EFFECTS OF MENTAL HEALTH ON COUPLE RELATIONSHIP STATUS

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ABSTRACT

We exploit the occurrence of postpartum depression (PPD), which has a random component according to the medical community, to estimate causal effects of a salient form of mental illness on couples' relationship status. We estimate single-equation models as well as bivariate probit models that address the endogeneity of PPD. We find that this relatively prevalent mental illness reduces the probability the couples are married (by 22–24%) as well the probability that they are living together (married or cohabiting) (by 24–26%) three years after the birth of the child. Models stratified by relationship status at the time of the birth indicate that PPD makes it more likely that unions dissolve (particularly among baseline cohabitors) and less likely that unions are formed (particularly among baseline non-cohabitors). The findings contribute to the literature on the effects of mental illness on relationships and to the broader literature on socioeconomic status and health.

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This study exploits the occurrence of postpartum depression, which is not uncommon and has at least some random component according to the medical community (O'Hara & Swain, 1996), to estimate causal effects of a salient form of mental illness on couples' relationship status and changes, outcomes that a growing literature has shown are important for many dimensions of parent and child well-being. Postpartum depression (PPD), which is defined as moderate to severe depression in a woman after she has given birth, is experienced by 10–20% of all childbearing women within 6 months of delivery (Miller, 2002). Symptoms include despondent mood, changes in sleeping and eating patterns, feelings of inadequacy as a parent, and impaired concentration (Miller, 2002).

Most research on links between mental illness and relationship status has focused on the effects of marriage on mental health (see Gove et al., 1983). Evidence on the reverse pathway (from mental health to relationship status) is much rarer, despite economic theory suggesting that mental illness would adversely affect couples' relationships and the fact that mental disorders are the leading cause of disability not only in the U.S., where 26% of adults suffer from a mental disorder in a given year (NIMH, 2013), but also in much of the world (Kessler et al., 2009). Selection into relationships on the basis of mental or physical health is often treated as a troublesome source of confounding in studies of the effects of relationship status on health rather than as a question of substantive interest in its own right.

The existing literature on the effects of mental illness on relationship status has focused largely on marriage, has focused on a patchwork of populations and outcomes, and does not lend itself to making causal inferences. Simon (2002) and Wade and Pevalin (2004) used panel data to explore relationships between mental health (depression in Simon; a composite measure in Wade & Pevalin) and changes in marital status. Both studies found that mental illness often predates

marital dissolution, although Simon pointed out that part of what may be going on is that marital discord is leading to marital dissolution, with the discord causing depression along the way. Simon did not find evidence that depression is associated with subsequent transitions to marriage in a nationally representative U.S. sample and, using the same data as used by Simon (National Survey of Families and Households, NSFH), Lamb et al. (2003) did not find that depression predicts subsequent marriage or cohabitation. Together, these studies found little evidence that depression is associated with the subsequent union formation, but that it may be associated with dissolution.

Agerbo and colleagues (2004), using Danish registry data, found that schizophrenia increased the likelihood that individuals remained unmarried over a 25-year period. Schizophrenia, although it is a severe disorder and relatively rare, is useful for assessing causality because it is less likely to be caused by social circumstances than many other mental illnesses, including depression (Dohrenwend et al., 1992). However, the findings cannot necessarily be generalized to more common and less severe types of mental illness.

Bartel and Taubman (1986) considered different classes of diagnoses as well as when during the life course the individual was diagnosed. Using panel data on veterans, they examined the effects of psychoses (e.g., schizophrenia), neuroses (e.g., mood disorders), and other mental illnesses on the likelihood of marriage. They found that neuroses diagnosed when the individual was young were negatively associated with marriage, but that recent diagnoses were not. They found no associations for psychoses or other mental illnesses in their sample of men who had served in the military.

Two studies considered the effects of mental illness on the timing, rather than incidence, of marriage. Forthofer and colleagues (1996) looked at many specific diagnoses and found that

affective disorders (particularly depression) and conduct disorder have substantial associations with timing of entry into first marriage for both women and men. In particular, those disorders were positively associated with early first marriage, defined as marriage before age 19. Teitler and Reichman (2008) investigated how a history of mental illness is related to a woman's likelihood of marriage over a 5-year period following a non-marital birth. They found that by 1 year after giving birth, 10% of mothers without mental illness had married, compared to 5% of mothers with mental illness. By 5 years, the respective figures were 26 and 16%; that is, mothers with mental illness were about 40% less likely to have married.

The evidence from this body of literature suggests that the mental illness may affect relationship status, but that the potential effects vary by the type of mental disorder, outcome, timing of mental illness relative to the outcome, and population studied. Depression is perhaps the most important mental illness to consider, as it is the leading cause of disability in the U.S. for individuals ages 15-44, particularly women (NIMH, 2013). As far as we know, no previous studies of the effects of mental illness on relationship status have explicitly addressed the potential endogeneity of mental illness. Additionally, most studies have focused on marriage (i.e., not on non-marital cohabitation or other relationship types). This study addresses those gaps by focusing on the effects of PPD—a salient and relatively common form of mental illness with clear timing of onset—on parents' relationship status within a clearly defined 3-year period in a contemporary sample with high rates of relationship change, explicitly addressing the potential endogeneity of mental illness, and focusing on couple relationships and relationship changes well beyond a marital/non-marital dichotomy.

Theoretical Model

According to Weiss and Willis (1997), marriages dissolve because individuals obtain new information about partners, leading to a reassessment of the expected net benefits of maintaining relationships, or because there is an unexpected change in an important factor, such as health or earnings, which reduces the expected net benefits of remaining in the relationship. In their model, generalized as Equation 1 below, the probability of divorce (D) depends on the husband's characteristics at time t (x_{ht}), the wife's characteristics at time t (x_{wt}), laws or other factors that affect the divorce settlement (s_t), marital capital such as children or joint assets (k_t), and the quality of the relationship (θ_t,) which is generally unobserved.

(1) $D = D(x_{ht}, x_{wt}, s_t, k_t, \theta_t)$

Weiss and Willis focused on one specific type of change—a partner's earnings at time t differing substantially from that individual's expected earnings at the time the relationship was formed. The authors posited that unexpected positive changes in earnings could either strengthen or weaken the relationship. While the individual whose earnings increased will become more valuable to his/her partner, that individual will also become more desirable to other potential partners and the net effect will reflect the relative strength of these two opposing forces. Using data from the 1972 National Longitudinal Survey of Youth, Weiss and Willis found that for men, higher than expected earnings decrease the probability of divorce, whereas for women, higher than expected earnings increase the probability of divorce. They found that expected earnings of the partner at the *time of the marriage* do not affect the probability of divorce and inferred that unexpected changes in earnings are an important factor in marital dissolution.

Recent literature, including the Weiss and Willis article, has acknowledged the growth in, and importance of, non-marital cohabiting relationships and non-marital childbearing. In terms of the latter, the percentage of births in the U.S. taking place outside of marriage increased from

11% in 1970 to 41% in 2009 (Wildsmith et al., 2011). Carlson, McLanahan and England (2004) discussed the range of contemporary relationship types among new parents and argued that it may be more appropriate to consider "union formation" and "union dissolution" more broadly than changes within the traditional marital/nonmarital dichotomy. The authors hypothesized that the same factors that affect changes in marital status would affect changes in relationship types with looser bonds of commitment, such as non-marital cohabitation, but that the strength of the associations may differ, depending on the factor considered. Their findings are generally consistent with that hypothesis.

The Weiss and Willis model could be applied to study any life event that is unexpected and that affects the arguments in Equation (1). E.g., Wolfers (2006) studied the effects of changes in divorce laws on divorce rates, carefully disentangling pre-existing trends from the policy implementation, and found that implementation of unilateral divorce laws (which loosen restrictions to divorce) significantly increase divorce rates. Reichman et al. (2004) found that a shock in child quality—i.e., having a newborn with an unexpected but severe exogenous health problem as opposed to having a healthy newborn—decreases the probability that the parents live together 12–18 months later.

In this study, we investigate the extent to which a mental health shock—PPD—affects couples' relationship status and transitions. We would expect this particular shock to have negative impacts on the relationship (e.g., reduce the probability the couple would maintain a cohabiting or marital union) and that the effects would operate through changes in (1) relationship quality (θ), (2) the woman's personal attributes (x_{wt}), and/or (3) relationship capital (k_t). In terms of (1), previous studies have found that maternal depression is associated with marital discord and conflict (e.g., Burke, 2003). In terms of (2), Marcotte et al. (2000) found,

using econometric techniques to address endogeneity, that depression reduces women's labor supply. In terms of (3), PPD appears to have adverse effects on maternal-infant interactions (e.g., Murray et al., 1996; Field, 2010) and parenting practices (e.g., Field, 2010); that is, depression may reduce the mother's investment in the new child (and potentially the couple's other children) and hence the family unit. Declines in relationship quality (θ) and in relationship capital (k_t) would increase the chance of relationship dissolution. However, potential deterioration in the mother's characteristics (x_{wt}) would have an ambiguous effect. The mother may be more likely to remain in the relationship because she is less desirable to other potential partners, but the father may be more likely to leave the relationship because the mother is relatively less desirable. Overall, we expect PPD to decrease the likelihood that a couple is married or in a cohabiting relationship a few years later, increase the probability of relationship dissolution, and decrease the probability of that the couple will form a stronger union (e.g., cohabiting to married).

