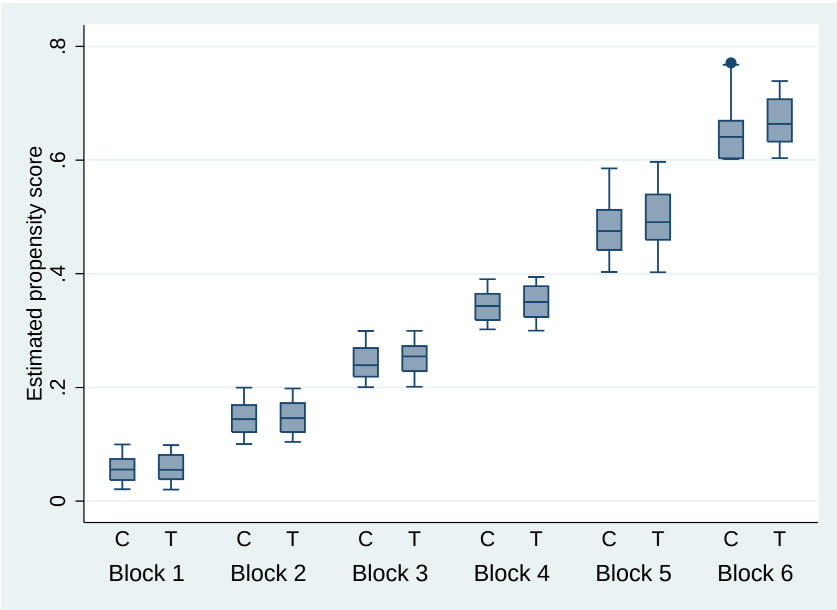


TABLE 3
Probit Estimates of the Propensity Score

	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 3

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 $\in [0.02025512, 0.77094784]$.

TABLE 4
Estimated Effect of Marriage on Child PPVT Score Administered at Age 3

	OLS		**Matching**				
	Unadjusted	Adjusted	Gaussian	Epanechnikov		Uniform	
				(h = 0.01)	(h = 0.005)	(r = 0.01)	(r = 0.005)
Control Group: All Unmarried at Age 3							
Estimate	3.073*	2.158+	3.610*	3.500*	4.366*	3.524*	3.914*
Standard Error	[1.277]	[1.224]	[1.830]	[1.717]	[1.791]	[1.404]	[1.487]
N Treated	192	192	192	192	192	189	182
N Controls	766	766	766	766	766	765	697
% matched treated	N.A.	N.A.	100	100	100	98	95
Control Group: Cohabitors at Age 3							
Estimate			2.868	2.675	2.954	2.878	3.065
Standard Error			[1.886]	[2.181]	[2.333]	[1.771]	[1.972]
N Treated			188	188	188	182	167
N Controls			357	357	357	353	315
% matched treated			98	98	98	95	87

Notes: [a] OLS (unadjusted) = unadjusted mean difference in the PPVT score between the unmatched treated and control groups, OLS (adjusted) = adjusted mean difference in the PPVT score between the unmatched treated and control groups, controlling for the full set of controls included in the propensity score estimation (Table 3); [b] Robust standard errors (OLS) and bootstrapped standard errors (Matching) are reported in brackets. Standard errors for the matching estimators are obtained by bootstrap with 500 replications; [c] Statistical significance at the * = 5% level, and + = 10% level; [d] N.A. = Not Applicable; [e] 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; [f] 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; [g] The propensity score is estimated using a probit model with full controls as shown in Table 3; [h] Sets of controls included: "Basic Controls" include parents' relationship status at childbirth, child gender, low birth weight, birth order, and mother's state of residence at baseline; "Mother's characteristics" include mother's age at baseline (< 20), race/ethnicity, foreign-born, education (baseline), labor force participation, weekly hours of work, catholic, frequency of attending religious activities, pre-natal smoking and/or drinking, PPVT score; "Father's characteristics" include father's age at baseline (< 20), race/ethnicity, foreign-born, education (baseline), labor force participation, weekly hours of work; and "Parent's relationship characteristics" include parents' assortative mating patterns defined by whether they are of different race/ethnicity, one or both partners are foreign-born, one or both parents work, father is less educated than mother, father earns lower labor income than mother (if both work), length of time parents have known each other prior to pregnancy, father suggested abortion during pregnancy.

