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The Costs of Teenage Out-of-Wedlock Childbearing: Analysis with a Within-School Propensity Score Matching Estimator

by

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Abstract: Teen out-of-wedlock mothers have lower education and earnings than peers who have children later. This study uses the National Educational Longitudinal Survey of 1988 (NELS) to examine the extent to which the apparent effects of out-of-wedlock teen fertility are due to pre-existing disadvantages of the young women and their families. We use a novel method that matches teen mothers to similar young women in their junior high school (that is, prior to pregnancy). We find that out-of-wedlock fertility reduces education substantially, although far less than the cross-sectional comparisons of means suggest. We further find that this effect is largest among those with the lowest probability of having a child out of wedlock.

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Our most serious social problem [is] the epidemic of teen pregnancies and births where there is no marriage.

-- President Clinton, 1995 State of the Union Address

Little of [their disadvantage] would be changed just by getting teen mothers to delay their childbearing into adulthood.

-- Hotz, Sanders and McElroy, 1999

As the authors of both of the quotations above agree, teen mothers have lower average education and earnings than peers who have children later. At the same time, several studies find that much of the apparent bad effects of teen parenthood are not causal (Geronimus and Korenman, 1992 and 1993; Hotz, Mullin, and Sanders, 1997, Hoffman, *et al.*, 1993a, b; Hotz, Sanders and McElroy, 1999; Ribar, 1994). That is, most teen mothers were disadvantaged before motherhood. On average, if these young mothers had delayed childbearing, that delay would not have avoided all the poor outcomes for themselves or their children.

A key question is how much (if any) of the correlations are causal. Surprisingly, some analyses cannot reject that *none* of the disadvantage of teen mothers is due to young motherhood. If such findings are correct, then all the many disadvantages were due to pre-existing disadvantages.

This study uses the National Education Longitudinal Survey (NELS) of 1988 to examine how much of the links between teen out-of-wedlock fertility and the young mothers' poor outcomes could have been predicted using pre-motherhood characteristics of the young women. We examine these issues using both parametric methods and a novel within-school semi-nonparametric method based on matching. That is, we match each teen mother with a young woman who attended the same junior high school and who, in eighth grade, was similar on many observable characteristics. We then compare the outcomes of teen mothers with their matches.

This method permits larger sample sizes than most previous studies. Taking advantage of the larger sample size, we also extend previous research by permitting the effect of teen out-of-wedlock fertility on later educational attainment to vary depending on the pre-existing advantages and disadvantages of the young women.

Theory and Methods

The vast literature on teen pregnancies leads us to believe that young women who will become teen out-of-wedlock mothers were disadvantaged in terms of parental income and education and other resources prior to their first childbirth. This familiar result reappears in the NELS data set we examine here (Table 1). Moreover, in part due to these observable disadvantages, we expect young women who will become teen out-of-wedlock mothers to have poor outcomes before their first childbirth; for example, low tests scores and high rates of smoking and using drugs.

Complementing these simple cross-tabs, the large literature on the "underclass" lists a number of factors that can cause both teen out-of-wedlock fertility and low educational attainment. This literature emphasizes that America's least advantaged neighborhoods often combine low adult employment rates, high crime and gang activity, few fully-employed and married adult role models, and poor schools. These factors, in turn, lead to a set of outcomes for youth including high rates of dropping out of high school, using drugs, committing crimes, and having a child out of wedlock. (Jencks and Peterson [1991] review this literature.)

Even in neighborhoods without such disadvantages, young women who are doing poorly academically are likely to find school more burdensome and to perceive the rewards to additional education as lower than their classmates. Thus, precisely the young women at highest risk of dropping out are also often the ones with the lowest costs of out-of-wedlock teen pregnancy.

When teen mothers-to-be were already disadvantaged prior to giving birth, a cross-sectional comparison finding higher dropout rates for teen mothers overstates the causal links between out-of-wedlock fertility and low education. As noted by Hoffman, *et al*., (1993a and b), a common missing ingredient in most analyses of the impact of teen fertility on the achievement of young women is adequate measures of family background and parental involvement in education. A number of studies have either used a socioeconomic status index provided by the data set (e.g. Lee *et al*, 1994), created an *ad hoc* index of parent's characteristics (e.g. Herrnstein and Murray, 1994), or used a limited set of family background measures.

Fortunately, the topic of the effects of teen pregnancy has attracted some of the most careful studies in the social sciences. Unfortunately, results often differ across datasets, across outcomes, or with modest changes in specification. Moreover, as the studies authors' noted, even with very good control groups some selection based on unobservables remains.

One set of studies compared the children of teen mothers with the children of the teen mothers' sisters who had children at an older age. Such a comparison implicitly controls for all aspects of the sisters' shared family background. In two of the three datasets examined, the children of the teen mother were not substantially disadvantaged compared to their cousins whose mother had children at a later age (Geronimus and Korenman, 1993). Moreover, in one dataset the young mothers were not disadvantaged compared with their sisters who delayed childbearing (Geronimus and Korenman, 1992). These results were not conclusive, as standard errors were often large and results varied by data set. Hoffman, *et al*. (1993a and b), agreed with the Geronimus and Korenman findings that much of the cross-sectional correlation of teen childbearing and poor outcomes is not causal, but they emphasized the advantages of the data set that finds the largest effects when controlling for family characteristics (*contra* see Geronimus and Korenman, 1993).

A second set of studies used almost-natural experiments to identify (almost) exogenous variability in teen fertility. One set of studies examined the incidence of miscarriage, an almost-natural experiment that delayed child-bearing by some teenage women (Hotz, Mullin, and Sanders, 1997, Hotz, Sanders and McElroy, 1999). A miscarriage typically delays the age of first birth by several years. In general, teenagers who became pregnant, but whose first birth was delayed by miscarriage, did not have systematically better outcomes than their peers who carried their baby to term. Teen mothers had lower high school graduation rates, but were advantaged on several other outcomes. (Teen mothers had less education and correspondingly more years of work experience. The relatively good earnings of teen mothers during their twenties may not persist as the non-mothers with more education gained labor market experience.)

In a separate study, David Ribar examined age at menarche, noting that earlier age at menarche led to more years at risk of becoming pregnant (1994). (He also used several other instruments.) He found that controlling for the endogeneity of teen fertility eliminated any negative impact of teen births on high school completion.

The conclusion of both sets of studies indicate that the apparent disadvantages of teen parenthood are due in large part to the disadvantages of the mothers involved, not to their young age. Both of these sets of studies emphasize the importance of identifying a good control group. The Geronimus and Korenman (1992, 1993) studies examined pairs of sisters to implicitly control for unobserved family background. At the same time, the sister who had a child as a teenager often differed systematically in other ways from her sister (Geronimus and Korenman, 1993). In addition, this sample is necessarily drawn from larger families (families with at least two children), and therefore may not be representative of all families. The studies by Hotz and his colleagues compare young women who became pregnant but had a miscarriage with those that experience the birth of a child. These studies depend on the assumption of miscarriages (particularly reported miscarriages) being random events, and "there are important reasons for believing that this is not the case" (Wolfe et al., 1999; but see Hotz, et al., 1997, who address some of these issues by bounding the importance of noncausal channels). Moreover, the studies of miscarriages rely on a sample of sexually active teens, which may not be representative of all teens. Similarly, age at menarche may not be uncorrelated with unobservable factors; in other settings it has correlated with race and poverty.