Data

The Fragile Families and Child Wellbeing (FFCWB) study follows a cohort of parents and their newborn children in 20 large cities in the U.S. The study randomly sampled births in 75 hospitals between 1998 and 2000. By design, 75% of the mothers were unmarried at the time of the birth (baseline). Face-to-face interviews were conducted with 4,898 mothers while they were still in the hospital after giving birth (see Reichman et al. 2001), with a baseline response rate of 86% among eligible mothers. The newborns' fathers were also interviewed.

Follow-up interviews were conducted over the telephone approximately 1 and 3 years after the birth of the child (there were also 5- and 9-year interviews, which were not used for our study). Eighty nine percent of the mothers who completed baseline interviews were re-

interviewed when their children were 1 year old and 86% of mothers who completed baseline interviews were re-interviewed when their children were 3 years old. As part of an "add on" study to the core survey, data from medical records (from the birth hospitalization) were collected. The availability of medical record data depended, for the most part, on administrative processes of hospitals rather than decisions on the part of survey respondents to make their records available. Medical record data are available for 3,684 (75%) of the 4,898 births in the FFCWB sample.

The FFCWB data are well suited for analyzing the effects of PPD on parents' relationship status because they include: (1) survey questions asked at the 1-year follow-up interview that allow us to characterize depression during the postpartum year; (2) detailed survey questions at all interviews that allow us to characterize couple relationship status and changes; (3) data from hospital medical records, allowing us to construct measures of the mother's mental and physical health before the focal child was born; and (4) rich data to use for control variables or identifiers for PPD, including the mother's parents' history of depressive symptoms.

Methodological Approach

As discussed above, a key limitation of the small and fragmented literature on the effects of mental illness on relationship status is that existing studies have not been able to address the endogeneity of mental illness. As discussed by Simon (2002), it is very difficult to establish the timing of mental illness relative to changes in couples' relationships that lead to status changes, and it is possible that both mental illness and relationship status/changes are associated with unobserved factors. As such, it would be ideal to consider a *shock* to mental health and observe the couple's relationship status before and after the shock. We adopt this strategy by considering PPD, which is not uncommon and has a large random component according to the medical

community, and using a multi-pronged estimation strategy to assess robustness of our results and explore patterns in our estimates.

In our first main set of analyses, we estimate multivariate probit models of the effects of PPD (assessed at 1 year) on the parents' relationship status at 3 years, controlling for relationship status at the time of the birth (before the PPD) and a host of potentially confounding variables. We focus on the 3-year endpoint (versus 1 or 5 years) for three reasons: (1) in order to preserve the temporal ordering of events—so that the PPD, if any, clearly precedes relationship changes that may occur; (2) so that relationship changes are not so far removed temporally from the PPD that they are likely to reflect factors other than PPD; and (3) because we observe substantial relationship change within the relevant 3-year period in our data.

According to O'Hara and Swain (1996), PPD is unrelated to many sociodemographic characteristics, but strongly associated with having a history of psychopathology. We explore the extent to which this is the case in our sample and include both detailed sociodemographic characteristics and medically-documented prenatal mental illness (as described later), as well as measures of the mother's parents' history of depressive symptoms, in our models. We estimate models for the sample overall and for salient subsamples (e.g., by prenatal mental illness), and conduct a number of specification checks. We also conduct falsification or placebo tests that exploit our ability to establish the temporal ordering of events and allow us to assess whether we observe "effects" in implausible cases (i.e., the post-birth shock predicting relationship status at the time of the birth, which it should not). Additionally, we estimate 2-stage models using the grandparents' history of depressive symptoms as identifiers for PPD and conduct relevant statistical tests.

Finally, we stratify the sample by baseline relationship status in order to estimate the effects of PPD on specific types of relationship status changes between baseline and three years. For mothers who were married at baseline, we estimate probit models predicting remaining married to the father at three years. For baseline cohabitors, we estimate multinomial probit models predicting both becoming married and living apart at three years, versus maintaining the cohabiting relationship. For those who were not living together at baseline, we estimate multinomial probit models predicting transitions to both cohabitation and marriage, compared to continuing living apart.

Descriptive Analysis

The sample is limited to cases for which medical record data are available and the mother completed both the 1-year and 3-year surveys. Of the 3,684 mothers with medical record data (needed to control for prenatal mental illness), 3,031 completed both the 1- and 3-year surveys. Of the 3,031 mothers, 24 were excluded from the analyses because the baby's father was deceased, another 27 were excluded because of missing information on relationship status at 3 years, and 97 additional mothers were excluded because of missing data on covariates, leaving an analysis sample of 2,883 cases. We describe our measures below and present summary statistics in Tables 1 and 2. Unless indicated otherwise, all covariates are measured at baseline, to ensure that these characteristics preceded the birth and therefore the PPD if that occurred.

Postpartum depression

We measure PPD using a dichotomous indicator for whether the mother met the diagnostic criteria for major depression in the past 12 months according to the Composite International Diagnostic Interview Short Form (CIDI-SF) Version 1.0 November 1998, which was embedded in the mother's 1-year follow-up interview. Our main (validated) measure of

depression is based on a count of number of depressive symptoms ranging from 0 to 7, with a major depressive episode defined as the experience of 3 or more symptoms of dysphoria or anhedonia for most of the day for a period of at least 2 weeks. The symptoms include being sad, being blue, and losing interest in things (FFCWB, 2012). Twelve percent of the mothers in our sample experienced depression in the 12 months prior to their 1-year interviews based on this measure. We assess sensitivity to a broader validated measure characterizing respondents who reported experiencing symptoms for at least half the day (instead of most of the day) for a period of at least 2 weeks in the 12 months prior to their 1-year interviews (FFCWB 2012). Sixteen percent of mothers in our sample are characterized having experienced depression based on this more inclusive measure.

As discussed by Mitchell et al. (2011), who similarly characterized PPD with FFCWB data, measures of depression based on the 1-year CIDI characterize any depression during the postpartum year and therefore may capture depressive episodes not directly related to childbearing. In addition, the questions were asked one year after childbirth, so some mothers who experienced PPD shortly after giving birth may have faulty recall. Despite these issues, Mitchell et al. found that rates of CIDI-based depression in the postpartum year among FFCWB mothers fell in the expected range for PPD.

Relationship status and changes

At baseline, mothers were asked to classify their relationship status with the focal child's father as married, cohabiting, romantically involved but not living together, friends, or little or no relationship. At the follow-up interviews, there was an additional category for separation or divorce. The relationship statuses of the couples in our sample at baseline and three years are cross-tabulated in Table 1. Over three quarters (76%) of the mothers were unmarried (reflecting

the oversampling of non-marital births in the FFCWB study) and almost half (49%) of mothers who were unmarried cohabited with the father at the time of the birth. Almost one third (31%) of the mothers in the sample reported three years later that they were married to the focal child's father, and 20% reported that they and the father were cohabiting. Thus, about half (51%) of the mothers were living with (married or cohabiting with) the focal child's father at the time of 3-year interview.

We consider both relationship status and changes as outcomes. For relationship status, we consider whether the mother and father of the child were married at the time of the mother's 3-year interview and also whether they were living together (married or cohabiting) at that time. A large literature indicates that having married parents is strongly associated with favorable educational, social, cognitive, and behavioral outcomes (e.g., see Brown, 2010). In addition, a recent critical review indicates that father residence in the household (which can include cohabiting unions) has positive effects on socio-emotional adjustment, high school graduation, and adult mental health of offspring (McLanahan et al., 2012). The effects are thought to operate through financial resources, time, and social capital (e.g., the father's relatives) (McLanahan 1999). For relationship changes, we consider the following changes from baseline to three years—married to unmarried, cohabiting to married, cohabiting to not living together, not living together to cohabiting, and not living together to married.

As can be seen in Table 1, there was considerable fluidity in parental relationships in our sample. For couples who cohabited at the time of the birth, over half changed status by three years. Among baseline cohabiters, over 20% were married to the father of the focal child and over 40% of the couples were no longer living together by the 3-year survey. The group with the least change in status was the baseline married group, although even that group had a non-trivial rate of dissolution (12% no longer lived together at three years). Among couples who were living

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in the same household at the time of the birth (married or cohabiting), the father was no longer in the household at three years in 29% of the cases. In sum, over one-third of couples changed status within the 3-year observation window, with slightly more than half of those who changed status moving in the direction of less commitment.

Other analysis variables

The means for all covariates are shown in Table 2, both for the sample as a whole and by whether the mother had PPD. Below we discuss the overall characteristics of the sample and then the differences in those characteristics by whether the mother had PPD.

Overall sample characteristics

As PPD is strongly associated with a history of psychopathology, it is necessary to control for the prenatal mental health situation in order to ensure that we are estimating the effects of postpartum, rather than pre-existing or ongoing depression. We control for the mother's history of mental illness, based on documentation of any pre-existing mental illness (e.g., specific diagnoses, indication of use of psychiatric drugs, indication of mental illness in progress notes) in her prenatal medical record. About 11% of the mothers in the sample had a history of diagnosed mental illness.