TABLE 5

Estimated Effect of Marriage on Child Health and Behavioral Outcomes at Age 3

	OLS	**Matching**				
		Gaussian	Epanechnikov		Uniform	
			(h = 0.01)	(h = 0.005)	(r = 0.01)	(r = 0.005)
Health Outcome						
Asthma	−0.014	−0.021	−0.028	−0.010	−0.027	−0.021
	[0.037]	[0.039]	[0.047]	[0.051]	[0.039]	[0.044]
N Treated	192	192	192	192	189	182
N Controls	766	766	766	766	765	697
% Matched Treated	N.A.	100	100	100	98	95
Behavioral Outcomes						
Aggressive Behavior	−0.033	−0.039	−0.063	−0.070	−0.050	−0.053
($\alpha = 0.880$)	[0.029]	[0.038]	[0.042]	[0.045]	[0.030]	[0.033]
N Treated	192	156	156	156	144	141
N Controls	766	640	640	640	637	600
% Matched Treated	N.A.	81	81	81	75	73
Attention Deficit Disorder	−0.024	−0.020	−0.012	−0.021	−0.015	−0.019
($\alpha = 0.710$)	[0.027]	[0.030]	[0.040]	[0.045]	[0.030]	[0.033]
N Treated	192	159	159	159	154	148
N Controls	766	674	674	674	671	650
% Matched Treated	N.A.	83	83	83	80	77
Oppositional Defiant Disorder	0.009	0.012	0.004	0.009	0.005	0.002
($\alpha = 0.778$)	[0.026]	[0.027]	[0.033]	[0.037]	[0.026]	[0.030]
N Treated	192	188	188	188	183	176
N Controls	766	735	735	735	730	680
% Matched Treated	N.A.	98	98	98	95	92
ASBI (“Express” Subscale)	0.018	0.023	0.015	0.015	0.020	0.011
($\alpha = 0.730$)	[0.025]	[0.029]	[0.037]	[0.039]	[0.028]	[0.033]
N Treated	192	156	156	156	151	145
N Controls	766	674	674	674	672	641
% Matched Treated	N.A.	81	81	81	79	76

Notes: [a] Aggressive behavior, attention deficit disorder, and oppositional defiant disorder are taken from the Achenbach and Rescorla (2000) scales and diagnostics; ASBI express subscale derived from items representing an abbreviated version of the ASBI Express Subscale developed by Hogan et al. (1992); [b] Aggressive behavior, ADHD, and ODD are dichotomized at a t-score ≥ 63 to indicate a borderline clinical threshold; for the ASBI, mean response to the items included in the ASBI express subscale is used; [c] Robust standard errors (for OLS) and bootstrapped standard errors using 500 replications (for PSM) are reported in brackets; [d] The 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; [e] N.A. = Not Applicable.