Both of these methods identify quite good control groups, but neither method is applicable in our dataset. Thus, we use a propensity score matching method, described below, to identify a suitable comparison group. We extend existing propensity matching methods to incorporate the counterpart of school fixed effects. We compare the outcomes of a teen out-of-wedlock mothers with someone from her junior high school of the same race. This matching controls for many observable and unobservable features of the family and neighborhood. We further also match on a rich set of family and youth characteristics.

An advantage of this approach over those mentioned previously is that we are able to utilize significantly larger sample of teen mothers than most previous studies. (Hotz, et al., 1999, examined a sample with more teen mothers, but with only 69 controls – that is, women who miscarry.) Moreover, our method selects a more-similar control group than standard regression analyses.

At the same time, as in any non-experimental study, additional unobserved factors may affect both a young woman's decision to have a child out of wedlock and her decision to continue her education. Thus, the current findings provide an upper bound on the causal effect of teen out-of-wedlock pregnancy, not necessarily an unbiased estimate. For example, if our matching method estimates a gap in dropout rates that is half the gap in the raw data, it is possible that if we could match on more factors, the estimated gap in dropout rates could be smaller.

Methods

An experiment to measure the effect of out-of-wedlock fertility would pick matched pairs of young unmarried women with identical schools, race, academic ability, family income, smoking behavior etc., and randomly have half of them carry a baby to term. To describe the "ideal" experiment is to assure its impossibility (and ethical undesirability if possible).

The challenge, then, is to identify a good control group. Below, we introduce a within-school propensity-score matching model, and contrast its results with a standard parametric regression method. The standard parametric method estimates the coefficient of teen out-of-wedlock motherhood when predicting youth outcomes, and then examines how the estimated coefficient declines as additional controls are added. Thus, we, like the previous literature, estimated several logit models:

$$\Pr(y=1) = F(b_1 \cdot \text{teen childbearing}), \quad (1)$$

$$\Pr(y=1) = F(b_2 \cdot \text{teen childbearing} + C_2 \cdot X), \quad (2)$$

where

y = Educational outcomes dropping out of high school or attending college,

X = characteristics that preceded the birth of the child such as parental education and demographics, as well as eighth-grade characteristics of family and child such as family income and child test scores in 1988,

and

F(.) is the cumulative logistic distribution:

$$F(z) = e^z / (1 + e^z) .$$

We transform the logit coefficients from models (1) and (2) into predicted changes in probabilities of each outcome for teen out-of-wedlock mothers compared with similar others. To the extent the correlation between teen out-of-wedlock childbearing and poor outcomes is causal, the estimated effect of teen childbearing should not change much when controlling for pre-existing characteristics of the family. Conversely, if the estimated effects are strongly affected by the inclusion of pre-existing conditions, it suggests that most of the measured effects of teen childbearing are due to pre-childbearing disadvantages. This method is used by many prospective studies (e.g., Painter and Levine, 1999, and the studies cited in Wolfe, et al., 1999).

This standard method of estimating a logit or probit regression imposes strong restrictions on the functional form. Importantly, most women in the sample were quite different from most mothers-to-be. Nevertheless, in a typical regression the non-teen-mother sample is quite important in estimating the counter-factual behavior of the out-of-wedlock mothers-to-be if they had not given birth out of wedlock. The assumption of a linear or logistic function permits data from all observations to be smoothed into one estimate, but the validity of that estimate is suspect when the smoothing function operates over people with very different characteristics.

We used a variant of the method proposed by Rosenbaum and Rubin (1983) that requires weaker assumptions about functional forms. Assume that conditional on observable factors X, assignment to the treatment group (in this case, becoming a teen mother out of wedlock) is not correlated with unobservables that predict later education. In that case, all one must do to estimate the effects of teen out-of-wedlock fertility is to match each treatment youth with a control who has the same observable characteristics. The mean difference in the treatment and matched controls' outcomes equals the true effect of teen out-of-wedlock fertility on unmarried teen mothers. Note we are estimating the effect of the "treatment on the treated" -- a distinction that will arise again below.

Even if all important characteristics are observable, this method has the problem that the dataset contains many characteristics. A problem arises here, as in many contexts: "Selecting a subset of comparison units similar to the treatment units is difficult because units must be compared across a high-dimensional set of pre-treatment characteristics" (Dehejia and Wahba, 1998). Thus, few of the mothers-to-be have a control with precisely the same junior high school, maternal education, family income, and other characteristics. Rosenbaum and Rubin (1983) suggested the use of the propensity score to make matching feasible. The propensity score is a young woman's estimated probability of receiving the treatment (in this case, becoming an unmarried teen mother) given her observable characteristics. Rosenbaum and Rubin proved that matching on the propensity score provides as powerful a control as matching on all observable characteristics. This technique reduces the problem from matching on the number of family and youth characteristics to matching on one dimension, the propensity score.

Dehejia and Wahba (1998) provide an important example where the matching method closely estimates the true treatment effects of a training program. Importantly, they find that the results from the matching method are closer to the experimental results than are the estimates from a standard regression.

Matching with a clustered sample. The NELS tracked for six years a sample with an average of eight female students per junior high school. Thus, most junior high schools with mothers had zero or one mother-to-be. A matching model which did not restrict itself to one junior high school would almost always match mothers-to-be to women from different junior high schools. In Appendix 1 we briefly outline the evidence in this dataset and others that schools (including sorting on hard-to-observe characteristics of the families that attend them) matter in predicting youth outcomes. Moreover, observable characteristics of the school, the other students, and their families do not capture most of the actual effects of junior high schools. Thus, important information is lost if school effects are ignored.

The presence of clustering by schools implies a better solution than matching nation-wide is to match within the junior high. The junior high school match captures all the observable and unobservable features of the school and neighborhood. Within-school matching also controls for all unobservable characteristics of the family that led them to live in that neighborhood and/or send children to that school. In many studies this sorting by families is a problem that leads to bias in estimating the causality underlying observed neighborhood effects. In this study, our method of matching within junior high schools is useful regardless of whether the school fixed effect is causal or due to sorting. (In a different context, Heckman, Ichimura, and Todd (1997) note the increased efficiency of matching within the same region -- labor markets, in their case.)

To take advantage of the importance of junior high schools, we performed a two-stage matching that restricted all matches within the junior high school. Specifically, we estimated the propensity score with a conditional (fixed-effects) logit regression that included a separate intercept a_i for each junior high school (Chamberlin, 1980). Letting $T_{ij} = 1$ if observation j at junior high i is an unmarried teen mother (that is, treatment group), we have:

$$\Pr(T_{ij} = 1 \mid X_{ij}, a_i) = F(a_i + \delta \cdot X_{ij}). \qquad (3)$$

The coefficients $\hat{\delta}$, but not the school-specific fixed effects a_i, can be recovered from this estimation. Fortunately, the differences in predicted probabilities for two women in the same junior high school can be recovered because the school-specific fixed effects a_i cancel out.

Thus, for each young woman i at high school j, we estimated her predicted probability of having a child out of wedlock (T_{ij} = 1) conditional on there being no other unmarried teen mother in her junior high school sample:

$$\Pr(T_{ij} = 1, T_{ik} = 0, k \neq j) = \frac{\exp(X_{ij} \cdot \delta)}{\sum_{k=i}^{N_i} \exp(X_{ik} \cdot \delta)} \quad ,$$

where N_i is the number of classmates at junior high school i. We then matched each young mother-to-be with the young woman of the same race at her junior high school with the nearest propensity score.

