New Estimates on the Effect of Parental Separation on Child Health

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Abstract

This study examines the causal link between parental separation and the health status of young 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 separation between unmarried biological parents has a causal effect on a child's likelihood of developing asthma by age three. Comparing children with similar observable characteristics who differ only in terms of whether their parents separate, we find that parental separation increases the probability that a child develops asthma by age three by seven percentage points, relative to children whose parents remained romantically involved.

Keywords: Child Asthma, Fragile Families, Relationship Dissolution, Propensity Score Matching

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1 Introduction

While marriage remains the most common foundation of family life in the U.S., the prominence of the traditional process of family formation, namely marriage before having children, is diminishing. Today, more than one-third of all births in the U.S. occur outside of marriage (Martin et al., 2006). Although most unmarried parents are romantically involved when their child is born (Carlson et al., 2004), many separate before their child reaches age three (Osborne and McLanahan, 2006). While the consequences of parental divorce on children have been studied extensively,[1] the effect of relationship dissolution between never-married parents on child wellbeing has rarely been examined in large survey data.

Compared to couples who marry before having children, unmarried parents tend to be socioeconomically disadvantaged, have poorer prospects in the marriage market, and are more likely to be with less assortatively matched partners (Brown, 2004; Osborne and McLanahan, 2004; Nock, 1998; Rosenzweig, 1999; Jaffe and Chacon-Puignau, 1995; Garfinkel et al., 2002). Thus, generalizing the impact of separation between married parents on child wellbeing to children of never-married parents may be misleading. Furthermore, when examining how parental separation influences child wellbeing, factors driving relationship dissolution should also be considered. The determinants of relationship dissolution between unmarried parents are not well-understood,[2] mainly due to the lack of information on men who father children out-of wedlock.[3] To the extent that the effect of parents' relationship dissolution on the wellbeing of their children reflects the characteristics of both parents as well as the characteristics of the partnership (e.g., quality of the match), estimates of the effect of parental separation that do not account for these factors may be biased.

This study examines whether parental separation (defined as the dissolution of a romantic relationship), has a causal effect on child health, using data from the Fragile Families and Child Wellbeing

[1] See Cherlin (1999) and Liu (2005) for recent surveys of this literature. See Morrison and Ritualo (2000) for evidence on the economic consequences of cohabitation and remarriage for children who experienced parental divorce.

[2] While a number of recent studies examine the determinants of marriage among unmarried parents (e.g., Carlson et al., 2004; Goldstein and Harknett, 2006), the factors contributing to the dissolution of these unions are unclear.

[3] Finding a representative sample of nonresident fathers has proved extraordinarily difficult. In U.S. nationally representative surveys (such as the CPS, NSFH, and SIPP), researchers estimated that more than one fifth and perhaps as many as one-half of nonresident fathers are "missing," i.e. not identified as fathers (e.g., Cherlin et al., 1983; Garfinkel et al., 1998; Sorenson, 1997). The problem is especially pronounced for 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).

Study (FFCWS). The FFCWS provides detailed longitudinal information on both biological parents of a large sample of children born out-of-wedlock. We focus on the effect of relationship dissolution within three years since childbirth among romantically-involved but never-married parents, on their child's likelihood of developing asthma by age three.[4] To account for self-selection of relationship dissolution, our empirical strategy centers around a treatment outcome framework (Rubin, 1979; Rosenbaum and Rubin, 1983; Heckman and Hotz, 1989; Heckman et al., 1997, 1998), we compare children whose parents separate only to children who share similar parental characteristics and mating patterns but their parents remained romantically involved. We find that parental separation increases a child's odds of developing asthma by age three by 7%, relative to the situation where their parents *had remained romantically involved*.

2 Background

This section provides the conceptual and empirical background for analyzing the effects of separation on child wellbeing, with special emphasis on how separation of the biological parents may harm children born out-of-wedlock. We draw on the theoretical literature on family formation, dissolution, and resource allocation (e.g., Becker, 1973, 1974; Becker et al., 1977; Weiss and Willis, 1997; Willis, 1999; Ribar, 2004), which stress the importance of family resources (time and money) and endowments (caregivers' ability) in the production of family public goods such as child quality.

Consequences of Separation

Parental separation is expected to lead to a reduction in parental involvement with and resources for the children as benefits associated with growing up in a (parental) union are at best temporarily interrupted and potentially discontinued for a prolonged amount of time.[5] McLanahan (1985) shows that income explains up to half of the differences in child wellbeing between one- and two-parent families. Unions

[4]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. We focus on early child outcomes since unmarried families tend to be less stable and hence more short-lived (Bumpass and Lu, 2000; Manning et al., 2004), findings from these previous studies may be characteristic of stable unmarried families only.

[5]For a detailed discussion of the benefits of a parental union, see Becker (1991); Michael (1973); Shaw (1987); Drewianka (2004).

yield gains from specialization and exchange in the presence of comparative advantages of the partners. Couples may also pool individuals' resources, and realize economies of scale in household production and gains from exploiting risk-sharing opportunities.[6] Individuals may also be more productive as part of a family due to social learning or other positive externalities.[7] Finally, the effective use of monetary transfers from one partner to the other on behalf of the child is more easily monitored (Willis and Haaga, 1996; Willis, 1999).

Existing Evidence

Parents' economic resources have been shown to be important determinants of child wellbeing (Blau, 1999). While caregivers' 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, both time and material resources are needed for a healthy development (Coleman, 1988). Especially, parenting resources—the services provided by the parents using their time and childrearing ability are believed to be important complements to economics resources (McLanahan and Sandefur, 1994).[8] Studies that compare children across living arrangements have shown that children in single-parent families experience fewer economic and parenting resources (Brown, 2002; Hofferth, 2001). 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 parenting practices (Cherlin, 1992; Thomson et al., 1994; Wu, 1996). Conflicts over visitation may also encumber parenting effectiveness (Brown, 2004).

While a large body of research consistently shows a negative correlation between marital dissolution and child outcomes,[9] until very recently, the relationship between non-marital separation and child wellbeing has received little attention. Heiland and Liu (2006) report that children born to cohabiting or

[6]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 (McElroy, 1990; Manser and Brown, 1980; McElroy and Horney, 1981), one person's resources cannot be treated as common household income.