The choice of the other covariates was guided by the theoretical model presented earlier. These include a basic set of sociodemographic characteristics of the mother (pre-existing components of x_w in Equation 1)—age, race/ethnicity, nativity, education, whether the mother lived with both of her own parents at age 15 (proxy for family structure growing up), whether the birth was covered by Medicaid or other public insurance (proxy for poverty), whether the mother was employed during the 2-year period preceding the child's birth, whether the mother attended religious services several times per month, and the percent of households living below the

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poverty line in the mother's neighborhood (Census Tract). Education was classified as less than high school, high school graduate, some college, and college graduate. We include an indicator for missing data on neighborhood poverty, which applied to 3% of our sample, and set the census tract poverty rate to the sample mean for those cases. We also include indicators for the mother's state of residence at the time of the baseline interview in order to control for state policies or other potentially confounding state-level factors (s in Equation 1).

The mothers were relatively young when their children were born (mean was 25 years). About half of the sample was non-Hispanic black and a quarter was Hispanic. About 1 in 7 was foreign born. Education levels were low; over a third of the mothers did not complete high school, and only 10% were college graduates. About two thirds of the births were covered by Medicaid or public insurance. Most mothers (81%) worked within the 2-year period preceding the child's birth, and over a third (38%) regularly attended religious services.

Because mental illness is often associated with physical illness and the directionality is not always clear (Prince et al., 2007), we include a measure of the mother's physical health at the time of the birth. We code the mother as having a physical health condition if there was any documentation of a pre-existing physical health condition in her prenatal medical record (20%).

In order to be sure that we do not misattribute characteristics of the child to PPD, we include several variables related to the focal child that have been demonstrated in past research to affect relationship status and changes—gender (Lundberg & Rose, 2003), multiple birth (Jena et al., 2011), and poor infant health (Reichman et al., 2004). Some of these factors have also been related to PPD (e.g., Stowe & Nemeroff, 1995; Choi et al., 2009). For poor infant health, we use a measure that we call "severe infant health condition," which was demonstrated to reflect an exogenous shock in past research (e.g., Corman et al., 2011; Curtis et al., forthcoming).

That measure, which is based primarily on information abstracted from the hospital medical records (from the birth hospitalization) is described in Appendix Table 1. We also include the age (in months) of the child at the time of the 3-year interview, to control for time of exposure to potential parental relationship transitions.

We include measures of the parents' baseline relationship status (discussed earlier), plus a number of measures that may capture relationship quality and/or relationship capital (θ and k, respectively, in Equation 1)—whether the father visited the hospital during the birth hospitalization (82%), the number of months the mother and father knew each other prior to the birth, whether the mother and father had any previous children together; whether the mother had children with another partner, whether the father had children with another partner (this variable was measured at 1 year due to data availability), and whether the father did not complete a baseline interview, which may be an indicator of his involvement with the mother and was also used to control for the father's risk for depression at baseline, as described below.

We include sociodemographic information about the infant's father (x_h in Equation 1)—if he is of a different race/ethnicity than the mother, how much older he was than the mother (in years), if his education was in a category (of those listed earlier for mothers) below the mother's, and if his education was in a category above the mother's (both paternal education variables are relative to having education in the same category as the mother). We express these characteristics as differences from the mother for both practical and substantive reasons. Practically, there is a high degree of correlation in these factors within couples (e.g., the correlation between mother's and father's age is 0.75), making it difficult to disentangle independent associations. Substantively, a large literature in economics and sociology indicates

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that deviations from assortative mating along these and other dimensions are negative predictors of relationship stability (e.g., in theoretical work by Becker, Landes & Michael, 1977).

We also include measures of the father's physical and mental health. We code paternal suboptimal health using the father's self-reports of his overall health status (good, fair or poor, vs. excellent or very good). Forty percent of the fathers had suboptimal health as we have defined it. The father's risk for depression is based on his score from a short version of the Center for Epidemiologic Studies Depression Scale (CES-D), which was included in his baseline interview. Because all items in the standard CES-D were not asked in the survey, we followed Mirowsky and Ross (2001), using an abbreviated scale based on the following questions: On how many days in the past week did you: (1) feel that you could not shake off the blues even with help from your friends, (2) have trouble keeping your mind on what you were doing, (3) feel that everything was an effort, (4) sleep restlessly, (5) feel lonely, (6) feel sad, and (7) feel you could not get going. We calculated the mean response to these seven items, which ranges from 0 (low risk for depression) to 7 (high risk for depression). In the cases in which father did not complete the baseline interview, we set his CES-D score equal to the mean (recall that we also included an indicator for the father not having completed the baseline interview).

Finally, in certain models we include mental health of the each of the mother's parents. Measures of the maternal grandmother's and grandfather's history of depressive symptoms were based on the mother's positive response to the following question in the 3-year survey: "Did your biological mother /father ever have periods lasting two weeks or more when she/he was depressed, blue, or down in the dumps most of the time?" In models where we included the grandparents' history of depressive symptoms, we included indicators for missing data on grandmother's history of depressive symptoms and for missing data on grandfather's history of

depressive symptoms and set the corresponding measures to zero for those cases. These measures are intended to capture the mother's family-related (genetic or environmental) predisposition for depression. It is possible that PPD is less of a shock for mothers whose own parents had a history of depressive symptoms, making these measures important control variables. However, the measures of the parents' depressive symptoms could potentially pick up the effects of the mother's PPD. As such, we include these measures in some models and not others and interpret our findings accordingly. Finally, we also use the grandparents' history of depressive symptoms as identifiers for PPD in 2-stage models, as described later.

Sample characteristics by PPD status

As indicated earlier, past research has found that although PPD is strongly associated with having a history of psychopathology, is it unrelated to many sociodemographic characteristics. We assess whether this is the case in our data by comparing means of our covariates by whether the mother had PPD. From Table 2, we can see that PPD is not significantly associated with race/ethnicity, religious attendance, prenatal employment, having other children with the same father, or neighborhood poverty. There is a statistically significant age difference between the 2 groups, but the difference is less than 1 year and therefore not substantively important. PPD also is not significantly related to the characteristics of the child. However, in these bivariate tests that do not control for prenatal mental illness or any of the other covariates, we find that those with PPD are less likely to be native born, to be college graduates, and to have lived with both biological parents at age 15, and are more likely to have had a Medicaid-financed birth.

The two most glaring differences between mothers who had PPD and those who did not are their baseline relationships and history of mental illness. Mothers who experienced PPD were

less likely to be married to, and more likely to be neither married nor cohabiting with, the child's father at the time of the birth. The fathers were less likely to have visited in the hospital, and the mothers knew the fathers for a shorter period of time. Mothers with PPD and their partners were more likely to have had children with other partners. As expected, mothers who had PPD were far more likely to have experienced mental health problems themselves or to have a parent with a history of depression. These findings underscore the importance of accounting for these and other potential sources of selection into PPD in our econometric modeling.

Multivariate Analysis

Models of relationship status at three years

Table 3 presents probit estimates for the estimated effects of PPD on the likelihood that the mother and father are married at 3 years and that they are married or cohabiting at 3 years. For each outcome, estimates from two different models are presented—one with all of the covariates except grandparents' history of mental illness (Model 1), which are used later as identifiers for PPD in 2-stage models, and the other including those measures as additional controls (Model 2). Each cell contains the probit coefficient, the standard error which is corrected for city clustering of observations using the Huber-White method (in parentheses), and the marginal effect [in brackets].

We find that PPD significantly decreased the probability that the mother was married to the father by 6.9 percentage points (22% relative to the sample mean) and the likelihood that the father was living in the household (either married or cohabiting) by 12.1 percentage points (24%), holding constant prenatal mental illness, other maternal characteristics, child characteristics, relationship characteristics, and paternal characteristics (Model 1). Thus, the relative magnitudes of the estimated effects of PPD are similar for the two outcomes. The effect

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sizes and significance change little when also controlling for the mother's parents' history of depressive symptoms (Model 2).

Prenatal history of mental illness has a strong negative association with 3-year marital status when controlling for PPD and the other covariates, with effect sizes slightly larger than those of PPD. However, prenatal mental illness does not seem to affect whether the father was in the household at three years. Older mothers, foreign-born mothers, and more highly educated mothers are more likely to be married at three years, while non-Hispanic black mothers and those living in poor neighborhoods are less likely to be married. If the father had less (more) education than the mother, the parents were less (more) likely to be married at three years. These sociodemographic characteristics have similar associations with father presence in the household at three years as they do with marriage, with a few exceptions: religious attendance is not a significant predictor of father presence, severe infant health condition significantly reduces father presence, and fathers in suboptimal health are more likely to be in the household. It is notable that, holding constant maternal prenatal mental illness, the mother's parents' depression does not significantly predict relationship status.

Not surprisingly, the baseline relationship variables have very large associations with 3-year relationship status. Living together (either married or cohabiting) at the time of the birth is a strong predictor of both marriage and living together three years later. Whether the father visited the mother in the hospital is a strong and significant of living together at 3 years. Mothers are less likely to be married at three years if the father had children with other partners, and the parents are more likely to be living together at three years it they have previous relationship capital (other children together). The covariate estimates are similar when using the more inclusive measure of PPD described earlier (see Appendix Table 2).