As an additional screen, we required that each treatment woman have a match at her junior high school with a propensity score within 10 percentage points. Otherwise we did not analyze the outcome for that unwed mother-to-be. Heckman, Ichmura, and Todd (1997) stress the importance of the probability distributions of, in our case, being a teen mom coming from the same support. Below we discuss results with alternative bandwidths.

Intuitively, consider an eighth grader who will soon have a child out of wedlock and already has low-income parents, low test scores and many behavioral problems in an otherwise advantaged junior high school where all the young women in the NELS sample were academically successful. In this case, we had no good control group for this mother-to-be. A parametric method uses assumptions on functional forms to utilize information on the quite-different girls in the high school, while our method is less dependent on such assumptions.

We permitted a single control to match more than one treatment. This method minimizes the distance between treatments and their controls, but at the possible loss of some efficiency. Dehejia and Wahba (1998) found that in their sample this nearest-match algorithm performed better than algorithms that permit several “fairly near” controls to match a single treatment. Less than 17 percent of the controls were used more than once.

Assuming that a good match was found within the junior high school, the estimated percentage point effect of teen out-of-wedlock fertility on education (B_{match}) outcomes Y is the mean graduation rates of mothers-to-be (treatments) who have controls minus the mean graduation rates of those controls (with some controls entering more than once):

$$\left[\sum_{i=1}^{N_{match}} Y_{i,treatment} - Y_{i,control}\right] \Big/ N_{match}$$

where N_{match} is the number of matched pairs.

Matching within a junior high school largely captures physical neighborhood effects. At the same time, a small proportion (less than one percent) of the mothers-to-be attended a private junior high school in 1988. Thus, the control women for these teens probably do not come from the same physical neighborhood as the mothers-to-be. At the same time, both the students and families of students in private school probably resemble others in the private school more than others in their neighborhoods. In any case, the number of teen mothers in private schools was very small, and results were unchanged if they were dropped from the sample.

Hard-to-match mothers-to-be: Any matching method is less likely to find a close match for people who were most different from the typical member of the control group. In our setting, because we require a match within a junior high school, the relatively disadvantaged teen mothers-to-be are the least likely to have a close match. Thus, the within-school matching method examines a less-disadvantaged set of teen mothers than the average teen mother.

To investigate the effect of out-of-wedlock fertility on the group with no good match in their junior high schools, we applied our matching algorithm without regard to school. In the first stage equation that predicted teen out-of-wedlock fertility, we replaced the logit with school fixed effects (equation 3) with a logit regression that controlled for a number of characteristics of the school and its students (the Z_i):

$$\Pr(T_{ij} = 1 \mid X_{ij}, Z_i) = F(\delta' \cdot X_{ij} + \varphi Z_i). \quad (4)$$

We used the resulting coefficients to predict each young woman's probability of out-of-wedlock fertility. We then identified the young woman of the same race with the closest predicted probability of out-of-wedlock fertility, regardless of school.

Combining within- and across-school matching: An alternative way to view the within-school match is to consider it as one indicator of a good match, but not a requirement. In a linear model with fixed effects, for example, it is easy to trade off slightly more distant school fixed effects to achieve slightly closer matches on family characteristics. The problem is more difficult with a discrete outcome such as having a child out of wedlock, as the fixed effects from the regression cannot be recovered.

Our solution is a composite estimator that matches all students who have a match whose predicted probability of becoming a teen mother is less than some bandwidth P_0 within their junior high school, but use the closest match regardless of junior high school for others. To estimate the probabilities regardless of junior high school we estimated a logit with a number of controls for characteristics of the school. We report results for the within-school bandwidth P_0. equal to 10 percentage points, and perform sensitivity analyses with respect to choice of bandwidth.

Testing if effect sizes differ for the most disadvantaged. The standard parametric technique as well as the semi-nonparametric techniques described above both assume that effect of teen out-of-wedlock motherhood on the proportion of young women graduating high school is similar for more and for less advantaged youth. In fact, this result may not hold. Theory is ambiguous whether the effect size will be largest for the most advantaged or for the most disadvantaged. For example, if more of the disadvantaged young women are closer to the margin of dropping out and if the more advantaged are able to utilize greater resources to provide resiliency after a shock, then the effect size would be largest for the disadvantaged. Working the other direction, it is possible that the women whose characteristics were quite different from those of most teen mothers-to-be face greater stigma and other disadvantages if they have a child out of wedlock. If this is true, the effect size for the most advantaged would be larger than for the average female teen mother.

To test the possibility of different effect sizes, we divided the sample into quartiles based on the predicted probability of out-of-wedlock teen fertility from equation (4). We then tested for differences in effect sizes among the quartiles. We performed this test with the composite estimator so that the sample size for each quartile were large enough.

Data

The National Education Longitudinal Study of 1988 (NELS) is sponsored by the National Center for Education Statistics and carried out by the National Opinion Research Center. NELS is designed to provide trend data about critical transitions experienced by young people as they develop, attend school, and embark on their careers. The base year (1988) survey was a multifaceted study with questionnaires for students, teachers, parents, and the school.

Sampling was first conducted at the school level and then at the student level within schools. The data were drawn from a sample of 1,000 schools (800 public schools and 200 private schools, including parochial institutions). Within this school sample, 25,000 eighth grade students were selected. The three follow-ups revisited the majority of the same sample of students in 1990, 1992, and 1994; that is, when the respondents were typically in the tenth grade, in the twelfth grade, and roughly two years after high school graduation. A randomized sample of approximately 14,000 students were interviewed in the 1994 survey. These form the base sample for the estimation.

The NELS sample was stratified, clustered, and over-sampling rare groups. The NELS provides sampling weights to control for the effects of sampling design. While the primary analysis is done using unweighted estimates, the results are unchanged when using weighted estimates.

Teen motherhood. The results we present are for those teens who experienced an out-of-wedlock birth. We also reran our models including young mothers who married prior to giving birth, and the results were not changed substantively. All regressions dropped young women who gave birth prior to the first wave of the survey in 1988.

Socioeconomic Status and Family Background: Compared with most past studies, this study employs a much more detailed measure of family background and family involvement in education which is intended to better isolate the effect of out-of-wedlock teen fertility on outcomes. Variables were selected because past research (typically confirmed here) found that they predicted teen pregnancy, low educational attainment, or both. All variables also had theoretical links to these outcomes, although we do not review all of the theory here.

The measures of socioeconomic status are created from both the parent and student questionnaire. The set of variables include occupational status (using Duncan's index), parental education, and family income. These variables are converted into z-scores with mean zero and standard deviation equal to one. When there are missing values for parental education because of a missing parent, these are given a z-score of 0 and categorical variables are included to note these important missing values.[1] To adjust family income for its size, family income was divided by the poverty line adjusted for family size. This is an improvement over most studies which simply include some measure of family income in their estimated models. The log of this income/needs ratio (hereafter, called income:needs ratio) is included for the student's eighth grade year. In addition, a composite measure of socioeconomic status (see Levine and Painter, 1999) was interacted with the racial/ethnic categories to allow for disparate effects.