APPENDIX TABLE 1
Child Psychometrics for the Behavior Outcomes

	Item Description
Aggressive Behavior	Cannot stand waiting, wants everything now
(α = 0.880)	Defiant
	Demands must be met immediately
	Destroys things belonging to family or other children
	Disobedient
	Does not seem to feel guilty after misbehaving
	Easily frustrated
	Gets in many fights
	Hits others
	Hurts animals or people without meaning to
	Has angry moods
	Overtired
	Punishment does not change behavior
	Screams a lot
	Selfish or will not share
	Stubborn, sullen, or irritable
	Has temper tantrums or hot temper
	Uncooperative
	Wants a lot of attention
Attention Deficit Disorder	Cannot concentrate / pay attention for long
(α = 0.710)	Cannot sit still / restless / hyperactive
	Quickly shifts from one activity to another
	Cannot stand waiting, wants everything now
	Demands must be met immediately
	Gets into everything
Oppositional Defiant Disorder	Defiant
(α = 0.778)	Disobedient
	Has angry moods
	Stubborn / sullen / irritable
	Had temper tantrums or hot temper
	Uncooperative
ASBI (Express Subscale)	Understands others' feelings, like when they are happy / sad / mad
(α = 0.730)	Sympathetic toward other children's distress, tries to comfort others
	Open and direct about what (he/she) wants
	Will join a group of children playing
	Plays games and talks with other children
	Confident with other people
	Tends to be proud of things (he/she) does
	Interested in many and different things
	Enjoys talking to you

Notes: [a] Aggressive behavior, attention deficit disorder, and oppositional defiant disorder are taken from the Achenbach and Rescorla (2000) scales and diagnostics; ASBI express subscale is derived from items representing an abbreviated version of the ASBI Express Subscale developed by Hogan et al. (1992); [b] Mother's rating of the child with respect to each item is coded: 0 = Not True, 1 = Somewhat or sometimes true, and 2 = Very true or often true; [c] "α" refers to Cronbach's alpha, which assesses the reliability of a summative rating scale composed of variables specified.

TECHNICAL APPENDIX

Identification

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 be identical to the outcome distribution of the controls. 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. Nevertheless, the literature provides some guidance in assessing this assumption.

Specification of the Propensity Score. The propensity score matching estimator requires the potential outcomes be mean-independent of the treatment conditional on the propensity score, $p(X)$. An important consideration in the implementation is how to choose X, since the choice of X can make a substantial difference in the estimator's performance (Heckman et al., 1998; Lechner, 2001). Following Rosenbaum and Rubin (1983), if the propensity score is correctly specified, there should be no significant differences in means of covariates that affect selection into treatment. If after conditioning on the propensity score there is still dependence on treatment, this suggests a mis-specification of $p(X)$. The balancing test can be used to check the specification of the $p(X)$. For a given specification, if one cannot find a partition structure such that X is balanced within each block of the estimated propensity score, it then constitutes a well-defined criterion for rejecting the specification (Dehejia and Wahba, 1999), as it indicates that the covariates included in X do not fully capture the differences between the treatment and the control groups.

We examine how our estimated marriage effects on child PPVT score would fare in the absence of subsets of pre-treatment covariates. In Technical Appendix Table 1, we first estimate the propensity score using the fewest ("basic") controls (1), then sequentially add in household income (2), mother's characteristics (3), and father's characteristics (4). (For the ease of comparison, the last row (5) re-reports our main results using all covariates as in Table 4). The associated pseudo R^2 and log likelihood for each of the propensity score specifications are also reported.

Recall in Section V we showed that the covariate means are balanced based on our fully-specified propensity score specification (5). For the more parsimonious specifications (1)-(4), we are unable to find a partition structure such that the included covariates are balanced within each block. This indicates that the simpler specifications do not fully capture differences between the treated and controls which justifies the rejection of these specifications. Hence, although these estimates of ATET "appear" to be sensitive to the propensity score specifications in (1)-(4), they are invalid as the included covariates do not fully capture differences between the treated and control groups. Following Dehejia and Wahba (1999), the specification search generally begins with a linear specification, then adds higher-ordered and interaction terms until within stratum balance is satisfied. Our main results (based on a linear specification) are robust to the addition of higher-ordered and interaction terms (available upon request).

Imbens Test. Imbens (2004) proposes an indirect way of assessing the plausibility of the CIA assumption, 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 the control outcomes. The power of this test is enhanced if the variable used in this proxy test is closely related to the outcome of interest.