[7]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.

[8]For example, parental interaction with the child has been found to foster the development of the child by providing support, stimulation, and control (e.g., Maccoby and Martin, 1983).

[9]See Ribar (2004) and Liu and Heiland (2007) for recent surveys of the literature on the effect of marriage on child wellbeing.

visiting (i.e. romantically involved but living apart) biological parents who end their relationship within a year after birth are up to 9% more likely to have asthma compared to children whose parents stayed together. They also report an increase in child behavioral problems associated with a break-up among children born to romantically involved but not co-residing parents but no effect on mother-reported child health status measures. However, their estimates are obtained from conventional (parametric) models and whether these correlations reflect causal relationships is unclear.

Separation and Selection

A change in the parental relationship towards no (romantic) involvement is expected to decrease the availability of resources and paternal investments in children. However, the environment provided by and the characteristics of parents who separate may differ substantially from the ones of parents who remain together. In examining the effect of separation on child outcomes, potential differences in the characteristics of the parents who break up and those who stay together, need to be addressed.

Economic theories of relationship dissolution posit that individuals break up when the value of the 'outside opportunity' of one partner exceeds the benefits from continuing the relationship (Becker et al., 1977). This implies that dissolution does not occur randomly across couples and complicates the estimation of the effect of separation on child wellbeing. Simple comparisons of child outcomes by relationship status can be misleading if couples who are separated are different from those who stay together in ways that also affect child investments. For example, if couples with characteristics that benefit child development are also more likely to break up after childbearing (ceasing a source of positive influence), compared to those who remain together, then the (negative) consequences of separation may be overstated. Conversely, if arrangements induce adverse effects on the child—such as having an abusive father—are more likely to end in a break-up, the association between separation and child wellbeing may even become positive.

Benefits of father's involvement on children are increasingly recognized (Cabreba el al., 2000; Lamb, 2004). The father's involvement in the child's life may depend on the quality of his relationship with the mother. Couples involved in high quality relationships tend to communicate effectively and the mother is more likely to encourage the father's active involvement in both her and the child's lives

(Carlson et al., 2004). By contrast, when mothers are not able to cooperate with the father and do not perceive that he has the child's best interests at heart, they may discourage his involvement and end their romantic relationship. Separating from a "deadbeat" dad may reduce the mother's stress level and allow her to increase available resources for the child through forming new partnerships (e.g., Waller and Swisher, 2006).[10]

3 Statistical Model and Estimation Strategy

Conceptual Model

Consider a couple i that has a child out-of-wedlock. The model of parental investments in children and process of relationship dissolution following childbirth may be formalized as follows:

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

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

where C_i denotes the observed child outcome of couple i; S_i is equal to (1) if the couple separates (i.e. dissolve their romantic relationship) and (0) otherwise. The vector X_i includes characteristics of couple i that influence their child investment decisions and their risk of relationship dissolution.

If the decision to end the relationship is exogenous to the couple's child investment decisions, then ordinary least squares regression yields an unbiased estimate of the effect of parental separation on child outcome (β in (1)). However, a couple's child investment behavior might be endogenous to whether the couple remained (romantically) involved, i.e. if there is dependence between S_i and ε_i. Correlation between S_i and ε_i can arise due to: (*a*) dependence between X_i and ε_i; and (*b*) dependence between ε_i and ν_i (Rosenbaum and Rubin, 1983; Heckman and Robb, 1985).[11] The methodology employed here addresses selection on observables (*a*). The PSM method matches treated and control children based on multiple dimensions of parental characteristics and mating patterns available in the

[10] McLanahan and Sandefur (1994) found that children living in stepparent families generally have better outcomes than children in single-parent families.

[11] The two are not necessarily mutually exclusive.

FFCWS, thereby reducing potential bias induced by self-selection of relationship dissolution.[12]

Potential Outcome Approach

Using the terminology of the evaluation literature, consider the "treatment" to be the separation (i.e. romantic relationship dissolution) between the biological parents of child i: $S_i = 1$ denotes the "treatment group" (i.e. children whose parents separate), and $S_i = 0$ denotes the "control group" (i.e. children whose parents remain romantically involved). Let $C_i(1)$ denote the potential outcome of child i under treatment ($S_i = 1$), and $C_i(0)$ the potential outcome if the same child receives no treatment ($S_i = 0$). Thus, $C_i = S_i C_i(1) + (1 - S_i)C_i(0)$ 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' separation on children whose parents separate"), i.e. the ATET henceforth:

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

which is the difference between the expected outcome of a child whose parents separate, and the expected outcome of the same child if his/er parents were to remain romantically involved. While we observe the outcomes of children whose parents separate, and are thus able to construct $E[C_i(1)|S_i = 1]$, we cannot identify the counterfactual expectation $E[C_i(0)|S_i = 1]$ without invoking further assumptions. In our context where treatment status is likely non-random, replacing $E[C_i(0)|S_i = 1]$ with $E[C_i(0)|S_i = 0]$ is inappropriate since the treated and untreated might differ in their characteristics determining the outcome. Matching estimators can be devised to address this problem.

Matching

Statistical matching is a way to identify a suitable comparison group that is comparable to the treated on characteristics X that rule both the selection into treatment and the outcome under study. Selection bias is eliminated provided all variables in X are measured and balanced between the two groups. In

[12] Selection bias due to unobservables is reduced to the extent that the X_i are proxying for such unmeasured factors.

this case, outcome differences between the treated and controls provide an unbiased estimate of the treatment effect.

Conditional Independence Assumption (CIA)

An identifying assumption of the matching method, namely 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, the outcomes of children whose parents remained romantically involved are what the outcomes of children whose parents separate *would have been* if their parents had remained romantically involved.[13] It follows that 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.[14]

Average Treatment Effect for the Treated (ATET)

Following the CIA, the average treatment effect on the treated can be computed as follows:

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

To estimate the ATET, 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.[15]

Conditioning on X within a finite sample can be problematic if the vector of observables is of high dimension. Rubin (1979) and Rosenbaum and Rubin (1983) suggest the use of the *propensity score*, i.e. the conditional probability of participating in the treatment $p(X_i) = Pr(S_i = 1 \mid X_i = x) = E(S_i \mid X_i)$,

[13] This rules out possible unobservables affecting both $C_i(0)$ and S_i. Our analysis matches treated with controls that are comparable on a rich set of family and parental relationship characteristics available in the FFCWS.