Descriptors of a youth's family structure in eighth grade are included as well as indicators if there were any transitions in family structure during high school. The six family structures were intact families, single parent families with the biological mother present and with the father present, step-families with either the biological mother or father present, and those families with no biological parent present. In addition, four possible family transitions were included: divorce, remarriage, both divorce and remarriage, or death of a parent.

To supplement this fairly standard list, a wide range of measures are included which prior research suggests are indicators of advantages or disadvantages for young women. From the student questionnaire, there are a number of variables which are potentially important predictors of education. A first set of variables control for standard demographic characteristics: region, rural vs. urban vs. suburban, and a female categorical variable. A second set of variables are indirectly related to parental involvement in education, but are not exogenous to the outcome variable. These include whether a foreign language is spoken in the home, whether the mother or father is foreign born, the number of siblings, and whether the home has a library card, magazines, and many books.

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1. For father's education, this procedure is far from perfect. Most of these missing values are in female headed households. Furthermore, it may be the case that these values are missing in precisely those families which are the most disadvantaged because of the least connection to the father. This will cause the coefficient on single parent to be biased upward. In addition, it is not clear in the NELS, whether the value for a step-family is taken from the step-father or the biological father. For these reasons, the analysis was replicated without the variable father's education, and the differences in the results were small and not statistically significant.

From the parental questionnaire, indicators are obtained for whether the family was one of five religions, and any of four levels of religious observance. These variables may proxy for how closely a family is knit as well as proxy for the social capital (Coleman, 1990) available to the children. A categorical variable indicating whether the mother had been a teen when the young woman was born is also included. (Unfortunately, the dataset does not indicate whether the parents were married when the young woman was born.)

Four variables partially capture parents' involvement in the young woman's life and education. The first variable is equal to one if the parent belonged to a parent-teacher association or related organization, or volunteered at school. The second variable is equal to one if the parent helps the child with homework. Next, a categorical variable for whether the child had participated in clubs such as Boy or Girl Scouts during elementary school is included to proxy for the quantity of time spent with the child outside of the home. Finally, a measure of the parent's expectation is included. It takes the value one if the parent expected the student to obtain education levels beyond high school.

Three variables measure whether the student often comes to school without a pen/pencil and paper; without homework; and without books. Another variable indicates whether the student was ever held back in school, and a final indicator variable equals one if the student changed schools. This final variable is a strong univariate predictor of dropping out, and may measure low social capital and the need for friends.

Eighth-Grade Status: We use several measures of student status in eighth grade: whether she had behavioral problems (coded as present if the student had been disciplined at school more than three times or if the parents considered the child to have severe behavioral problems), emotional problems (coded as present if the parent said that the student had an emotional problem which could inhibit learning), smoked cigarettes, used drugs (marijuana, and harder drugs), and the student's test scores. The student's test scores are taken from a set of cognitive math and reading tests taken in eighth grade (see Levine and Painter, 1999, for a full description of the cognitive tests). Further, variables are included which were identified by the National Center for Education Statistics (1992) as good predictors of a student dropping out. These include whether the youth changed schools previous to junior high, was ever held back a grade, cut class, or often came to school without books, homework, or pen and paper.

Educational outcomes: We examined two educational outcomes of the youth in 1994, when they were roughly age 20. The first was whether the young woman dropped out of high school; that is, had no high school diploma by age 20. Second, we examined the proportion who had started college by 1994. We discuss the subset who received a GED below.

Summary statistics for the analysis variables are presented in Table 1. The means are for the entire sample we analyze. Approximately fourteen percent of the sample dropped out of high school, while seventy percent of the sample (and a higher proportion of the high school graduates) had attended some college by age 20. Thirteen percent of the young women had a child out of wedlock while a teenager.

Results

Unmarried teen mothers suffered far worse outcomes than their peers who did not have children out of wedlock. Teen out-of-wedlock mothers had a dropout rate of 44 percent, 5 times the rate of other young women (9 percent). In other words, teen mothers make up 13 percent of the sample, but 44 percent of the female dropouts. Among high school graduates, young mothers' rate of entering college by age 20 was less than half that of their peers (31 vs. 76 percent).

Although prior researchers have not achieved consensus on the precise extent to which the correlation is causal, all agree that much or most of the correlation is not causal (see cites above).[2] Consistent with these prior findings, the NELS data shows unwed mothers-to-be were disadvantaged in eighth grade, before they gave birth (Table 1). Compared to young women who would not give birth out of wedlock before age 20, in eighth grade teen-mothers-to-be were twice as likely to be living with a single mother (27 vs. 14%), both of their parents' education was .4 standard deviation lower than their peers' parents, and their parents reported somewhat

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2. Most past researchers have examined all teen births, while we examine only teen births out of wedlock. Some past researchers have looked at long-term effects on teen mothers, while our dataset only contains data on short-term effects. Most past researchers have compared teen mothers to mothers who had first births in their twenties. Our comparison group includes all other women. For all of these reasons, we probably have a larger gap in education outcomes than in other datasets. Nevertheless, these differences in data should not affect our main result. For example, when we pooled both married and unmarried teen mothers, our basic results were unchanged.

lower parental involvement. The family's income:needs ratios were only a third of the average.

Moreover, prior to giving birth out of wedlock, the teen mothers-to-be exhibited less socially desirable behaviors and lower academic achievement than their peers. By eighth grade they had a half of a standard deviation lower test scores than young women who would not become teenage unwed mothers. They were also twice as likely to smoke (11 vs. 5%). Their parents and teachers were more than twice as likely to report behavior problems (18 vs. 7%) and their rate of severe emotional problems, although low, was more than triple that of their peers (5.1 vs. 1.8%). The teen mothers-to-be were also much more likely to come to school unprepared or cut class. They had also changed schools much more frequently (41 vs. 21%), and had previously been held back in school (29 vs. 11%).

Logit results. The logit results show the effect of out-of-wedlock teen motherhood on high school dropping out fell from 35 percentage points in the raw data to 12.8 percentage points when controlling for demographic and eighth grade characteristics of the young women and their families (Table 2). These are the estimated logit effects when the logit coefficients were evaluated at the sample mean, as most social scientists do. As such, they correspond to the thought experiment of estimating the effect of the "treatment on the untreated" - how teen fertility out of wedlock affects non-mothers. This 65% decline is roughly consistent with findings from quasi-experimental methods (Hotz, et al., 1997) or from methods using sisters as matches (Geronimus and Korenman, 1992, 1993).

Importantly, the estimated effects of teen pregnancy were larger when the logit coefficients were evaluated at the mean of the sample of mothers-to-be. These estimates address a question that is closer to what the data can actually answer, as we can not estimate the effects of out-of-wedlock childbirth on non-mothers. As Figure 1 demonstrates, the effect size of having a child out-of-wedlock differs by the probability of being a teen mother. The estimated increase in the probability of dropping out due to having a child out of wedlock is 19.7 percentage points evaluated at the mean of the sample of mothers-to-be, instead of the 12.8 percentage points when evaluated at the characteristics of the mean woman. Correspondingly, even our very good controls reduce less of the gap when we evaluate the logit coefficients at the average characteristics of the mothers-to-be.