Exploring the exogeneity of PPD

The accuracy of the estimates presented thus far, from single-equation models, depends on the degree to which PPD represents a truly exogenous shock. We conducted a number of auxiliary analyses to explore the validity of this assumption.

Although past research suggests only weak associations between sociodemographic characteristics and PPD, we found in Table 2 that this was not so clearly the case in our sample. However, those comparisons did not control for the mother's own or family history of depression, which are strongly predictive of PPD. To further explore the associations between sociodemographic characteristics (particularly baseline relationship status) and PPD, we estimated probit models with PPD as the outcome that included all of the characteristics in Model 1 of Table 3 except PPD. Reassuringly, most characteristics were unassociated with PPD in those models (results not shown). The only characteristics that were statistically significant in predicting PPD were maternal history of mental illness, missing census tract poverty, mother having lived with both parents at age 15, father different race/ethnicity than mother, mother having children with a different partner, and some of the state indicators. Thus, few key sociodemographic characteristics were associated with PPD in a multivariate context that controlled for known confounders.

We further investigated whether our measures of PPD appear to be exogenous by conducting falsification tests wherein we estimated the effects of having PPD on baseline relationship status (married to the baby's father at the time of the birth, and separately, married to or cohabiting with the baby's father at the time the birth). If PPD is an exogenous shock, it should not be predictive of the mother's pre-birth behavior. Indeed, we found no associations between PPD and baseline relationship status in these models, providing additional evidence that

our measure of PPD captured an exogenous shock.

Next, we estimate models stratified by measures of the mother's and grandparents' history of mental illness. If PPD is truly exogenous in our models in Table 3, then the estimated effects of PPD should not differ based on whether the mother had a prenatal mental illness or whether her parents had a history of depressive symptoms. To verify that this is the case, we estimated the effects of PPD for three subgroups of mothers—those with no prenatal mental illness, those with no parental history of depressive symptoms, and those with no prenatal mental illness and no parental history of depressive symptoms (see Appendix Table 3). In five of the six regressions, we find that the estimated effects of PPD on relationship status for these groups are similar to those for the full sample in Table 3. The only exception was that for women with no prenatal mental illness, the marginal effect of PPD on being married or cohabiting at three years was 29% lower (-.086, vs. -.121). Overall, the fact that our estimated effects for women for whom PPD should be the biggest shock are so similar to those for the full sample suggests that our full-sample estimates do not suffer from substantial bias.

The final means by which we explored the exogeneity assumption was by estimating 2-stage (bivariate probit) models wherein we used (1) whether either of the baby's maternal grandparents had a history of depressive symptoms and (2) the indicator variable for missing information on both grandparent's history of depressive symptoms as identifiers for PPD. As discussed at several points in this article, although PPD has a large random component, it is associated with family history of depression. Although the measures of the mothers' parents' history of depressive symptoms were reported by the mother three years after the birth of the focal child and pertained to "ever," it seems unlikely that a sizable fraction of "first episodes" among grandparents took place within the past three years. Additionally, if risk for depression is

genetic as opposed to environmental, the timing of the grandparents' depressive symptoms would be less problematic for our purposes (using grandparents' history of depressive symptoms as identifiers for PPD). Estimates from the bivariate probit models, which estimate PPD in the first stage and 3-year relationship status in the second stage, are presented in Appendix Table 4. These results indicate that: (1) the two identifiers are jointly significant predictors of PPD, (2) the two identifiers are excludable from both outcome equations, and (3) the error term in the PPD equation is not significantly correlated with the error term in the outcome equation, for either outcome. Overall, the 2-stage results suggest that our single-equation estimates of the effects of PPD on relationship status are not biased.

In sum, we found in this set of analyses that most baseline maternal characteristics do not predict PPD in a multivariate context, that PPD does not predict baseline relationship status, and that our single-equation estimates of PPD on relationship status at 3 years appear to be unbiased. All of these results validate our assumption that we have captured an exogenous mental health shock and that PPD reduces the likelihood that parents will be married or living together (married or cohabiting) a few years later.

Additional specification checks

We controlled for the father's risk for depression because it represents a potential source of confounding, given findings from a recent meta-analysis that about 10% of fathers suffer from depression sometime between the first trimester of their partner's pregnancy and the child's first birthday and that paternal PPD has a moderate positive correlation with maternal depression (Paulsen & Bazemore, 2010). However, the control for the father's baseline risk for depression could potentially pick up effects of the mother's PPD. We estimated the models in Table 3 without the control for father's risk for depression and found that the estimated effects of

maternal PPD did not change. In addition, we re-estimated the models in Table 3 including father's depression at 1 year (based on the CIDI, the same instrument that was used for mothers at 1 year). In all cases, the effects of maternal PPD were substantively the same as in Table 3, although paternal PPD had independent negative associations with relationship status at three years (results not shown).

As discussed earlier, mental and physical health problems can be strongly co-morbid. To assess whether inclusion of mother's physical health affected the estimated effect of PPD, we conducted auxiliary analyses that included all variables from Table 3 except mother's physical health condition. The estimated effects of PPD on relationship status at three years remained identical to those in Table 3 (results not shown).

Models of relationship status change

We found that PPD reduces the likelihood that parents are married or cohabiting at three years, that the effects appear to be causal, and that—as expected—baseline relationship status is a strong predictor of 3-year relationship status. We further explore how PPD affects parents' relationship dynamics by estimating models that stratify by baseline relationship status.

In Table 4, we present estimates from models of the effects of PPD on relationship status for those who were married, those who were cohabiting (but not married), and those who were not living together at the time of the birth, controlling for the covariates in Model 1 of Table 3 (except for relationship status, multiple birth, severe infant health condition, and state indicators). The first column shows results from a probit regression predicting being married at three years among those who were married at baseline. Since transitioning from married to cohabiting is rare (see Table 1), we do not consider that potential transition. We find that PPD reduced the likelihood of remaining married by about 7 percentage points, or about 8% relative to the mean

at three years of 88%.

The shaded columns present results from a multinomial probit model predicting 3-year relationship status among those who cohabited at baseline. For these women, the relevant transitions are to marriage and to not living together (remaining cohabiting is the reference outcome). We find that PPD has a small and statistically insignificant effect on marriage among this group; however, PPD made it more likely that the parents were no longer living together at three years, by about 11 percentage points or 28%.

For those who were not living together at baseline (last two columns), PPD made them 4 percentage points, or 29%, less likely to become cohabiters (although the estimate is not statistically significant at conventional levels) and 3 percentage points, or 41%, less likely to marry. Overall, PPD makes it both more likely that unions dissolve (particularly among baseline cohabitors) and less likely that unions are formed (particularly among baseline non-cohabitors).

Conclusion

We found that a mental health shock in the form of PPD reduced the probability that the parents in our sample of mostly non-marital births were married to one another three years after the birth of the child (by 20–26%) as well the probability that they were living together (married or cohabiting) at that time (by 16–28%). Models stratified by relationship status at the time of the birth indicate that PPD made it both more likely that unions dissolved (particularly among baseline cohabitors) and less likely that unions were formed (particularly among baseline non-cohabitors). As indicated earlier, Simon (2002) and Wade & Pevalin (2004) found that depression often predates marital dissolution, but Simon was concerned about drawing causal inferences from that observation because it was not clear that depression predated the marital discord that led to the relationship dissolution. Our findings suggest that the associations found

in those studies could reflect causal effects.

On the other hand, Simon (2002) and Lamb and colleagues (2003), found no associations between depression and subsequent union formation (marriage for Simon, marriage or cohabitation for Lamb and colleagues), whereas we found negative effects of PPD on couples' union formation, particularly among baseline cohabitors. This discrepancy may reflect the different data and samples, measures of depression, or methodological approaches used. Both Simon and Lamb et al. used samples of adults (not necessarily women or parents) in the NSFH, whereas we used a sample of mostly unmarried couples with newborns in urban areas. Additionally, Simon and Lamb et al. used a measure of *risk for depression* from the CES-D, while the CIDI-based measures we used assessed whether mothers met diagnostic criteria for major depression in the past year. Finally, our methodological approach and tests were designed to capture the effects of an exogenous mental health shock, whereas the Simon and Lamb et al. studies did not explicitly account for the endogeneity of mental health.

Overall, this study makes an important contribution to the fragmented literature on the effects of mental illness on relationship status by focusing on a salient form of mental illness with clear timing of onset, addressing the potential endogeneity of mental illness, and focusing on parental relationship status and changes beyond a marital/non-marital dichotomy (only Lamb and colleagues considered cohabitation). The findings also contribute indirectly to the literature on the effects of marriage (and relationship status more broadly) on mental health by providing evidence of a reverse pathway. More broadly, the findings underscore that not only does socioeconomic status affect health, but also that health (in this case, maternal mental health) can affect socioeconomic status—to the extent that father living in another household or being less committed to the relationship results in lower household income for the mother and child.

The findings also have implications vis-à-vis PPD in particular. Not only can father absence resulting from PPD have negative financial ramifications for the mother and child, but the child can lose the benefits of day-to-day involvement with his/her father as well as the "insurance" provided by a second resident parent should the PPD result in inadequate bonding between mother and child or suboptimal mothering at a critical stage of development. Although some breakups may be beneficial for mothers and their children (e.g., in cases of abuse), overall the findings from this study suggest that PPD has detrimental implications for mothers and their children and underscore the importance of identification and treatment of mothers who experience depression following the birth of a child.