We estimate the "causal" effects of parents' marriage after childbirth on two pre-treatment outcomes: (1) whether the child is of low birth weight ($<$ 88 ozs), and (2) mother's education at baseline. Both of these measures were realized before the treatment can take place, and have been shown to be highly correlated with early child cognitive performance (e.g., Tong et al., 2006; Roberts et al., 1999). Approximately 10% of the children in our sample are of low birth weight, and 36% are born to mothers who did not graduate from high school (or obtain an GED equivalent). As demonstrated in Technical Appendix Table 2, all of our matching estimates show that parents' marriage has no effect on these pre-treatment outcomes. These tests provide additional support that the CIA assumption is satisfied.

Kernel Matching Estimators

Let T and C be the set of treated and untreated units, respectively. The observed outcome of a treated unit 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 units matched to the treated unit i with an estimated propensity score p_i. 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. We consider three matching estimators, namely *Uniform* (also known as the "radius" matching estimator), *Epanechinikov*, and *Gaussian* kernels, each uses a specific kernel function:

Uniform (Radius): $K(u) = 1/2$ for $|u| < 1$ and 0 otherwise

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

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 Technical 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.

Relaxing the Common Support

Our estimates are based on observations with propensity scores falling within the common support, to ensure that there is 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 not sensitive to the exclusion of these observations, we also relax the common support condition and re-estimate the ATET using all $1,051$ observations.

Technical 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. The Epanechnikov and uniform kernels bypass this problem since zero weights are placed on these potentially poor matches, conditional on the selected bandwidth/radius is sufficiently small. 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).

TECHNICAL APPENDIX TABLE 1

Sensitivity of the Estimated Marriage Effects on Child PPVT Score to Specification of the Propensity Score

	Matching				
	Gaussian	Epanechnikov		Uniform	
		($h = 0.01$)	($h = 0.005$)	($r = 0.01$)	($r = 0.005$)
(1) **Basic Controls**	3.986*	3.766*	4.084*	4.076*	4.327*
	[1.305]	[1.425]	[1.388]	[1.363]	[1.424]
N Treated	198	198	198	198	197
N Controls	848	848	848	844	825
[$p(X)$: Pseudo $R^2 = 0.075$; Log Likelihood = −470.47]					
(2) **Basic Controls + HH Income**	3.773*	3.715*	3.374*	4.158*	3.803*
	[1.338]	[1.399]	[1.567]	[1.376]	[1.471]
N Treated	198	198	198	198	197
N Controls	813	813	813	813	801
[$p(X)$: Pseudo $R^2 = 0.079$; Log Likelihood = −468.29]					
(3) **Basic Controls + HH Income + Mother's Characteristics**	2.308+	1.551	1.317	3.927*	3.919*
	[1.291]	[1.562]	[1.640]	[1.272]	[1.433]
N Treated	196	196	196	194	193
N Controls	790	790	790	777	715
[$p(X)$: Pseudo $R^2 = 0.135$; Log Likelihood = −440.00]					
(4) **Basic Controls + HH Income + Mother's Characteristics**	2.062	2.558	3.200+	3.798*	4.539*
+ Father's Characteristics	[1.435]	[1.671]	[1.683]	[1.340]	[1.456]
N Treated	193	193	193	191	185
N Controls	790	790	790	790	720
[$p(X)$: Pseudo $R^2 = 0.165$; Log Likelihood = −424.60]					
(5) **Full Controls**	3.610*	3.500*	4.366*	3.524*	3.914*
	[1.830]	[1.717]	[1.791]	[1.404]	[1.487]
N Treated	192	192	192	188	178
N Controls	766	766	766	765	697
[$p(X)$: Pseudo $R^2 = 0.174$; Log Likelihood = −420.00]					