Similarly, the effect of teen pregnancy on college attendance was 44.3 percentage point in the raw data (Table 1), and declined by more than half to 18.7 percentage points when the logit coefficients were evaluated at the sample mean. As with dropouts, the effect size rose to 28.7 percentage points when evaluated at the characteristics of the average teen mother-to-be.

Semi-parametric within-school matching method. A primary contribution of this paper is to compare the estimated effect size using the alternative within-school matching method. Our matching procedure restricted the sample to the 470 young mothers-to-be who had a classmate in junior high in this sample of the same race with a similar predicted probability of teen motherhood.

Our first-stage conditional logit estimates of the probability of teen motherhood are in Appendix 2. As others have found and as showed up in the means, young women were more likely to become teen mothers if they came from single-parent homes, if they were black, if they had low incomes, and so forth.

To identify appropriate matches, we first set the cut-off for "similar" probability at 10 percentage points in predicting the likelihood of teen motherhood and experimented to be sure other values did not appreciably change the results. We also required that matches be of the same race and attend the same junior high school. Fifty-five percent (470 of 840) of the young mothers-to-be had matches that met these criteria.

The cutoff of .10 in predicted probability of teen motherhood is substantively neither enormous nor small. It is roughly one standard deviation in the predicted probability of teen motherhood, as estimated in Appendix 2. That is, if we think of the predicted probability of teen motherhood as an index of "disadvantage" with weights chosen by the logit equation predicting teen motherhood, matches are constrained to be within one standard deviation on this index. It also equals roughly the effect of a one standard deviation decline in family income (holding all else constant), or the move from an intact family to one with only a single mother (holding constant income and other characteristics measured in the regression).

Our mothers-to-be and their matches were (as expected) much closer on observable pre-fertility behaviors than mothers-to-be were with other young women (comparing Tables 1 and 3). Of the comparisons we made between mothers-to-be and their matches, only two of the differences were statistically significant at the 5 percent level. (This figure is roughly what one would expect by chance, given the many comparisons.) In contrast, teen mothers-to-be were statistically significantly disadvantaged relative to the average young woman on 37 of the measures (Table 1).

Results: Using the within-school matching method, the estimated gap in dropout rates between teen mothers and their matches was 22.1 percentage points, a bit over half the 35 percentage point raw gap from the entire sample (Table 4). This 22.1 percentage points effect size of teen pregnancy was larger than the 12.8 percentage point estimate from the logit evaluated at the sample means, and the difference is statistically significant. At the same time, the 22.1 percentage point effect size is close to the effect size from the logit when the logit coefficients were evaluated at the characteristics of the mean mother-to-be. This convergence is to be expected as the latter logit results, like the matching model, estimated the effect of the treatment on the treated, while the former logit estimated the effect of the treatment on the average.

The matching method's 95 percent confidence interval stretches about 5 percentage points in each direction, over twice the confidence interval from the logit. The higher standard errors of the matching estimates is due to the sample size of 940 young women (470 pairs) for the matching as opposed to almost 6500 women in the logit. At the same time, most of the additional women analyzed in the logit sample were quite different from the mothers-to-be. Thus, the standard errors from the logit may be misleadingly narrow.

The raw gap in college attendance was 44 percentage points, while the gap estimated by the matching method was a much lower 26 percentage points (Table 5). The estimated effect of teen pregnancy on college attendance from the matching model (26 percentage points) is slightly smaller than the logit effect evaluated at the mean characteristics of teen mothers (29 percentage points). Although the results are similar in the matching model and when the logit effect is evaluated at the mean characteristics of teen mothers, the matching method is more credible as it relies on weaker assumptions concerning functional form.

Using information on those without a close within-school match. Our method requires that fairly similar matches be found within the junior high school of each teen mother-to-be. We would like to use additional information from the sample without a close match. To motivate the match-anywhere model, we first show that an estimate that matches regardless of school replicates our results on the sample that has close within-school matches. We then use the closest match anywhere on the hard-to-match students to create a composite estimator with a larger sample size and a representative sample.

Consider first the sample that has a close within-school match. The estimated decline in high school completion was 22.1 percentage points using within school matching, which was almost identical to the 21.7 percentage point effect size estimated using the closest match anywhere (Table 6, rows A and B). The college results were almost as close, with a 25.7 percentage point gap using within-school matching and a 23.0 percentage point gap matching anywhere. Thus, it appears that the loss of controlling for unobservables due to not using the school fixed effects was largely offset by the closer match in terms of observable factors.

The results concerning high school completion and college attendance were much different in the sample for which there was no close match within the school (Table 6, rows C vs. D). As noted earlier, these were disproportionately the most disadvantaged young women. Not surprisingly, if one matches within school the estimated effect of teen motherhood on education was very large. This result was due to the fact that these women were very different from their classmates.

If one instead identified the closest match at any school, the difference in the effect size reverses. The teen mothers' difference in high school completion (compared with their matches) fell to 0.176, and the difference in college attendance rates fell to -0.143. The estimated effect size on college attendance rates for this sample was close to 9 percentage points lower than for teen mothers with close within-school matches. It is possible the more disadvantaged women were in situations where a child out-of-wedlock carried less stigma and was less disruptive, but we do not have direct evidence on this point. It is also possible that the women who were not teen mothers-to-be, but were more likely to have adverse education outcomes were less effected by the out-of-wedlock childbirth due to the fact that they were more likely to have poor outcomes before the birth.

Finally, we present estimates concerning high school completion using a composite estimator on the entire sample (Table 6, rows E and F). The composite estimator matches within the junior high school if there is a match whose estimated probability of becoming a teen mother is within P_0; otherwise, the match is the closest at any school. Using the composite estimator and a bandwidth of $P_0 = .10$, the predicted probability of high school completion was 20.1

percentage points lower for teen mothers than for their matches. This estimate was similar to the 22.1 percentage point gap using only the within-school matches.

The two estimates of the effects of teen motherhood on the probability of starting college results were somewhat more distinct. The predicted probability of starting college was 20.7 percentage points lower for teen mothers than for their matches using the composite estimator, which was smaller than the 25.7 percentage point gap using only the within-school matches. This rise from 20.7 to 25.7 percentage points was both economically meaningful and statistically significant.

Results by quartile of disadvantage:

The changing effect size when we analyzed the larger sample was not due to the difference in method. Instead, it was due to the different effect size for the least advantaged. We took advantage of our large sample and divided it into quartiles and estimated the effect sizes using the composite estimator after dividing the sample into quartiles based on their estimated probability of becoming a teen mother (Figure 2).

The estimated effects of teen parentage on education were larger for the more advantaged. For high school completion, the effect sizes were near 0.16 for the most disadvantaged quartile and about 0.20 for the most advantaged. For college attendance, the effect size differences were even larger (0.11 vs. 0.22). In both cases, these differences among quartiles were statistically significant at the 5 percent level.

For college, these results were expected, because less than half of the matches from the most disadvantaged quartile attended college. Thus, it is not too unusual for the effect size to be smaller, even though the proportionate decline in college attendance was similar.

For high school completion, the larger effect sizes for the more advantaged were more surprising. On average, the teen mothers who were from the upper quartile of the distribution were presumably further from the margin of dropping out if they had not had a child. It is possible the more disadvantaged women were in situations where a child out of wedlock was less disruptive or the matches were more likely to drop out, but we have no direct evidence on this point.

Robustness tests

We performed a number of robustness tests of both the logit and matching results.