[14] It assumes that there are untreated individuals for each x: $Pr(S_i = 0 \mid X_i = x) > 0$ for all x, implying that individuals are matched only over the common support region of X_i where the treated and untreated group overlap.

[15] 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.

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: $X_i \perp S_i \mid p(X_i)$.[16] Furthermore, if $C_i(0) \perp S_i \mid X_i$, then $C_i(0) \perp S_i \mid p(X_i)$. 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 controls with the same propensity scores and placing them into one cell (i.e., observations with propensity scores falling within a specific range) means that the selection into treatment is random within each cell. 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 $p(X_i)$. Therefore, an unbiased estimate of the ATET can be obtained by conditioning on $p(X_i)$, which is equal to exact matching on $p(X_i)$: $\beta_{|S_i=1} = E_{p(X)}[(E(C_i \mid S_i = 1, p(X_i)) - E(C_i \mid S_i = 0, p(X_i))) \mid S_i = 1]$.

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 devised to solve this problem (See Becker and Ichino (2002) for a discussion). This study employs three variations of *Kernel* estimators.[17,18] 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.

4 Data, Sample, and Descriptive Evidence

Our data are drawn from the Fragile Families and Child Wellbeing Study (FFCWS). The study follows a cohort of $4,898$ children and their parents in 20 U.S. cities from birth ($1998 \sim 2000$), at age one, and again when the child is about three years old.[19] The FFCWS is unique as it includes a large set of children born to unmarried parents. Areas of information covered include parent-parent and parent-

[16] This is called the *balancing property* of the propensity score.

[17] Various methods exist to implement matching estimates, all based on the same strategy of pairing individuals but with different techniques for pairing or weighing schemes given to counterfactual individuals. This study implements three derivatives of kernel matching: Uniform (i.e. radius), Epanechnikov and Gaussian kernels. Refer to the Technical Appendix for a discussion of these estimators.

[18] 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.

[19] For a detailed description of the study design and sampling methods, see Reichman et al. (2001).

child relationships, socioeconomic activities, and child development.

Sample Selection

Our study sample consists of $1,419$ children all born to parents who were unmarried but romantically involved at childbirth. The sample is selected in the following manner. First, given that the relationship arrangement between the biological parents is crucial for our study question, we exclude children whose parents' relationship status at either the one- or three-year follow-ups cannot be identified ($n = 1,733$ are dropped). Second, we focus on children born to unmarried biological parents who were romantically involved at childbirth (i.e. either in cohabiting or visiting unions), therefore children whose parents were either married (944 cases) or not romantically involved (302 cases) at childbirth are excluded. Third, we exclude children for whom we do not observe the outcome measure, i.e. whether they have developed asthma by age three (406 cases). Fourth, the parents of 32 of the remaining children had been married within the first year after childbirth, but divorced before their child reached age three. To avoid confounding the effect of separation between never-married parents and parental divorce, these observations are dropped.[20] Fifth, 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 (9 observations). An additional 32 observations are dropped due to missing information on important socioeconomic and demographic characteristics.[21] In the resulting sample, consisting of $1,434$ children all born to unmarried parents, 37% of the parents have ended their (romantic) relationship by the time their child reaches age three.

Finally, we estimate the propensity score of selection into treatment (i.e. the probability of parental separation within three years since childbirth) within this sample of $1,434$ 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 (7 treated and

[20] We note, however, that our results are robust to the inclusion of these observations (results available upon request).

[21] To ensure that exclusion of these observations does not result in a selected sample (i.e. if the tendency of under-reporting is correlated with the treatment), we constructed missing indicators for each of these covariates and conducted t-tests of means for each of the missing indicators between the treated and control groups. None of the t-tests showed significant differences in the prevalence of under-reporting across the two groups (results available upon request).

8 controls), resulting in the final sample size of $1,419$ children.

Sample Descriptives

Table 1 presents summary statistics of the measures employed in this study. Sample means are presented for the full sample (Columns 2 and 3) and by treatment status (Columns 4 and 5).

Measure of Child Health

Child health is measured by a child's likelihood of developing asthma by age three. Asthma is the most common chronic illness affecting children,[22] with symptoms formulated since infancy (Klinnert et al., 2001). Genetic predispositions combined with exposure to environmental toxins are common risk factors for asthma onset (Weisch et al., 1999; Sporik et al., 1991; Cogswell et al., 1987; Weitzman et al., 1990). In the U.S., children from lower socioeconomic and minority backgrounds develop higher rates of asthma, a pattern attributable to toxic environmental exposures and poor health investments (Neidell, 2004; Gergen et al., 1988; Oliveti et al., 1996).

Psychological stress is also known to aggravate asthma, and the relationship between stressful life events and the onset of asthma has been well established among the adult population (Teiramaa, 1979; Levitan, 1985; Kilel*ä*inen et al., 2002). Recent research also points to stress experienced by a caretaker as an independent factor contributing to child asthma (Wright et al., 2002).[23] 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 behavior (Klinnert et al., 1994).

In the FFCWS, mothers are asked to report whether her child has asthma or asthma attacks (or were informed by a health care professional that the child has asthma)[24] by age one, and again by age

[22] "Asthma in Children Fact Sheet," American Lung Association, 2004.

[23] Wright et al. studied the role of caregiver stress on infant asthma. Using a birth cohort with a family history of asthma to account for genetic predisposition, they find that greater stress levels experienced by caregivers when the child is 2 to 3 months old (before any symptoms of asthma can be detected) is associated with increased risk of recurrent episodes of wheezing (clinical definition of asthma) in children during the first 14 months of life. The findings are robust to established controls and potential mediators (including socioeconomic status, birth weight, race/ethnicity, maternal smoking, breast-feeding, indoor allergen exposure, and lower respiratory infections). In addition, the direction of causality runs from caregiver stress to levels of infant wheezing, rather than the reverse.