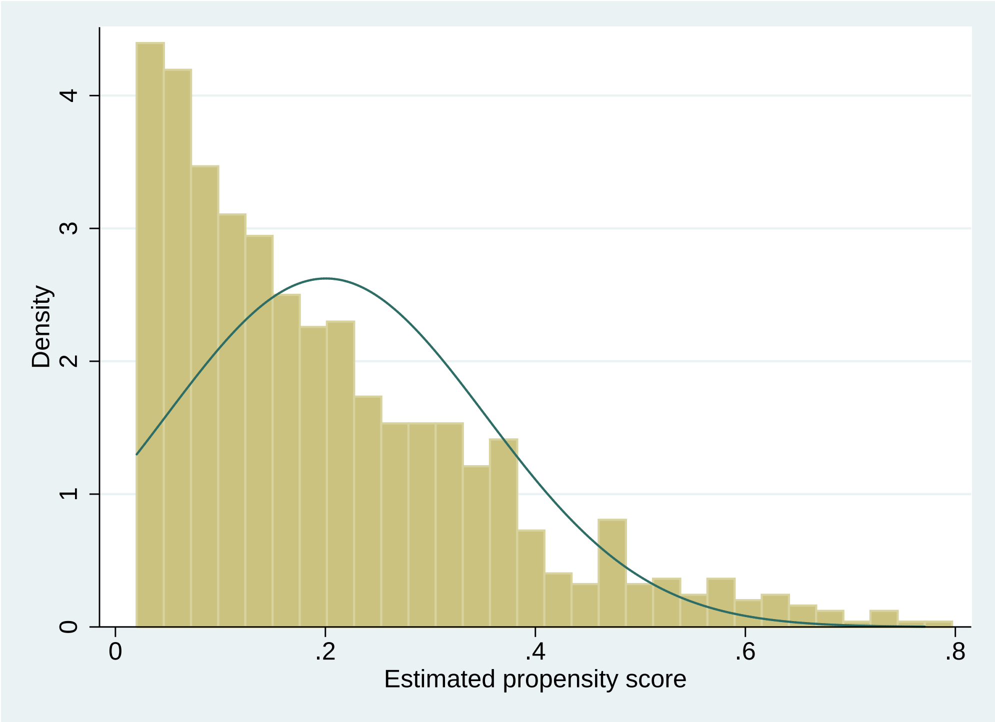
Notes: [a] All models estimate the propensity score using probit; [b] Bootstrapped standard errors using 500 replications are reported in brackets; [c] The propensity score is re-estimated at each replication of the bootstrap procedure to account for the uncertainty associated with the estimation of the propensity score; [d] Statistically significant at the $* = 5\%$ level, $+ = 10\%$ level.

TECHNICAL APPENDIX TABLE 2
Imbens' Test of the Conditional Independence Assumption:
Estimated Effect of Marriage after Childbearing on Pre-Treatment Outcomes

	Matching				
Pre-treatment Outcome	Gaussian	Epanechnikov		Uniform	
		($h = 0.01$)	($h = 0.005$)	($r = 0.01$)	($r = 0.005$)
Child is of Low Birth Weight	−0.016	−0.016	−0.009	−0.017	−0.010
(1 = less than 88 ozs)	[0.017]	[0.023]	[0.024]	[0.019]	[0.023]
N Treated	192	192	192	186	181
N Controls	766	766	766	763	724
% Matched Treated	100	100	100	97	94
Mother's Education at Baseline	0.017	−0.006	0.038	0.006	0.017
(1 = High School Drop-Out)	[0.026]	[0.036]	[0.042]	[0.032]	[0.034]
N Treated	192	192	192	186	181
N Controls	766	766	766	763	724
% Matched Treated	100	100	100	97	94

Notes: [a] Total number of treated = 192, total number of controls = 766; [b] Bootstrapped standard errors are reported in brackets. Standard errors for the matching estimators are obtained by bootstrap with 500 replications; [c] The propensity score is estimated using a probit model with full controls as shown in Table 3; [d] 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.

TECHNICAL APPENDIX FIGURE 1
Distribution of the Propensity Score



TECHNICAL APPENDIX FIGURE 2
Boxplot of the Propensity Score Overlap