GED: It is possible that some of the higher dropout rate we observe in teenagers who had children is a short-run effect due to disruption, but that the effect of teen childbearing later declines. High GED rates for teen mothers, for example, is a main result in Hotz, et al. (1999). If the effects of teen childbearing declines as women age, then teen mothers who dropped out of high school would be more likely to return for a GED degree than other female dropouts.

We found no evidence that teen mothers were more likely to return to school. In fact, among those without a high school diploma by 1994 (that is, roughly at age 20), 26% of the teen mothers and 36% of other female dropouts had a GED (Table 1). The relative advantage of the non-teen-mother dropouts remained when looking at the matched sample (Table 2). Studies with more years of data can examine longer-term catch-up, as in Geronimus and Korenman (1992) and Hotz, et al. (1999).

Varying coefficients by race: Several studies find that the effects of teen motherhood on graduation vary by race (GAO 1998). Both the matching and logit procedures should correctly reproduce the average result across races, but the result may not hold for any single race. In fact, the point estimates for the effects of teen motherhood on graduation were similar, with estimated effects 2 percentage points higher for blacks and 2 percentage points lower for Hispanics than for whites. These small differences were well under one standard error.

Wider bandwidths: We reran the results using the somewhat larger sample of young women who had a match within .20, not .10, in the predicted probability of becoming a teen out-of-wedlock mother. The advantage of this cutoff is that the sample grew from 470 with the .10 cutoff to 581 with .20 cutoff. The disadvantage was that the mothers-to-be and their matches now differed more on observable characteristics. The gap in the two groups' mean predicted probability of out-of-wedlock motherhood was 3.4 percentage points, which was statistically significant at the 5 percent level.

With the cutoff of .20 and slightly poorer matches but a larger sample size, the estimated effect of motherhood out of wedlock on dropping out of high school was 23.6 percent, which is substantively and statistically similar to the results with cutoff equal to the more conservative .10. This effect size after matching remains a bit over half the total cross-sectional effect of teen motherhood in the representative sample. Thus, the controls explain less than in the naive logit, and about the same as with the smaller cutoff. As we expect, the less-perfect matching implies a slightly larger estimated gap.

We also re-estimated the composite estimator using cutoffs of .05 and .20 (instead of .10) for the bandwidth to use the within-school estimator instead of the closest match anywhere. Results were similar regardless of bandwidth.

Alternative treatment of timing: As Upchurch and McCarthy (1990) emphasized, the timing of dropping out and having the teen birth can be important in determining the impact of teen out-of-wedlock fertility on high school completion. Unfortunately, the NELS includes only annual data on dropouts. Thus, we erroneously classified some young women as having dropped out after becoming pregnant or giving birth, when, in fact, they gave birth (or at least knew they were pregnant) before leaving school. We reran the analysis dropping all cases where the pregnancy may have preceded the departure from high school. Results were quite similar.

Discussion

Rates of teen pregnancy are very high in the U.S. Almost two in five young women will become pregnant before they are 20. About half of these pregnancies will end in abortion or miscarriage, and about half in a live birth (Sylvester, 1994). Moreover, approximately one in five white children is born out of wedlock, roughly the same rate of fertility out of wedlock that Black women had when Moynihan decried the death of the Black family in 1967. Moreover, about three out of five Black children are born out of wedlock.[3]

The results we report support prior findings that a substantial portion of the relation between teen childbearing and high school completion is due to pre-existing disadvantages of the young women, not due to the childbirth itself. At the same time, about half the very large disadvantages remain using all methods regardless of controls. Moreover, the causal part of the effect appears largest for the most advantaged mothers-to-be relative to the least advantaged.

This analysis has provided several contributions to the existing literature on how out-of-wedlock fertility affects education. First, we use the NELS, which has extremely good measures

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3. Importantly, the rising share of Black births that are out of wedlock is due to a small increase in rates of out-of-wedlock births over the last 30 years and a dramatic decline in births within marriage—falling by two thirds since the 1950s. Akerlof, Yellen and Katz review the evidence and provide innovative theory for the rise in out-of-wedlock fertility (1996).

of the characteristics of young women and their families. The junior high match provides complete controls for school, neighborhood and unobserved family characteristics -- an important advance on most previous studies. Second, we use a propensity score method that is less sensitive to functional forms than standard regression analysis. Third, we have more pairs available to us (470 or more) than do the other matching studies which use sisters as controls, or studies of the contaminated natural experiment of miscarriage. Finally, we use our larger sample to permit effect sizes to vary by characteristics of the young women.

In spite of our good dataset and appropriate methods, our analysis does not control for all possible characteristics of the young women. Thus, the true causal links between teen childbearing and low maternal education may be lower than we estimate. Similar critiques hold, for example, in studies that use sisters as matches. Unwed teen mothers differ from their sisters in observable ways; thus, it is likely they also differ in unobservable ways.

Finally, our results suggest that one reason that our effect size is larger than those found in the sister's studies or in the studies of the contaminated natural experiment of miscarriage is that they may be finding results based on a more disadvantaged sample that would be estimated for the average female. In the sister's studies, the families are relatively disadvantaged because of larger family sizes. We found some evidence of differences by family size, but the differences were not significant. In the miscarriage studies, the teens are relatively disadvantaged because they are already sexually active. Among this sample, our results would suggest a finding of a smaller effect size than for the average female.

Methodological implications: Because clustering reduces costs of data collection, almost all household datasets have observations that are clustered geographically. At the same time, this clustering implies that many analyses can control for unobserved characteristics correlated with neighborhood (and usually school) by matching within the enumeration area. Solon, Page, and Duncan (1999), for example, used this method to study neighborhood effects. Other studies can use the matching method described here to control for neighborhood effects.

Policy implications. From a policy perspective, we (like others) find enormous nonrandom selection into teen motherhood. That is, young mothers end up with lower education, but had many disadvantages prior to giving birth that predicted low education. Thus, half or more of young mothers' disadvantages would not have been eliminated by the young women waiting until their twenties to have children.

At the same time, almost all estimates in this study and in many of its predecessors indicate substantial disadvantages remain that are plausibly due to becoming a teen mother. Thus, policy-makers should not ignore the potential effectiveness of policies that delay first births in affecting young women's education and other outcomes. The question is what to do with these findings.

Out-of-wedlock teen parenting is the result of a complex set of factors. Many of these factors reflect disadvantages that society should reduce, regardless of their effects on education. For example, roughly half of teen out-of-wedlock births are to women who were sexually molested at some time (Sylvester, 1994). Many young women (and men) do not believe that they are likely to be able to succeed academically in high school, nor that a high school diploma will lead to further education or career success. Many young women (and men) lack basic information on pregnancy and sexuality, are not supported by peer groups that encourage wise choices such as delaying the start of sexual activity, and (when sexually active) do not have access to contraception.

On the one hand, the precise cost-benefit analysis for policies to address these problems depends in part on the causal links between teen out-of-wedlock pregnancy and educational attainment. On the other hand, reducing sexual molestation, improving young peoples' perceptions (and the reality) that "playing by the rules" has positive payoffs, and giving young people the skills, knowledge, and resources to handle their sexuality wisely are policies that make sense regardless of how much of the correlation between teen pregnancy and educational attainment is causal.