[24] This is consistent with the standard definition of childhood asthma, which is measured based on the response of a parent or adult household member ("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).

three. Within our sample, 25% report having asthma or an asthma attack by age three.[25] The incidence of asthma differs markedly by treatment status: A significantly higher proportion of children whose parents separated by age three reports have asthma (30%), relative to children whose parents remained romantically involved (22%).

Who Gets Separated?

Relationships that dissolve within three years after childbirth were potentially less stable at the onset ("childbirth"). Parents in visiting relationships at the time of childbirth are more likely than cohabiting parents to separate within three years after a premarital birth: 26% of cohabiting parents as opposed to 57% of visiting parents end their romantic ties within three years after childbirth (not shown). Children whose parents separate are potentially more likely unplanned, as indicated by the greater percentage of fathers who suggested abortion during the pregnancy. Having an unplanned pregnancy can strain a romantic relationship, as it has been found to be associated with less positive interactions between spouses (Cox et al., 1999).

Studies of married couples have found husbands' socioeconomic characteristics to be positively correlated with marital stability, but not the wife's (e.g., Whyte, 1990). One of the most important barriers to a stable relationship is financial instability, as a father that cannot contribute to the economic wellbeing of the family is seen as a liability (Edin, 2000). Consistent with this argument, we find that fathers who separate from the child's mother tend to be younger, foreign-born, less educated, and less attached to the labor force, relative to fathers who remain romantically involved with their child's mother. Low levels of education and poverty are linked to risky and abusive behavior (e.g., Clark et al., 2004). Unmarried non-resident fathers have been found to exhibit these risk factors at higher rates than married or cohabiting fathers (Wilson and Brooks-Gunn, 2001; Jaffee et al., 2001). Risk factors may lead to lower father involvement with children both directly or indirectly, by weakening relationships with the mother. Mothers may further mediate father involvement with the child even after their romantic relationship with the father has ended (Fagan and Barnett, 2003).

[25] According to the 2002 National Health Interview Survey, about 12% of U.S. children under the age of 18 are diagnosed with asthma, but the incidence is much higher among minority children (CDC, 2004). Diagnosing asthma in young children is more difficult than in older children, but an estimated 50% of kids with asthma develop symptoms by age two.

5 Estimation Results

Our descriptive evidence points to a negative association between parental separation and child's likelihood of developing asthma. However, one cannot readily conclude that this association is causal, as there may be factors that influence both the child outcomes and parental separation. Ideally, to determine whether this association ma be causal, we would like to identify the potential outcomes of these children *if their parents had remained romantically involved*. Since the counterfactual outcome is never directly observed, statistical methods rely on using observed outcomes of the control group to estimate the counterfactual.

In a standard OLS framework, the average outcomes of all control observations are used as the counterfactual. The linearity assumption permits data from 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). The estimation procedures create estimates that are complex averages of the typical treatment effect on the treated (ATET) and the treatment effect on controls (ATEC).[26] As a result, the outcomes of children who experience parental separation are potentially compared to children who are subjected to markedly different conditions, in addition to their treatment status. Hence, it is difficult to conclude whether the estimated effect is indeed causal, since it is potentially confounded by factors that drive parental relationship status as well.

Propensity score matching (PSM) methods relax the linearity assumption by matching each treated observation *only* with controls who share similar observable characteristics. In this setting, children who experience parental separation are compared only to children whose parents remain romantically involved but share very similar (environmental) characteristics, and not to children who have are subjected to very different conditions in addition to their treatment status. Hence, the estimated effect of parental separation is the average of the typical effect of treatment on the treated only, and the differences in their outcomes are taken as driven by their treatment status only (i.e. the "causal" effect of parental separation).

[26]This means that the ATET is assumed to be equivalent to the ATEC.

The Propensity Score of Parental Relationship Dissolution

The first step in implementing the matching method is to estimate the propensity score for the treatment ("parental separation") under study. Parents' propensity to separate is defined as a function of each parent's socioeconomic and demographic characteristics, child-specific characteristics observed at childbirth, and measures of union match quality. Table 2 presents the probit estimates of the propensity score.[27] Consistent with our descriptive evidence (holding everything else constant), parents who did not co-reside at the time of childbirth ("visiting relationships") are significantly more likely to dissolve their romantic relationship within three years after childbirth. Unmarried fathers who are young (less than 20 years of age), foreign-born, poorly educated, and work few hours per week are significantly more likely to see their romantic relationship with the child's mother end.

Main Findings

The estimated effect of parental separation within three years after childbirth on child's likelihood of developing asthma by age three are presented in Table 3.[28] We report both the OLS estimate (Column 2), and the propensity score matching estimates based on the Gaussian, Epanechnikov, and uniform kernel (radius) estimators, respectively (Columns 3 to 7). To assess the sensitivity of the estimates to the choice of bandwidth (or radius), we report results using different bandwidths (or radiuses).[29]

We find that parental separation within three years after childbirth significantly increases the child's likelihood of developing asthma by age three. Specifically, the matching estimates show that parental separation increases the child's likelihood of developing asthma by 6% to 7%. Recall that disadvantaged fathers are significantly more likely to dissolve their romantic relationships with the child's mother. A notable share of unmarried fathers have disadvantaged characteristics that may not be conducive to increase engagement (or sustain romantic involvement), hence the mothers are more likely to terminate their potentially "unhealthy" relationships (see Waller and Swisher, 2006). Recall that the

[27] Estimating the propensity score using a logit model produces very similar results.

[28] 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.

[29] For a detailed discussion, refer to the Technical Appendix.

PSM estimates the potential outcome difference of children whose parents separate if their parents had remained romantically involved. Hence, this result implies that, if these fathers had remained involved with their children's mothers, their children would have had significantly worse health outcomes.

We also note that while the matching estimates confirm the direction of the effect suggested by the parametric estimate, they are consistently larger in magnitude. This indicates that relationship dissolution is not as detrimental (at least for some children) for the health of out-of-wedlock children as one might suspect. To see this, consider an average child whose parents separate (treatment group). As discussed above, this child is more likely to have a father with risk factors. The fact that the outcome difference between a treated child and a child in the control group that does not (necessarily) share similar disadvantages is smaller than the outcome difference between the same treated child and a control child that does share these disadvantages implies that at least for some children in the treated group, having a disadvantaged father who is no longer involved with the mother is not as detrimental as if their parents had remained romantically involved.