We close with a few caveats. The findings of this study of mothers giving birth in urban areas may not generalize to all women giving birth in the U.S. We technically measure depression during postpartum year rather than PPD, although Mitchell et al. (2011) found that CIDI-based measures pertaining to the first year after childbirth result in rates in line with those of PPD. Our findings may not generalize to other forms of depression among women, to women who are not parents, or to males. Our measure of prenatal mental illness, from medical records, was not specific to depression and would not capture cases of depression that had not been diagnosed. Grandparents' depression was subjectively assessed and reported by the mother. Finally, we were unable to test the main hypothesized mechanism—changes in relationship quality, which Tach and Edin (forthcoming) showed is an important predictor of union dissolution in these data—because it was impossible to establish the temporal ordering of PPD, changes in relationship quality, and changes in relationship status.

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Table 1: Parents' Relationship Status at Baseline and 3 Years

	Baseline Married	Cohabiting	Not Living Together	All
3 years **Married**	603	232	72	907
Cohabiting	3	402	170	575
Not living together	80	436	885	1,401
	686	1,070	1,127	2,883

Table 2: Sample Characteristics

	Full Sample	Postpartum Depression	No Postpartum Depression
Maternal Characteristics			
Prenatal history of mental illness	0.11***	0.21	0.09
Age in years, mean	25.0**	24.4	25.1
	(6.0)	(5.8)	(6.1)
Non-Hispanic white[a]	0.21	0.20	0.21
Non-Hispanic black	0.48	0.51	0.48
Hispanic	0.27	0.25	0.28
Other race/ethnicity	0.04	0.03	0.04
Foreign born	0.15***	0.10	0.15
< High school graduate[a]	0.34	0.34	0.34
High school graduate	0.31	0.32	0.31
Some college but not graduate	0.25	0.27	0.25
College graduate	0.10**	0.07	0.11
Lived with both parents at age 15	0.42**	0.36	0.43
Medicaid birth	0.65*	0.69	0.64
Pre-existing physical health condition	0.20	0.21	0.20
Neighborhood poverty rate	0.19	0.20	0.19
Employed	0.81	0.83	0.81
Regularly attends religious services	0.38	0.35	0.39
Child Characteristics			
Male	0.52	0.52	0.52
Multiple birth	0.02	0.02	0.02
Severe infant health condition	0.02	0.02	0.02
Age in months at 3 year interview, mean	35.7	35.8	35.7
	(2.4)	(2.4)	(2.5)
Relationship Characteristics			
Married at time of birth	0.24***	0.18	0.25
Cohabiting at time of birth	0.37	0.37	0.37
Not living together at time of birth[a]	0.39**	0.45	0.38
Father visited hospital	0.82**	0.78	0.83
# months knew father, mean	57.1**	50.3	58.1
	(55.8)	(52.1)	(56.2)
Parents had other children together	0.36	0.34	0.36
Mother had child with another partner	0.35**	0.41	0.34
Father had child with another partner	0.35***	0.41	0.34
Father did not complete baseline interview	0.17	0.18	0.17
Paternal Characteristics			
Age difference (father minus mother in years), mean	2.6	2.9	2.5
	(5.0)	(5.0)	(5.0)
Different race/ethnicity than mother	0.04**	0.02	0.04

CES-D score, mean	1.2	1.3	1.2
	(1.2)	(1.1)	(1.2)
Lower education category than mother	0.26	0.29	0.26
Higher education category than mother	0.24	0.22	0.24
Suboptimal physical health	0.40	0.43	0.40
Grandparent's Mental Illness			
Grandmother's history of depressive symptoms	0.26***	0.47	0.23
Grandfather's history of depressive symptoms	0.12***	0.21	0.11
Missing grandmother's history of depressive symptoms	0.07**	0.10	0.07
Missing grandfather's history of depressive symptoms	0.28***	0.36	0.27
N	**2,883**	**355**	**2,528**

Notes: *** p <0.01; ** p <0.05; * p < 0.10 for significant difference between mothers who had postpartum depression and those who did not. All figures are proportions unless indicated otherwise. Standard deviations are in parentheses. All parent and relationship characteristics are measured at baseline, except father had children with another partner, which is measured at 1 year. [a] Reference category in regression models.

Table 3: Multivariate Probit Estimates of the Effects of Postpartum Depression and Covariates on Parents' Relationship Status at 3 Years (N=2,883)

	Married at 3 years Coefficient (Standard Error) [Marginal Effect]		Married or Cohabiting at 3 Years Coefficient (Standard Error) [Marginal Effect]	
	Model 1	**Model 2**	**Model 1**	**Model 2**
Maternal Mental Illness				
Postpartum depression	-0.229***	-0.248***	-0.306***	-0.333***
	(0.088)	(0.096)	(0.085)	(0.089)
	[-0.069]	[-0.074]	[-0.121]	[-0.132]
Prenatal history of mental illness	-0.246***	-0.256***	-0.002	-0.014
	(0.077)	(0.078)	(0.066)	(0.067)
	[-0.073]	[-0.076]	[-0.001]	[-0.006]
Other Maternal Characteristics				
Age, years	0.076**	0.073*	0.058**	0.057**
	(0.038)	(0.039)	(0.029)	(0.028)
	[0.024]	[0.023]	[0.023]	[0.023]
Age squared	-0.001*	-0.001*	-0.001*	-0.001*
	(0.001)	(0.001)	(0.001)	(0.001)
	[-0.000]	[-0.000]	[-0.000]	[-0.000]
Non-Hispanic black	-0.252***	-0.245***	-0.290***	-0.280***
	(0.095)	(0.092)	(0.081)	(0.083)
	[-0.080]	[-0.078]	[-0.115]	[-0.111]
Hispanic	-0.116	-0.105	-0.030	-0.013
	(0.079)	(0.077)	(0.067)	(0.069)
	[-0.036]	[-0.033]	[-0.012]	[-0.005]
Other race/ethnicity	-0.051	-0.052	-0.244	-0.231
	(0.204)	(0.205)	(0.189)	(0.190)
	[-0.016]	[-0.016]	[-0.097]	[-0.092]
Foreign born	0.357***	0.362***	0.454***	0.464***
	(0.116)	(0.118)	(0.127)	(0.126)
	[0.122]	[0.124]	[0.175]	[0.179]
High school graduate	0.094	0.099	0.006	0.015
	(0.085)	(0.084)	(0.077)	(0.076)
	[0.030]	[0.032]	[0.002]	[0.006]
Some college, but not graduate	0.331***	0.336***	0.159**	0.163**
	(0.102)	(0.102)	(0.081)	0.083

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	[0.111]	[0.113]	[0.063]	[0.065]
College graduate	0.683***	0.686***	0.405***	0.415***
	(0.149)	(0.147)	(0.149)	(0.150)
	[0.248]	[0.249]	[0.157]	[0.160]
Lived with both parents at age 15	-0.025	-0.004	0.061	0.092*
	(0.069)	(0.076)	(0.049)	(0.052)
	[-0.008]	[-0.001]	[0.024]	[0.036]
Medicaid birth	-0.113	-0.113	-0.138*	-0.139*
	(0.081)	(0.083)	(0.080)	(0.081)
	[-0.037]	[-0.036]	[-0.055]	[-0.055]
Pre-existing physical health condition	0.059	0.052	0.040	0.030
	(0.103)	(0.104)	(0.057)	(0.055)
	[0.019]	[0.017]	[0.016]	[0.012]
Neighborhood poverty rate	-0.766**	-0.768**	-0.374	-0.367
	(0.364)	(0.368)	(0.304)	(0.305)
	[-0.245]	[-0.245]	[-0.149]	[-0.146]
Employed	0.009	0.011	-0.023	-0.024
	(0.081)	(0.079)	(0.069)	(0.071)
	[0.003]	[0.004]	[-0.009]	[-0.010]
Regularly attends religious services	0.192**	0.196**	-0.013	-0.009
	(0.085)	(0.085)	(0.070)	(0.071)
	[0.062]	[0.063]	[-0.005]	[-0.003]

Child Characteristics

Male	0.014	0.012	0.027	0.027
	(0.053)	(0.052)	(0.052)	(0.053)
	[0.005]	[0.004]	[0.011]	[0.011]
Multiple birth	0.039	0.031	0.032	0.027
	(0.201)	(0.205)	(0.285)	(0.295)
	[0.013]	[0.010]	[0.013]	[0.011]
Severe infant health condition	-0.115	-0.116	-0.419***	-0.402***
	(0.140)	(0.141)	(0.130)	(0.134)
	[-0.035]	[-0.035]	[-0.164]	[-0.158]
Age at 3 year interview, months	-0.027*	-0.028*	-0.055***	-0.055***
	(0.015)	(0.015)	(0.011)	(0.010)
	[-0.009]	[-0.009]	[-0.022]	[-0.022]