Table 1: Summary Statistics by Fertility Status

Entire sample

	All Females	Non teen mothers	Mothers-to-be
N	6476	5636	840
Family Structure			
Intact in eighth grade	0.673	0.705	0.456 *
Single - Female Headed in eighth grade	0.153	0.136	0.268 *
Single - Male Headed in eighth grade	0.014	0.014	0.012
Stepfather family in eighth grade	0.096	0.089	0.143 *
Stepmother family in eighth grade	0.018	0.018	0.018
Resided with no Biological Parents in eighth grade	0.047	0.039	0.104 *
Divorced during High School	0.065	0.062	0.086 *
Remarried during High School	0.024	0.023	0.031
Both a Divorce and Remarriage Occurred During High School	0.008	0.007	0.011
Parent died during High School	0.011	0.011	0.013
Family in 1988 (Young woman in eighth grade)			
Ethnicity - African American (Omitted is Caucasian)	0.109	0.087	0.261 *
Ethnicity - Latino American	0.131	0.120	0.204 *
Ethnicity - Asian American	0.069	0.077	0.020 *
SES*African American interaction term	-0.051	-0.025	-0.228 *
SES*Latina American interaction term	-0.110	-0.093	-0.219 *
SES*Asian American interaction term	0.028	0.033	-0.004
Parental Involvement in Education	0.519	0.539	0.389 *
Parents and children are involved in clubs	0.834	0.847	0.748 *
Parents help with homework	0.406	0.404	0.418
Mother's education (z)	-0.065	-0.004	-0.475 *
Father's education (z)	-0.043	0.013	-0.418 *
Mother was a teen when this daughter was born	0.126	0.114	0.213 *
Eighth grade income/needs	0.858	0.942	0.299 *
Father foreign born	0.164	0.167	0.149
Mother foreign born	0.170	0.172	0.156
Live in the south (Omitted category is northeast)	0.358	0.355	0.381
Live in the west	0.198	0.195	0.220
Live in the central	0.274	0.273	0.282
Live in urban area (Omitted category is suburb)	0.247	0.243	0.274
Live in rural area	0.326	0.322	0.352
Oldest child	0.311	0.317	0.264
Father's occupation {z}	-0.042	0.003	-0.344 *
Father unemployed	0.069	0.062	0.113 *
Mother's occupation {z}	-0.047	0.002	-0.380 *
Mother unemployed	0.295	0.288	0.344 *
Religious affiliation - Baptist (Omitted religion is other Protestant)	0.205	0.192	0.294 *
Religious affiliation - Catholic	0.325	0.330	0.292
Religious affiliation - Other religion	0.121	0.119	0.131
Religious affiliation - Missing religion	0.036	0.035	0.043

Table 1: Summary Statistics by Fertility Status

Entire sample

	All Females	Non teen mothers	Mothers-to-be
Religious affiliation - No religion	0.028	0.028	0.033
Religiosity - very religious (Omitted religiosity is "Not at all religious")	0.416	0.440	0.252 *
Religiosity - religious	0.155	0.155	0.155
Religiosity - somewhat religious	0.172	0.172	0.171
Number of siblings	2.318	2.224	2.950 *
More than 50 books in home	0.882	0.898	0.780 *
Has at least one magazine subscription	0.741	0.765	0.579 *
Family has a public library card	0.820	0.834	0.726 *
Parents expect the youth to continue in school past high school	0.898	0.915	0.786 *
Young woman in 1988 (That is, in eighth grade)			
Behavioral problems reported by teacher or parents	0.086	0.072	0.177 *
Emotional problems	0.022	0.018	0.051 *
Cigarette smoking	0.055	0.048	0.106 *
Eighth grade test scores (z)	-0.024	0.045	-0.484 *
Cuts classes at school	0.093	0.081	0.169 *
Often comes to school without a pen/pencil and paper	0.156	0.150	0.196 *
Often comes to school without homework	0.160	0.145	0.263 *
Often comes to school without books	0.067	0.057	0.130 *
Ever held back in school	0.133	0.110	0.287 *
Changed schools during elementary school or junior high	0.239	0.213	0.410 *
<Variables above this point are controls in Table 2.>			
Predicted probability of having a child out of wedlock			
Predicted probability of a having a child out of wedlock based on characteristics of the young woman and her family; coefficients from Table 4.	0.127	0.096	0.239 *
Outcomes 1992-94 (Aged roughly 18 to 20)			
Dropout	0.136	0.090	0.440 *
College attender	0.699	0.756	0.313 *
College attender (among those with a high school diploma)	0.783	0.813	0.449 *
Received a GED (among those without a high school diploma)	0.316	0.358	0.257 *

* represents that the value for mothers-to-be is significantly different from non-teen mothers at the 5 percent level. All variables above the row "Predicted Probability of having a child out of wedlock" are controls in tables 3 and 4. Students attended 919 junior high schools.

Table 2
Logit Results on how Controls Affect The Coefficient on Teen Fertility for Dropout and Started College

Reference group is young women who did not have a child out of wedlock.

	No controls	Controlling for demographic and eighth grade characteristics of family and child (Evaluated at the mean of the sample)	Controlling for demographic and eighth grade characteristics of family and child (Evaluated at the mean of teen mothers-to-be)
Dropout (N = 6486)			
Had a Child out of Wedlock	0.350 ** (0.014)	0.128 ** (0.011)	0.197 ** (0.011)
Started college (N = 6486)			
Had a Child out of Wedlock	-0.443 ** (0.019)	-0.187 ** (0.016)	-0.287 ** (0.016)

Notes: Eighth grade characteristics of family and child include all controls listed as such in Table 1.
** represents different from zero at the 5 percent level.

Figure 1

The Probability of Dropping out of High School as a Function of the Predicted Probability of Having a Child Out of Wedlock