6 Conclusion

To date, one in every three children in the U.S. is born to unmarried parents. As a results, understanding the influences of parental separation on out-of-wedlock children is becoming increasingly important. While the implications of relationship dissolution between married couples ("divorce") on their children has been extensively studied, the consequences of a break-up between unmarried couples on children involved has received very little systematic attention. The well-established negative association between parental divorce and child wellbeing may not readily generalize to the population of unmarried families, since couples who have children out-of-wedlock are known to be different from "traditional couples". Furthermore, existing evidence of a negative association between parental separation and child outcomes does not readily speak of a causal relationship since factors driving the dissolution may be correlated with determinants of child wellbeing.

This study documents a causal relationship of parental separation on child health among the population of out-of-wedlock children. Using a recent and representative sample of children all born to unmarried parents in the U.S. and adopting a treatment outcome framework to account for self-selection

into relationship dissolution, we provide evidence that parents' separation has a detrimental effect on child health. By matching children who share similar conditions but differ only in terms of whether their parents separate, we find that children whose parents separate are up to 7% more likely to develop asthma by age three. In addition, our results provide some evidence that the negative impact on children *could have been* even larger if the parents who dissolved their relationships had remained involved.

Our findings are consistent with explanations that poor health investments and caretaker stress are important determinants of asthma among young children. In particular, we find that socioeconomic disadvantages of fathers are crucial in explaining the relationship dissolution of unwed parents. Similarly, the status and quality of unmarried parents' relationships seem to be important predictors of early paternal involvement (Carlson and McLanahan, 2004; Johnson, 2001). In addition to the lack of available resources as a result of having a "deadbeat" dad, having a partner who is unable (and potentially unwilling) to provide for the family may contribute to relationship instability and heightened stress level for the mother. If the mother were to maintain a romantic relationship with the father, as opposed to being single or involved with a new partner, she may experience greater socioeconomic hardships and tension with adverse effects on her parenting behavior. Hence, promoting greater (or maintained) involvement between these parents may push them into unhealthy relationships (Allard et al., 1991; Raphael and Tolman, 1997), with potentially undesirable consequences for the children involved.

The rise in unmarried parenthood and research suggesting that children from single parent families face disadvantages as adults, prompted recent policies geared towards responsible fatherhood initiatives and promoting greater involvement of fathers with their biological children (Harden, 2002). While there is evidence suggesting that the majority of unmarried fathers are highly involved in their child's lives, especially during the first few years after childbirth (McLanahan et al., 1998), studies of divorced fathers indicate that men often disengage from their children when their romantic relationship with the mother ends (e.g., Furstenberg and Cherlin, 1991). Even more controversial, government funding for programs promoting fathers' co-residence with their children through marriage are in place. While our findings generally support stronger child support enforcements to protect out-of-wedlock children from socioeconomic hardship, policies that promote marriage between unmarried parents should be mindful that a notable share of the fathers that they are targeting will have characteristics that may not be conducive for healthy relationships nor increased engagement.

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TABLE 1: Sample Means by Relationship Status Three Years after an Out-of-Wedlock Birth

	Entire Sample		Parents' Relationship Status (3 Years after Childbirth)	
	Mean	[S.D.]	**Involved**	**Separated**
Child developed asthma by Age 3	0.249	[0.433]	0.221	0.298*
Parents Separated by Age 3	0.371	[0.483]		
Parents' Relationship at Childbirth				
Cohabiting	0.654	[0.476]	0.765	0.466*
Visiting	0.346	[0.476]	0.235	0.534*
Child Characteristics				
Child is of low birth weight ($<$ 88 oz)	0.107	[0.309]	0.108	0.105
Child is female	0.464	[0.499]	0.479	0.437
Child's birth order (mother):				
- 1^{st}	0.376	[0.485]	0.353	0.416*
- 2^{nd}	0.330	[0.470]	0.336	0.319
- 3^{rd} or higher	0.294	[0.456]	0.311	0.264+
Parent's Demographic Characteristics				
Mother's age $<$ 20 at childbirth	0.228	[0.419]	0.197	0.279*
Father's age $<$ 20 at childbirth	0.111	[0.315]	0.089	0.149*
Father is younger than mother	0.195	[0.380]	0.207	0.175
Mother's race/ethnicity:				
- white	0.165	[0.371]	0.185	0.129*
- black	0.523	[0.500]	0.456	0.635*
- Hispanic	0.285	[0.452]	0.331	0.207*
- other	0.028	[0.164]	0.027	0.029
Father's race/ethnicity:				
- white	0.126	[0.332]	0.144	0.095*
- black	0.557	[0.497]	0.495	0.662*
- Hispanic	0.285	[0.452]	0.328	0.213*
- other	0.032	[0.175]	0.032	0.030
Mother and father of different race/ethnicity	0.145	[0.353]	0.143	0.150
Mother is foreign-born	0.111	[0.315]	0.147	0.051*
Father is foreign-born	0.218	[0.413]	0.209	0.234
Child's Household Income				
Income less than $\$10,000$	0.202	[0.402]	0.163	0.269*
Income between $\$10,000$ and $\$24,999$	0.340	[0.474]	0.352	0.319
Income at least $\$25,000$	0.458	[0.498]	0.484	0.412*
N	1,419		893	526

(Continued)

TABLE 1: Sample Means by Relationship Status Three Years after an Out-of-Wedlock Birth