Relationship Characteristics

Married	2.176***	2.175***	1.338***	1.337***
	(0.081)	(0.079)	(0.095)	(0.094)
	[0.721]	[0.721]	[0.461]	[0.461]
Cohabiting	0.508***	0.504***	0.721***	0.721***
	(0.095)	(0.096)	(0.040)	(0.041)
	[0.168]	[0.166]	[0.278]	[0.278]
Father visited hospital	0.267	0.270	0.467***	0.469***
	(0.211)	(0.214)	(0.086)	(0.086)
	[0.080]	[0.081]	[0.184]	[0.185]
# months knew father	-0.001*	-0.001*	0.000	-0.000
	(0.001)	(0.001)	(0.001)	(0.000)
	[-0.000]	[-0.000]	[0.000]	[-0.000]
Parents had other children together	0.139*	0.141*	0.221***	0.225***
	(0.080)	(0.080)	(0.062)	(0.060)
	[0.045]	[0.046]	[0.088]	[0.089]
Mother had child with another partner	0.008	0.007	-0.009	-0.009
	(0.067)	(0.067)	(0.055)	(0.057)
	[0.003]	[0.002]	[-0.003]	[-0.004]
Father had child with another partner	-0.153**	-0.154**	-0.067	-0.067
	(0.062)	(0.063)	(0.051)	(0.051)
	[-0.048]	[-0.048]	[-0.027]	[-0.027]
Father did not complete baseline interview	-0.479***	-0.473***	-0.496***	-0.488***
	(0.109)	(0.110)	(0.085)	(0.086)
	[-0.135]	[-0.134]	[-0.195]	[-0.192]
Paternal Characteristics				
Age difference (father minus mother), years	0.002	0.002	-0.004	-0.005
	(0.008)	(0.008)	(0.006)	(0.006)
	[0.001]	[0.001]	[-0.002]	[-0.002]
Different race/ ethnicity than mother	-0.170	-0.167	-0.086	-0.082
	(0.172)	(0.175)	(0.156)	(0.158)
	[-0.051]	[-0.051]	[-0.034]	[-0.033]
CES-D score	0.006	0.005	-0.060**	-0.061**
	(0.026)	(0.026)	(0.025)	(0.025)
	[0.002]	[0.002]	[-0.024]	[-0.024]
Lower education category than mother	-0.206**	-0.210**	-0.105**	-0.104**
	(0.086)	(0.084)	(0.048)	(0.049)
	[-0.064]	[-0.065]	[-0.042]	[-0.041]

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Higher education category than mother	0.128* (0.068) [0.042]	0.129* (0.068) [0.042]	0.054 (0.053) [0.021]	0.057 (0.054) [0.023]
Suboptimal physical health	0.068 (0.080) [0.022]	0.067 (0.079) [0.021]	0.166** (0.075) [0.066]	0.166** (0.075) [0.066]
Grandparent's Mental Illness				
Grandmother's history of depressive symptoms		0.059 (0.095) [0.019]		0.048 (0.076) [0.019]
Grandfather's history of depressive symptoms		0.007 (0.124) [0.002]		0.123 (0.088) [0.049]
Missing grandmother's history of depressive symptoms		0.108 (0.153) [0.036]		-0.018 (0.126) [-0.007]
Missing grandfather's history of depressive symptoms		0.026 (0.083) [0.008]		0.094** (0.045) [0.038]

Notes: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.10$. All models include indicators for mother's state of residence at baseline and missing neighborhood level poverty.

Table 4: Effects of Postpartum Depression on Parents' Relationship Status at 3 Years by Relationship Status at Baseline

| | Baseline Relationship Status | | | | |
| | Married | Cohabiting | | Not Living Together | |
3-Year Status:	Married	Married	Not Living Together	Married	Cohabiting
Postpartum Depression	-0.411**	0.103	0.463**	-0.454**	-0.349
	(0.186)	(0.163)	(0.189)	(0.169)	(0.221)
	[-0.074]	[-0.028]	[0.114]	[-0.026]	[-0.044]
Prenatal history of mental illness	-0.125	-0.374*	0.048	-0.307	0.274
	(0.165)	(0.227)	(0.161)	(0.301)	(0.229)
	[-0.019]	[-0.075]	[0.047]	[-0.028]	[0.054]
Other Maternal Characteristics					
Age, years	0.060	0.060	-0.034	0.433***	0.103
	(0.123)	(0.125)	(0.112)	(0.100)	(0.073)
	[0.009]	[0.016]	[-0.015]	[0.034]	[0.007]
Age squared	-0.000	-0.001	0.000	-0.008***	-0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)
	[-0.000]	[-0.000]	[0.000]	[-0.001]	[-0.000]
Non-Hispanic black	0.055	-0.358**	0.335*	-0.382*	-0.267
	(0.195)	(0.176)	(0.187)	(0.211)	(0.199)
	[0.008]	[-0.109]	[0.128]	[-0.027]	[-0.035]
Hispanic	-0.011	-0.068	-0.239	0.107	0.055
	(0.281)	0.207	(0.165)	(0.287)	(0.262)
	[-0.002]	[0.010]	[-0.056]	[0.008]	[0.006]
Other race/ethnicity	0.120	0.223	0.492	0.001	-0.709
	(0.574)	(0.395)	(0.406)	(0.612)	(0.502)
	[0.016]	[-0.008]	[0.108]	[0.014]	[-0.089]
Foreign born	0.494*	0.028	-0.569***	0.499**	0.342
	(0.254)	(0.209)	(0.188)	(0.238)	(0.219)
	[0.060]	[0.063]	[-0.149]	[0.039]	[0.046]
High school graduate	-0.239	0.158	-0.184	0.007	-0.258
	(0.195)	(0.147)	(0.178)	(0.185)	(0.168)
	[-0.038]	[0.052]	[-0.064]	[0.006]	[-0.041]

Some college, but not graduate	-0.185 (0.208) [0.025]	0.511*** (0.193) [0.135]	-0.195 (0.239) [-0.105]	0.139 (0.240) [0.015]	-0.121 (0.239) [-0.022]
College graduate	0.458* (0.258) [0.060]	1.047*** (0.368) [0.252]	0.083 (0.553) [-0.111]	0.063 (0.548) [0.008]	-0.097 (0.572) [-0.017]
Lived with both parents at age 15	0.171 (0.144) [0.025]	-0.065 (0.182) [-0.010]	-0.035 (0.127) [-0.003]	-0.135 (0.177) [-0.017]	0.287*** (0.108) [0.051]
Medicaid birth	-0.301 (0.220) [-0.047]	0.103 (0.180) [0.008]	0.139 (0.185) [0.026]	-0.357 (0.166) [-0.033]	0.006 (0.109) [0.010]
Pre-existing physical health condition	0.009 (0.127) [0.001]	0.111 (0.191) [0.024]	-0.005 (0.117) [-0.013]	-0.047 (0.206) [-0.006]	0.073 (0.215) [0.013]
Neighborhood poverty rate	-0.519 (1.136) [-0.074]	-0.948* (0.495) [-0.198]	0.012 (0.411) [0.099]	-1.592** (0.640) [-0.130]	-0.098 (0.432) [0.021]
Employed	-0.308 (0.188) [-0.039]	0.246* (0.134) [0.039]	0.114 (0.163) [0.006]	0.019 (0.198) [-0.001]	0.122 (0.208) [0.019]
Regularly attends religious services	0.114 (0.146) [0.016]	0.496** (0.194) [0.060]	0.425*** (0.139) [0.059]	0.324** (0.156) [0.031]	-0.111 (0.111) [-0.025]
Child Characteristics					
Male	0.043 (0.152) [0.006]	-0.012 (0.065) [0.009]	-0.114 (0.101) [-0.029]	-0.104 (0.159) [-0.008]	-0.050 (0.122) [-0.006]
Age at 3 year interview, months	-0.059** (0.029) [-0.008]	0.079 (0.036) [0.005]	0.115*** (0.019) [0.022]	-0.057 (0.040) [-0.004]	-0.024 (0.026) [-0.003]
Relationship Characteristics					

Father visited hospital	0.238 (0.372) [0.040]	-0.187 (0.404) [0.013]	-0.473 (0.161) [-0.107]	0.619*** (0.183) [0.033]	0.733*** (0.159) [0.099]
# months knew father	-0.002 (0.002) [-0.000]	-0.003* (0.001) [-0.000]	-0.001 (0.001) [0.000]	0.001 (0.002) [0.000]	-0.001 (0.001) [-0.000]
Parents had other children together	0.105 (0.131) [0.015]	-0.034 (0.146) [0.027]	-0.341** (0.142) [-0.085]	0.379** (0.192) [0.028]	0.231 (0.161) [0.029]
Mother had child with another partner	0.091 (0.150) [0.013]	-0.132 (0.124) [-0.026]	-0.018 (0.123) [0.009]	0.229 (0.140) [0.022]	-0.119 (0.104) [-0.024]
Father had child with another partner	-0.424 (0.191) [-0.073]	-0.080 (0.096) [-0.023]	-0.473*** (0.161) [0.024]	-0.207 (0.215) [-0.018]	0.051 (0.135) [0.013]
Father did not complete baseline interview	-0.288 (0.254) [-0.049]	-0.254 (0.243) [-0.105]	0.632*** (0.164) [0.193]	-1.086*** (0.302) [-0.064]	-0.511** (0.245) [-0.059]