	Entire Sample		Parents' Relationship Status (3 Years after Childbirth)	
	Mean	[S.D.]	**Involved**	**Separated**
Parents' Education				
Mother's education:				
- less than H.S. diploma	0.367	[0.482]	0.364	0.373
- high school diploma / GED	0.356	[0.479]	0.345	0.375
- some college	0.247	[0.432]	0.285	0.230
- bachelor & beyond	0.030	[0.170]	0.034	0.023
Father's education:				
- less than H.S. diploma	0.375	[0.484]	0.386	0.357
- high school diploma / GED	0.383	[0.486]	0.354	0.434^{*}
- some college	0.213	[0.410]	0.229	0.186^{+}
- bachelor & beyond	0.028	[0.166]	0.032	0.023
Father is less educated than mother	0.271	[0.445]	0.279	0.257
Parents' Labor Market Activities				
Mother works	0.190	[0.393]	0.199	0.175
Mother's weekly hours of work	35.75	[9.199]	36.08	35.10
Mother's annual labor income:				
- less than $\$10,000$	0.423	[0.495]	0.417	0.432
- between $\$10,000$ and $\$24,999$	0.432	[0.496]	0.424	0.444
- at least $\$25,000$	0.145	[0.353]	0.158	0.123
Father works	0.839	[0.368]	0.862	0.798^{*}
Father's weekly hours of work	43.71	[11.52]	44.11	42.88
Father's annual labor income:				
- less than $\$10,000$	0.280	[0.449]	0.264	0.315^{+}
- between $\$10,000$ and $\$24,999$	0.473	[0.500]	0.466	0.486
- at least $\$25,000$	0.247	[0.431]	0.270	0.199^{*}
Mother's labor income $>$ father's	0.121	[0.328]	0.145	0.071
Other Characteristics				
Mother is catholic	0.281	[0.450]	0.326	0.204^{*}
Mother reports no religious affiliation	0.128	[0.334]	0.123	0.137
Mother attends religious activities frequently	0.166	[0.372]	0.165	0.169
Parents' have known each other for <1 Year before pregnancy	0.245	[0.430]	0.236	0.260
Father suggested abortion during pregnancy	0.152	[0.359]	0.137	0.177^{*}
Prenatal smoking and/or drinking (mother)	0.268	[0.443]	0.263	0.278
Maternal grandmother's education ($>$ HS)	0.216	[0.412]	0.218	0.213
Mother's PPVT score (Year 3)	88.11	[11.15]	88.58	87.39^{+}
N	1,419		893	526

Notes: Sample means between "children whose parents remained romantically involved" and "children whose parents separated" by age 3 is statistically significantly different at the $^{*} = 5\%$ level, $^{+} = 10\%$ level.

TABLE 2: Probit Estimates of the Propensity Score

	Coefficient	Robust Standard Error	$P > \|z\|$
Child is of low birth weight ($<$ 88 oz)	-0.034	0.120	[0.780]
Child is female	-0.080	0.073	[0.278]
Child's birth order (mother):			
- (Ref: 1^{st})			
- 2^{nd}	-0.114	0.092	[0.214]
- 3^{rd} or higher	-0.170	0.104	[0.101]
Mother's age $<$ 20	0.048	0.107	[0.652]
Father's age $<$ 20	0.227	0.134	[0.091]
Father is younger than mother	-0.059	0.103	[0.565]
Parents' race/ethnicity:			
- (Ref: both black)			
- both white	-0.274	0.144	[0.057]
- both Hispanic	-0.122	0.150	[0.413]
- both other	0.312	0.397	[0.432]
- mother is white, father is non-white	-0.002	0.198	[0.992]
- mother is black, father is non-black	0.213	0.224	[0.343]
- mother is Hispanic, father is non-Hispanic	0.074	0.203	[0.717]
- mother is other, father is non-other	-0.218	0.465	[0.639]
Parents' region of birth:			
- (Ref: both U.S.)			
- mother is foreign-born, father is not	-0.403	0.278	[0.147]
- father is foreign-born, mother is not	0.308	0.122	[0.011]
- both parents are foreign-born	-0.318	0.183	[0.081]
Mother's education:			
- (Ref: less than HS)			
- H.S. diploma / GED	-0.059	0.156	[0.703]
- some college	-0.146	0.255	[0.567]
- bachelor & beyond	-0.440	0.424	[0.299]
Father's education:			
- (Ref: less than HS)			
- H.S. diploma / GED	0.250	0.150	[0.095]
- some college	0.174	0.251	[0.488]
- bachelor & beyond	0.344	0.422	[0.415]

(Continued)

TABLE 2: Probit Estimates of the Propensity Score

	Coefficient	Robust Standard Error	$P > \|z\|$
Father's education relative to mother's:			
- (Ref: same)			
- less	0.061	0.174	[0.725]
- more	−0.131	0.169	[0.439]
Child's household income:			
- (Ref: less than $\$10,000$)			
- between $\$10,000$ and $\$24,999$	−0.153	0.112	[0.172]
- at least $\$25,000$	−0.092	0.117	[0.428]
Parents' labor force participation:			
- (Ref: neither parents work)			
- both parents work	−0.092	0.361	[0.800]
- only mother works	0.358	0.423	[0.397]
- only father works	0.219	0.137	[0.109]
Mother's weekly hours of work	0.007	0.009	[0.450]
Father's weekly hours of work	−0.005	0.002	[0.034]
Mother's labor income exceeds father's	−0.538	0.336	[0.110]
Length of parents' relationship before pregnancy:			
- (Ref: more than 2 years)			
- less than 6 months	0.030	0.123	[0.807]
- 6 months to 1 year	0.173	0.112	[0.120]
- 1 to 2 years	0.029	0.095	[0.762]
Mother is catholic	−0.078	0.113	[0.490]
Mother has no religious affiliation	0.031	0.114	[0.786]
Mother attends religious activities frequently	−0.003	0.102	[0.978]
Father suggested abortion during pregnancy	−0.007	0.101	[0.946]
Maternal grandmother attained more than a high school education	−0.055	0.099	[0.576]
Prenatal smoking / drinking (mother)	0.105	0.089	[0.242]
Parents in visiting relationship at childbirth	0.604	0.085	[0.000]
Mother's PPVT score (Year 3)	−0.000	0.004	[0.965]
Constant	−0.570	0.441	[0.196]
Log Likelihood $= -821.31$			
Pseudo $R^2 = 0.132$			

Notes: [a] Additional controls for "mother's state of residence at childbirth" (14 state dummies) omitted here. [b] Region of Common Support $\in$ [0.05292221, 0.83660801].