Paternal Characteristics

Age difference (father minus mother), years	0.005 (0.018) [0.001]	-0.002 (0.010) [0.001]	-0.014 (0.011) [-0.003]	0.004 (0.021) [0.001]	-0.023 (0.015) [-0.004]
Different race/ ethnicity than mother	-0.129 0.293 [-0.020]	-0.320 0.277 [-0.070]	0.105 (0.388) [0.058]	-0.357 (0.521) [-0.022]	-0.210 (0.345) [-0.025]
CES-D score	-0.036 (0.074) [-0.005]	0.112* (0.061) [0.005]	0.178*** (0.058) [0.036]	-0.018 (0.046) [-0.000]	-0.065 (0.053) [-0.010]
Lower education category than mother	-0.321** (0.140) [-0.051]	-0.103 (0.121) [-0.016]	-0.055 (0.116) [-0.004]	-0.538* (0.276) [-0.040]	0.052 (0.198) [0.020]
Higher education category than mother	0.039 (0.164) [0.006]	0.320* (0.175) [0.060]	0.086 (0.174) [-0.011]	0.100 (0.192) [0.006]	0.099 (0.178) [0.014]
Suboptimal physical health	-0.176 (0.148) [-0.027]	-0.049 (0.103) [0.031]	-0.417*** (0.151) [-0.104]	0.348 (0.226) [0.026]	0.151 (0.165) [0.016]

| N | 686 | 1070 | 1127 |

Notes: *** p <0.01; ** p <0.05; * p <0.10 ; † p <0.15. Top figures in each cell are probit coefficients (for those who were married at baseline) or multinomial probit coefficients (for those who were cohabiting and those who were not living together at baseline. Models include all variables in Model 1 in Table 3 other than baseline relationship status, multiple birth, severe infant health condition, and state indicators.

Appendix Table 1: Coding Poor Infant Health

The coding of abnormal infant health conditions in the FFCWB data was designed to identify cases that were at least moderately severe, unlikely caused by prenatal behavior, had a poor long term prognosis, and were present at birth. A pediatric consultant was directed to glean information from the medical records from the birth hospitalization (augmented with 1-year maternal reports of conditions that were likely present at birth) and to assign all infant conditions a number between 1 and 16 according to the grid below. After giving the consultant the grid and clear instructions, the investigators had no further input into how particular conditions were coded. If a child had multiple conditions, each condition was assigned a separate number. A number of variables were constructed from the resulting coding, including:

Severe Infant Health Condition, which was coded as a one (yes) if the child had a health condition in cell #1. Examples of conditions in cell #1 are microcephalus, renal agenesis, total blindness, and Down Syndrome. This is the measure used in the current paper.

Examples of high severity conditions considered possibly related to parents' behavior are cerebral palsy (cell 5) and likely related to prenatal behavior are fetal alcohol syndrome (cell 9). These conditions are not coded as 1 in the measure of severe infant health condition.

	Severity			
	High	Medium	Low	Unknown
Not Behavior Related	1	2	3	4
Possibly Behavior Related	5	6	7	8
Likely Behavior Related	9	10	11	12
Not Enough Information To Determine if Behavior Related	13	14	15	16

Appendix Table 2: Multivariate Probit Estimates of the Effects of Postpartum Depression and Covariates on Parents' Relationship Status at 3 Years, Using Broader Measure of Postpartum Depression (N=2,883)

	Married at 3 years Coefficient (standard error) [marginal effect]		Married or Cohabiting at 3 years Coefficient (standard error) [marginal effect]	
	Model 1	**Model 2**	**Model 1**	**Model 2**
Maternal Mental Illness				
Postpartum depression	-0.256*** (0.075) [-0.077]	-0.276*** (0.084) [-0.082]	-0.321*** (0.066) [-0.128]	-0.349*** (0.069) [-0.138]
Prenatal history of mental illness	-0.236*** (0.073) [-0.070]	-0.246*** (0.075) [-0.073]	0.012 (0.067) [0.005]	-0.000 (0.069) [-0.000]
Other Maternal Characteristics				
Age, years	0.077** (0.038) [0.025]	0.074** (0.039) [0.024]	0.060** (0.029) [0.024]	0.059** (0.028) [0.023]
Age squared	-0.001** (0.001) [-0.000]	-0.001* (0.001) [-0.000]	-0.001* (0.001) [-0.000]	-0.001* (0.001) [-0.000]
Non-Hispanic black	-0.253*** (0.094) [-0.080]	-0.280*** (0.083) [-0.078]	-0.293*** (0.082) [-0.116]	-0.282*** (0.083) [-0.112]
Hispanic	-0.122 (0.078) [-0.038]	-0.111 (0.076) [-0.035]	-0.039 (0.067) [-0.015]	-0.022 (0.068) [-0.009]
Other race/ethnicity	-0.057 (0.203) [-0.018]	-0.058 (0.205) [-0.018]	-0.253 (0.186) [-0.101]	-0.242 (0.187) [-0.096]
Foreign born	0.359*** (0.118) [0.123]	0.366*** (0.120) [0.126]	0.461*** (0.128) [0.178]	0.473*** (0.128) [0.182]
High school graduate	0.090 (0.084)	0.095 (0.084)	0.001 (0.078)	0.011 (0.078)

	[0.029]	[0.031]	[0.000]	[0.004]

Some college, but not graduate	0.331***	0.336***	0.158*	0.162*
	(0.101)	(0.101)	(0.081)	(0.083)
	[0.111]	[0.112]	[0.063]	[0.064]
College graduate	0.678***	0.682***	0.397***	0.407***
	(0.151)	(0.148)	(0.152)	(0.153)
	[0.246]	[0.247]	[0.154]	[0.157]
Lived with both parents at age 15	-0.028	-0.006	0.058	0.090*
	(0.069)	(0.077)	(0.048)	(0.051)
	[-0.009]	[-0.002]	[0.023]	[0.036]
Medicaid birth	-0.113	-0.112	-0.137*	-0.138*
	(0.081)	(0.082)	(-0.080)	(0.081)
	[-0.036]	[-0.036]	[-0.055]	[-0.055]
Pre-existing physical health condition	0.054	0.047	0.032	0.022
	(0.103)	(0.104)	(0.056)	(0.055)
	[0.018]	[0.015]	[0.013]	[0.009]
Neighborhood poverty rate	-0.767**	-0.768**	-0.375	-0.367
	(0.363)	(0.367)	(0.305)	(0.306)
	[-0.245]	[-0.245]	[-0.149]	[-0.146]
Employed	0.011	0.014	-0.022	-0.023
	(0.082)	(0.079)	(0.069)	(0.071)
	[0.003]	[0.004]	[-0.009]	[-0.009]
Regularly attends religious services	0.193**	0.197**	-0.013	-0.008
	(0.085)	(0.085)	(0.072)	(0.073)
	[0.063]	[0.064]	[-0.005]	[-0.003]

Child Characteristics

Male	0.013	0.011	0.026	0.026
	(0.054)	(0.053)	(0.053)	(0.054)
	[0.004]	[0.003]	[0.010]	[0.010]
Multiple birth	0.041	0.033	0.042	0.036
	(0.198)	(0.202)	(0.287)	(0.297)
	[0.013]	[0.011]	[0.017]	[0.014]
Severe infant health condition	-0.121	-0.121	-0.427***	-0.410***
	(0.140)	(0.141)	(0.130)	(0.134)
	[-0.037]	[-0.037]	[-0.167]	[-0.161]

Age at 3 year interview, months	-0.027* (0.015) [-0.009]	-0.028* (0.015) [-0.009]	-0.055*** (0.010) [-0.022]	-0.056*** (0.010) [-0.022]

Relationship Characteristics

Married	2.178*** (0.083) [0.721]	2.176*** (0.081) [0.721]	1.340*** (0.096) [0.461]	1.338*** (0.095) [0.461]
Cohabiting	0.510*** (0.096) [0.169]	0.507*** (0.097) [0.167]	0.724*** (0.040) [0.279]	0.724*** (0.041) [0.279]
Father visited hospital	0.265*** (0.210) [0.080]	0.269 (0.214) [0.080]	0.467*** (0.084) [0.184]	0.469*** (0.084) [0.185]
# months knew father	-0.001* (0.001) [-0.000]	-0.001* (0.001) [-0.000]	-0.000 (0.000) [-0.000]	-0.000 (0.000) [-0.000]
Parents had other children together	0.139* (0.079) [0.045]	0.142* (0.079) [0.046]	0.220*** (0.061) [0.087]	0.225*** (0.060) [0.089]
Mother had child with another partner	0.007 (0.067) [0.002]	0.006 (0.067) [0.002]	-0.012 (0.056) [-0.005]	-0.013 (0.058) [-0.005]
Father had child with another partner	-0.149** (0.062) [-0.047]	-0.150** (0.062) [-0.047]	-0.063 (0.051) [-0.025]	-0.062 (0.051) [-0.025]
Father did not complete baseline interview	-0.478*** (0.110) [-0.135]	-0.472*** (0.111) [-0.133]	-0.496*** (0.086) [-0.195]	-0.488*** (0.087) [-0.192]

Paternal Characteristics

Age difference (father minus mother),years	0.002 (0.008) [0.001]	0.002 (0.008) [0.001]	-0.005 (0.006) [-0.002]	-0.005 (0.006) [-0.002]
Different	-0.168	-0.164	-0.087	-0.083

race/ethnicity than mother	(0.173) [-0.051]	(0.177) [-0.049]	(0.155) [-0.035]	(0.158) [-0.033]
CES-D score	0.007 (0.025) [0.002]	0.006 (0.025) [0.002]	-0.059** (0.025) [-0.023]	-0.059** (0.025) [-0.024]
Lower education category than mother	-0.206** (0.086) [-0.064]	-0.210** (0.083) [-0.065]	-0.104** (0.048) [-0.042]	-0.104** (0.049) [-0.041]
Higher education category than mother	0.132** (0.067) [0.043]	0.134** (0.067) [0.044]	0.057 (0.053) [0.023]	0.061 (0.052) [0.024]
Suboptimal physical health	0.069 (0.079) [0.022]	0.069 (0.078) [0.022]	0.168** (0.074) [0.067]	0.168** (0.074) [-0.067]
Grandparent's Mental Illness				
Grandmother's history of depressive symptoms		0.069 (0.096) [0.022]		0.058 (0.074) [0.023]
Grandfather's history of depressive symptoms		0.009 (0.121) [0.003]		0.125 (0.088) [0.050]
Missing grandmother's history of depressive symptoms		0.116 (0.152) [0.038]		-0.010 (0.124) [-0.004]
Missing grandfather's history of depressive symptoms		0.026 (0.083) [0.008]		0.095** (0.045) [0.038]

Notes: *** p <0.01; ** p <0.05; * p <0.10. All models include indicators for mother's state of residence at baseline and missing neighborhood level poverty.

Appendix Table 3: Effects of Postpartum Depression on Parent's Relationship Status at 3 Years for Select Subsamples Based on Mental Illness History

	Married at 3 Years	Married or Cohabiting at 3 Years
	Coefficient (standard error) [marginal effect]	Coefficient (standard error) [marginal effect]
Subsample:		
No history of prenatal mental illness (N=2,574)	-0.210** (0.102) [-0.066]	-0.216** (0.089) [-0.086]
No grandparent history of mental illness (N=1,981)	-0.442*** (0.161) [-0.121]	-0.419*** (0.152) [-0.165]
No history of prenatal mental illness or grandparent history of mental illness (N= 1,809)	-0.455*** (0.169) [-0.129]	-0.343** (0.156) [-0.136]

Notes: *** p <0.01; ** p <0.05; * p <0.10. Probit regressions in the first and third rows include all covariates from Model 1 of Table 3 except mother's prenatal history of mental illness. Probit regressions in the second row included all covariates from Model 1 of Table 3.

Appendix Table 4: Bivariate Probit Estimates of Effects of Postpartum Depression on Relationship Status at 3 Years (N=2,883)

	Postpartum Depression	Married at 3 Years	Postpartum Depression	Married or Cohabiting at 3 Years
	Coefficient (SE)	Coefficient (SE) [ME]	Coefficient (SE)	Coefficient (SE) [ME]
Maternal Depression				
Postpartum depression		0.155 (0.399) [0.052]		-0.036 (0.379) [-0.014]
Prenatal history of mental illness	0.417*** (0.077)	-0.320*** (0.088) [-0.094]	0.414*** (0.077)	-0.074 (0.087) [-0.029]
Other Maternal Characteristics				
Age, years	-0.046 (0.051)	0.078** (0.038) [0.025]	-0.051 (0.051)	0.057** (0.028) [0.023]
Age squared	0.001 (0.001)	-0.001** (0.001) [-0.000]	0.001 (0.001)	0.001 (0.001) [0.000]
Non-Hispanic black	0.023 (0.088)	-0.285*** (0.088) [-0.091]	0.023 (0.084)	-0.257*** (0.085) [-0.102]
Hispanic	0.082 (0.144)	0.015 (0.107) [0.005]	0.086 (0.141)	0.077 (0.074) [0.031]
Other race/ethnicity	0.128 (0.190)	0.007 (0.208) [0.002]	0.130 (0.187)	-0.194 (0.200) [-0.077]
Foreign born	-0.048 (0.152)	0.265** (0.123) [0.090]	-0.05 (0.149)	0.423*** (0.117) [0.164]
High school graduate	0.098 (0.069)	0.105 (0.078) [0.034]	0.102 (0.071)	0.027 (0.077) [0.011]

Some college, but not graduate	0.150 (0.105)	0.332*** (0.099) [0.112]	0.155 (0.108)	0.175** (0.088) [0.069]
College graduate	0.028 (0.155)	0.698*** (0.145) [0.255]	0.029 (0.156)	0.435*** (0.152) [0.167]
Lived with both parents at age 15	0.016 (0.044)	-0.008 (0.067) [-0.003]	0.014 (0.045)	0.072 (0.047) [0.029]
Medicaid birth	0.012 (0.103)	-0.102 (0.084) [-0.033]	0.012 (0.102)	-0.132 (0.083) [-0.052]
Pre-existing physical health condition	-0.045 (0.079)	0.034 (0.103) [0.011]	-0.044 (0.080)	0.024 (0.010) [0.008]
Neighborhood poverty rate	0.134 (0.275)	-0.764** (0.353) [-0.246]	0.137 (0.281)	-0.310 (0.292) [-0.123]
Employed	0.078 (0.087)	0.002 (0.080) [0.001]	0.076 (0.088)	-0.043 (0.069) [-0.017]
Regularly attends religious services	-0.014 (0.051)	0.192** (0.080) [0.062]	-0.018 (0.050)	-0.021 (0.069) [-0.008]
Child Characteristics				
Male	-0.012 (0.075)	0.013 (0.054) [0.004]	-0.009 (0.073)	0.025 (0.051) [0.010]
Multiple birth	0.046 (0.203)	0.006 (0.203) [0.002]	0.052 (0.199)	0.018 (0.285) [0.007]
Severe infant health condition	0.069 (0.174)	-0.091 (0.145) [-0.028]	0.070 (0.175)	-0.419*** (0.139) [-0.165]

Age at 3 year interview, months	0.002 (0.016)	-0.016 (0.017) [-0.005]	0.003 (0.016)	-0.046*** (0.010) [-0.018]
Relationship Characteristics				
Married	-0.091 (0.135)	2.129*** (0.085) [0.710]	-0.086 (0.132)	1.334*** (0.092) [0.495]
Cohabiting	-0.083 (0.056)	0.496*** (0.093) [0.165]	-0.085 (0.055)	0.718*** (0.040) [0.277]
Father visited hospital	-0.107 (0.105)	0.273 (0.208) [0.083]	-0.112 (0.106)	0.473*** (0.086) [0.186]
# months knew father	-0.000 (0.001)	-0.001* (0.001) [-0.000]	-0.000 (0.001)	-0.000 (0.000) [-0.000]
Parents had other children together	0.091* (0.048)	0.144* (0.081) [0.047]	0.087* (0.048)	0.209*** (0.063) [0.083]
Mother had child with another partner	0.119 (0.088)	-0.004 (0.068) [-0.001]	0.118 (0.089)	-0.025 (0.061) [-0.010]
Father had child with another partner	0.104 (0.077)	-0.170*** (0.063) [-0.054]	0.105 (0.077)	-0.081 (0.054) [-0.032]
Father did not complete baseline interview	-0.092 (0.138)	-0.472*** (0.096) [-0.135]	-0.095 (0.138)	-0.464*** (0.082) [-0.183]
Parental Characteristics				
Age difference (father minus mother), years	0.002 (0.006)	0.003 (0.008) [0.001]	0.002 (0.006)	-0.003 (0.006) [-0.001]
Different race/ethnicity than mother	-0.412** (0.206)	-0.147 (0.175) [-0.045]	-0.420** (0.203)	-0.075 (0.164) [-0.030]

CES-D score	-0.023	0.007	-0.023	-0.062**
	(0.025)	(0.025)	(0.025)	(0.026)
		[0.002]		[-0.025]
Lower education category than mother	0.028	-0.207**	0.026	-0.108**
	(0.067)	(0.087)	(0.068)	(0.049)
		[-0.065]		[-0.043]
Higher education category than mother	-0.021	0.143**	-0.03	0.071
	(0.100)	(0.061)	(0.098)	(0.052)
		[0.047]		[0.028]
Suboptimal physical health	0.053	0.052	0.052	0.154**
	(0.063)	(0.076)	(0.065)	(0.072)
		[0.017]		[0.061]
Identifiers				
Either grandparent had history of depressive symptoms	0.623*** (0.083)		0.622*** (0.082)	
Missing both grandparent's history of depressive symptoms	0.500*** (0.118)		0.500*** (0.116)	
Rho		-0.209 (0.203)		-0.150 (0.205)
Test Results (p-values)				
Wald Test of rho =0		0.318		0.471
Chi-square joint significance test of identifiers		0.000		0.000
Exclusion tests (p-values)				
Either grandparent's history of depressive symptoms		0.219		0.224
Missing both grandparents' history of depressive symptoms		0.978		0.700

Notes: *** p <0.01; ** p <0.05; * p <0.10. All models include quadratic terms for age and an indicator for missing neighborhood level poverty. State indicators not included. SE = standard error. ME = marginal effect.