FIGURE 1: Box Plot of the Propensity Score Overlap

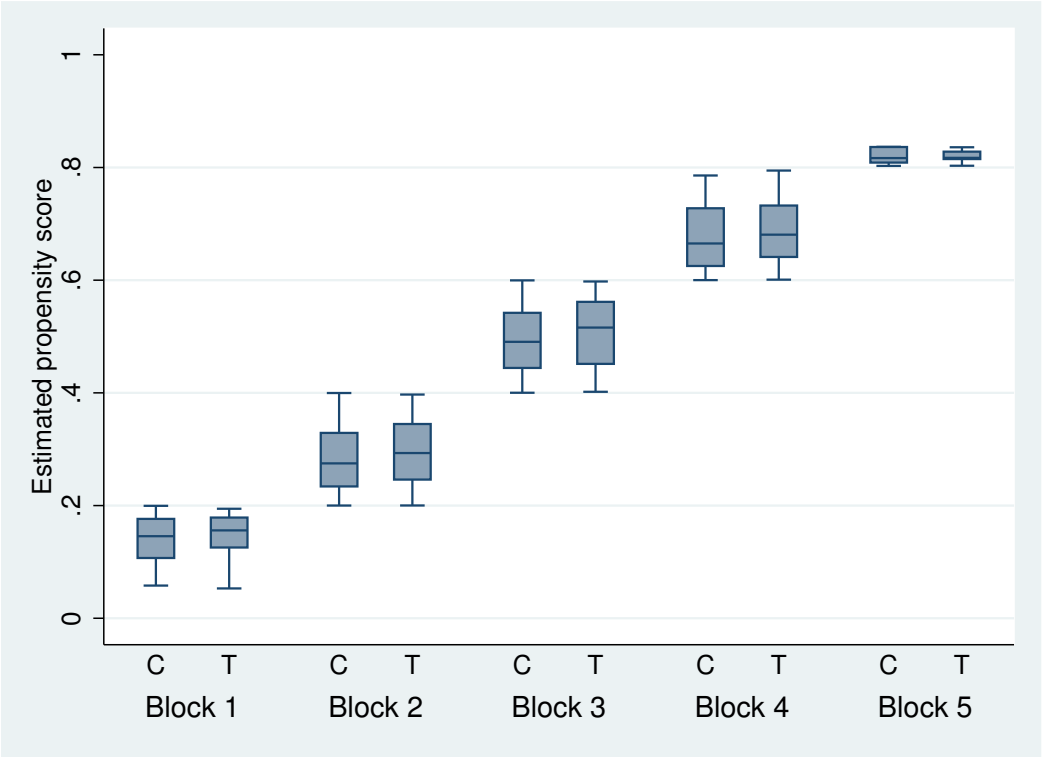


TABLE 3: Effect of Parents' Separation on the Child's Likelihood of Developing Asthma by Age 3

	OLS	**Propensity Score Matching**				
		Gaussian Kernel	Epanechnikov Kernel		Radius	
			($h = 0.01$)	($h = 0.005$)	($r = 0.01$)	($r = 0.005$)
Estimate	0.052*	0.061*	0.071*	0.071*	0.067*	0.069*
Standard Error	[0.026]	[0.028]	[0.033]	[0.035]	[0.027]	[0.028]
N Treated		526	526	526	526	517
N Controls		893	893	893	880	862
% Matched Treated		100	100	100	100	98

Total Treated: $N = 526$
Total Controls: $N = 893$

Notes: [a] h = Bandwidth, and r = Radius; [b] Robust standard error reported for the OLS estimate, standard errors for the matching estimates are obtained by bootstrapping with 500 replications. [c] 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] Estimated propensity score in region of common support [0.05292221, 0.83660801], which is defined by the minimum estimated propensity score within the treatment group, and the maximum estimated propensity score within the control group; [e] The propensity score is estimated using a probit model with the following specification: $Pr[S_i = 1] = F$[Parents' relationship status at childbirth, child is of low birth weight, child gender, birth order of the child (mother), mother is less than 20 years old, father is less than 20 years old, father is younger than mother, both parents are white, both parents are Hispanic, both parents are of other race, mother is white (not father), mother is Hispanic (not father), mother is of other race (not father), mother is foreign-born (not father), father is foreign-born (not mother), both parents are foreign-born, mother's education, father's education, father is less educated than mother, father is more educated than mother, length of time parents knew 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 and/or drinking (mother), household income at childbirth, mother works (not father), father works (not mother), both parents work, mother's hours of work per week at childbirth, father's hours of work per week at childbirth, mother's labor income exceeds father's, maternal grandmother has some college education (or more), mother's state of residence at childbirth]; [f] 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 ($\widehat{h} \approx 0.048$) 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 8 control and 7 treated units being dropped from our main analysis. To ensure that our estimates are not sensitive to the inclusion of these observations, we relax the common support condition and re-estimate the ATET using all $1,434$ observations.

Appendix Figure 2 presents the box plot of the propensity score overlap for this sample. Overall, the ATET estimates obtained by relaxing the common support condition are very 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. 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" effect of parents' separation within three years 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 health development. All of our matching estimates show that parents' separation has no effect on child's 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

	Block 1	Block 2	Block 3	Block 4	Block 5
Range of the Propensity Score	$[0.053, 0.200]$	$[0.200, 0.400]$	$[0.400, 0.600]$	$[0.600, 0.800]$	$[0.800, 0.837]$
N Treated	37	166	175	133	15
N Controls	264	392	169	62	6
		Two-Sample Test of Means: Significance Level $= 0.01$ $\lvert T \rvert$ **Statistic**			
Propensity Score	1.314	2.432	2.136	1.116	0.005
Child is of low birth weight ($<$ 88 oz)	0.592	1.236	0.778	0.323	0.679
Child is female	0.105	1.006	0.150	0.897	0.400
Child birth order (mother):					
- (Ref: 1^{st})					
- 2^{nd}	0.640	0.660	1.185	2.102	1.405
- 3^{rd} or higher	1.173	0.751	0.308	0.226	0.679
Mother's age ($<$ 20)	1.372	0.619	0.262	0.149	0.535
Father's age ($<$ 20)	0.842	1.020	0.443	0.618	0.291
Father is younger than mother	0.316	0.906	1.587	0.120	0.623
Parents' Race/Ethnicity:					
- (Ref: Both parents are black)					
- Both parents are white	0.274	0.643	0.449	1.011	0.000
- Both parents are Hispanic	0.225	1.206	0.779	0.538	0.000
- Both parents are of "other" race/ethnicity	0.018	1.386	0.427	0.787	0.679
- Mother $=$ white, Father $\neq$ non-white	0.755	0.144	0.157	0.293	0.000
- Mother $=$ black, Father $\neq$ non-black	0.374	1.150	0.664	1.772	1.165
- Mother $=$ Hispanic, Father $\neq$ non-Hispanic	0.515	1.308	0.891	0.420	0.000
- Mother $=$ other, Father $\neq$ other	0.752	1.150	0.043	0.057	0.679
Parents' Region of Birth:					
- (Ref: Both parents are born in U.S.)					
- Mother is foreign-born (not Father)	0.032	0.069	0.025	0.000	0.000
- Father is foreign-born (not Mother)	1.114	1.490	0.717	1.140	0.400
- Both parents are foreign-born	0.966	1.210	2.104	0.682	0.000
Child household income: (Ref: $<$ \$10,000)					
- between \$10,000 to \$24,999	0.452	0.267	0.057	0.251	1.405
- More than \$25,000	0.338	0.185	0.341	0.515	0.623
Parents' Educational Backgrounds:					
- (Ref: Less than HS)					

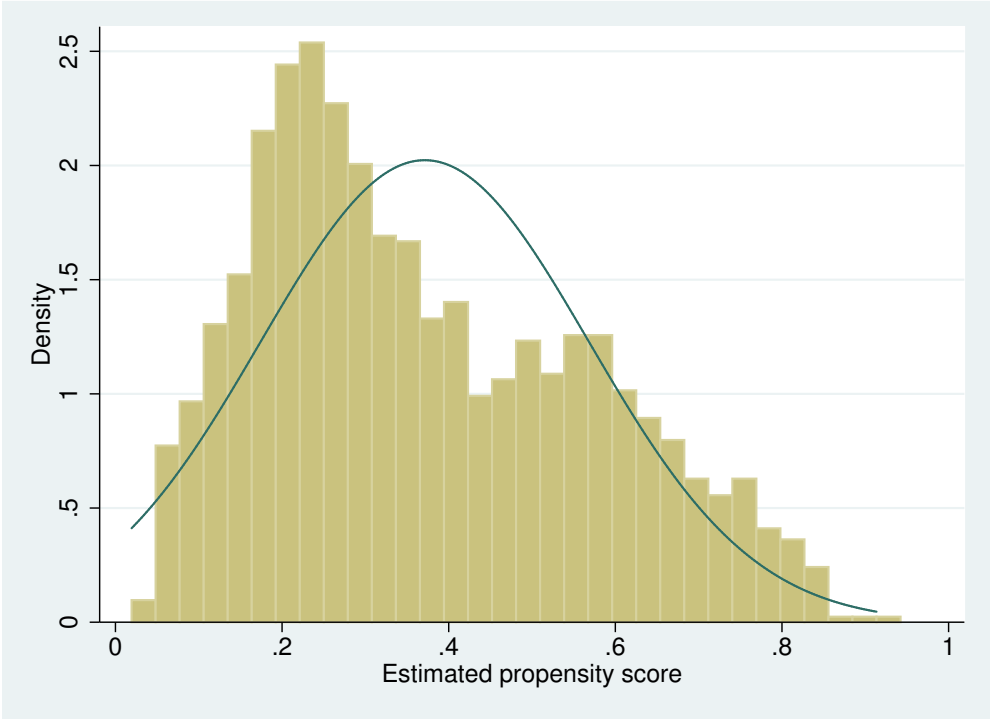
(Continued)

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
- Mother's education: H.S. diploma / GED	1.898	1.198	0.801	1.247	0.400
- Mother's education: some college	0.859	1.383	1.410	1.047	0.914
- Mother's education: bachelor and beyond	1.026	0.018	1.227	0.553	0.000
- Father's education: H.S. diploma / GED	1.530	1.055	1.041	2.422	0.734
- Father's education: some college	0.070	0.091	0.408	1.403	0.914
- Father's education: bachelor and beyond	0.515	0.333	1.312	0.057	0.000
Mother's education relative to father's:					
- (Ref: Same)					
- Father is less educated than Mother	1.355	1.897	1.229	0.230	0.167
- Father is more educated than Mother	0.164	0.245	0.561	0.666	1.371
Parents' labor force participation:					
- (Ref: Neither parents work)					
- Both parents work	1.018	0.453	0.585	0.334	1.648
- Only Mother works	0.000	0.650	0.247	0.571	0.167
- Only Father works	1.024	0.727	0.306	0.167	0.291
Mother's weekly hours of work	0.627	0.404	0.451	0.450	0.035
Father's weekly hours of work	0.396	0.713	1.918	0.506	0.077
Mother's labor inc. $>$ Father's labor inc.	1.065	1.462	0.025	0.000	0.000
Length of parents' relationship prior to preg.					
- (Ref: $>$ 2 yrs)					
- $\leq$ 6 months	1.527	0.293	0.781	0.509	1.165
- 6 months $\sim$ 1 year	0.400	0.414	0.855	0.900	0.623
- 1 year $\sim$ 2 years	1.050	0.587	1.673	0.230	1.031
Mother is catholic	0.451	0.084	0.291	0.862	0.623
Mother has no religious affiliation	1.547	1.691	0.837	0.148	0.914
Mother attends religious activities	1.608	1.482	1.005	0.874	0.465
(at least few times a week)					
Father suggested abortion during pregnancy	0.122	0.814	0.568	0.496	1.405
Maternal grandmother's education	0.450	0.439	0.742	0.077	0.679
(some college and beyond)					
Prenatal smoking or drinking (mother)	1.678	0.329	1.046	0.423	0.167
Parents in visiting relationship (baseline)	1.114	0.092	1.259	0.186	0.000
Mother's PPVT score (Measured at Year 3)	1.786	1.327	0.782	0.653	0.401

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).

APPENDIX FIGURE 1: Distribution of the Estimated Propensity Score
(Relaxing the Common Support Condition)



APPENDIX FIGURE 2: Box Plot of the Propensity Score
(Relaxing the Common Support Condition)