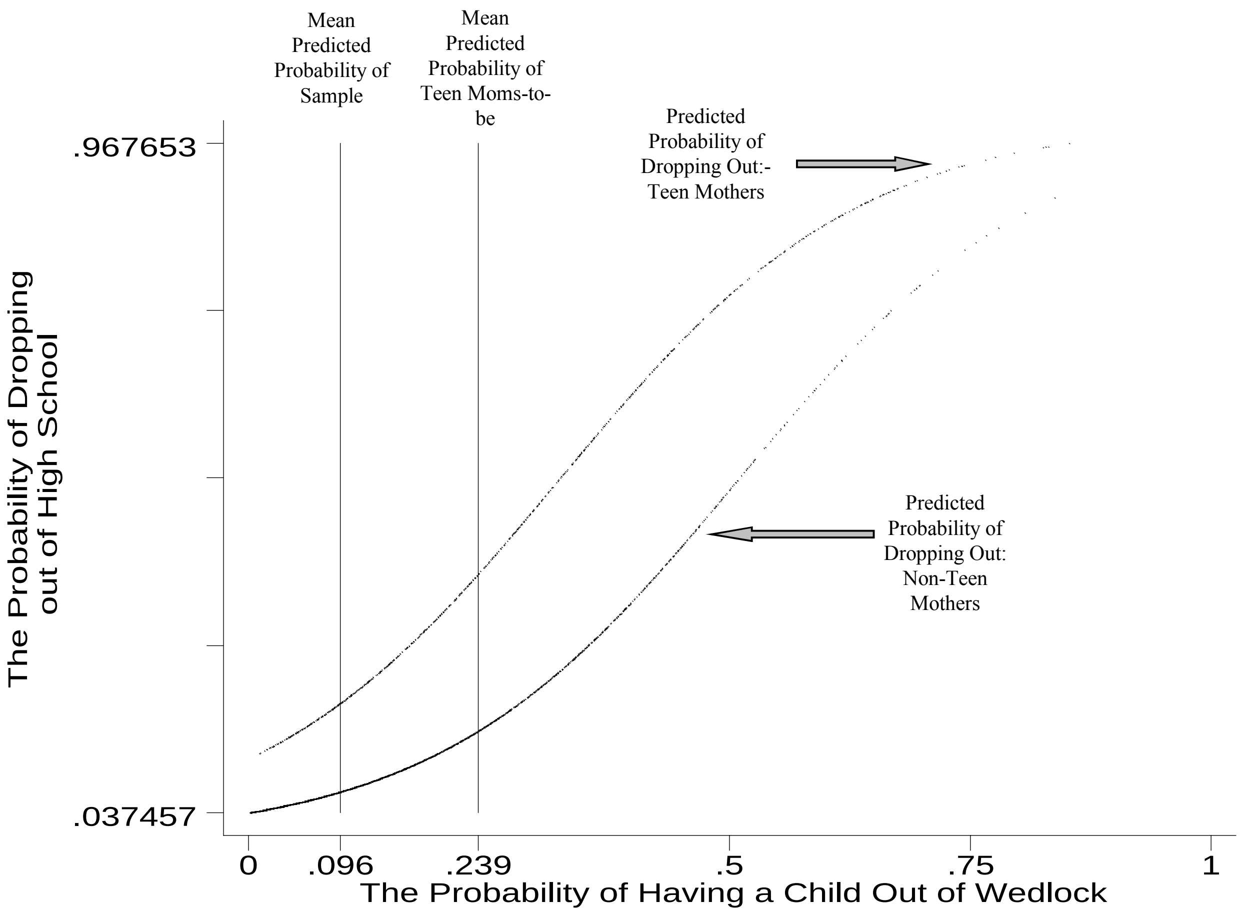


Table 3: Summary Statistics by Fertility Status

Matched sample

	Mothers-to-be	Matched non-teen-mothers
N	470	470
Family Structure		
Intact in eighth grade	0.545	0.604
Single - Female Headed in eighth grade	0.219	0.226
Single - Male Headed in eighth grade	0.011	0.021
Stepfather family in eighth grade	0.128	0.094
Stepmother family in eighth grade	0.019	0.019
Resided with no Biological Parents in eighth grade	0.079	0.036 *
Divorced during High School	0.087	0.081
Remarried during High School	0.034	0.023
Both a Divorce and Remarriage Occurred During High School	0.011	0.013
Parent died during High School	0.015	0.009
Family in 1988 (Young woman in eighth grade)		
Ethnicity - African American (Omitted is Caucasian)	0.164	0.164
Ethnicity - Latino American	0.177	0.177
Ethnicity - Asian American	0.021	0.021
SES Index*African American interaction	-0.113	-0.129
SES Index*Latino American interaction	-0.181	-0.193
SES Index*Asian American interaction	0.003	-0.005
Parental Involvement in Education	0.430	0.440
Parents and children are involved in clubs	0.796	0.794
Parents help with homework	0.409	0.411
Mother's education (z)	-0.378	-0.351
Father's education (z)	-0.347	-0.374
Mother was a teen when this daughter was born	0.187	0.166
Eighth grade income/needs (that is, poverty line)	0.517	0.568
Father foreign born	0.123	0.153
Mother foreign born	0.136	0.166
Live in the south (Omitted category is northeast)	0.368	0.368
Live in the west	0.226	0.226
Live in the central	0.287	0.287

Table 3: Summary Statistics by Fertility Status

Matched sample

	Mothers-to-be	Matched non-teen-mothers
Live in urban area (Omitted category is suburb)	0.245	0.245
Live in rural area	0.404	0.404
Oldest child	0.291	0.309
Father's occupation {z}	-0.326	-0.309
Father unemployed	0.104	0.106
Mother's occupation {z}	-0.277	-0.232
Mother unemployed	0.328	0.306
Religious affiliation - Baptist (Omitted religion is other Protestant)	0.251	0.234
Religious affiliation - Catholic	0.300	0.302
Religious affiliation - Other religion	0.140	0.121
Religious affiliation - Missing religion	0.040	0.053
Religious affiliation - No religion	0.032	0.023
Religiosity - very religious (Omitted religiosity is "Not at all religious")	0.311	0.338
Religiosity - religious	0.170	0.168
Religiosity - somewhat religious	0.194	0.189
Number of siblings	2.651	2.538
More than 50 books in home	0.836	0.836
Has at least one magazine subscription	0.619	0.666
Family has a public library card	0.787	0.753
Parents expect the youth to continue in school past high school	0.838	0.872
Young woman in 1988 (That is, in eighth grade)		
Behavioral problems reported by teacher or parents	0.100	0.089
Emotional problems	0.030	0.019
Cigarette smoking	0.072	0.055
Eighth grade test scores (z)	-0.397	-0.319
Cuts classes at school	0.123	0.098
Often comes to school without a pen/pencil and paper	0.172	0.155
Often comes to school without homework	0.191	0.177
Often comes to school without books	0.077	0.070
Ever held back in school	0.198	0.151 *
Changed schools during elementary school or junior high	0.336	0.344

Table 3: Summary Statistics by Fertility Status

Matched sample

	Mothers-to-be	Matched non-teen-mothers
Predicted probability of a having a child out of wedlock		
Predicted probability of a having a child out of wedlock based on characteristics of the young woman and her family. Calculated based on coefficients from Table 4.	0.129	0.113
Educational Outcomes 1992-94 (Aged roughly 18 to 20)		
Dropout	0.370	0.149 *
College attender	0.355	0.613 *
College attender (among those with a diploma – not necessarily matched, N = 296 and 400)	0.473	0.693 *
Received a GED (among those without a diploma -- not necessarily matched, N = 174 and 70)	0.310	0.400

***** represents that the t-test on the mean value for mothers to be is significantly different from matched non-teen mothers at the 5 percent level. Students in the matched sample attend 492 distinct junior high schools.

Table 4: Within-school Propensity Score Matching and Dropout Rates

Two-by-two matrix of matched pairs' outcomes at end of high school
Entries are proportions of matched pairs with similar or dissimilar outcomes
N = 470 pairs

	Young women who would not soon become unwed mothers (matched controls group)	
Mothers-to-be (treatment group)	**Dropped out**	**Graduated high school**
Dropped out	0.079	0.291
Graduated high school	0.070	0.560

Proportion who dropped out of high school:

		[95% conf. interval]	
Teen mothers	0.370		
Matched controls	0.149		
Difference	0.221**	0.169	0.274
Ratio	2.485**	1.972	3.133
Odds ratio	4.152	2.821	6.270
McNemar's $\chi^2(1)$	63.62**		

Notes: Odds ratio = % of pairs where control graduated and mother-to-be dropped out / % of pairs where mother-to-be graduated and control dropped out (that is, 0.291 / 0.070).
McNemar's χ^2 tests if the odds ratio equals 1.
Confidence intervals and test statistics are described further in the text.

** implies rejects the hypothesis of that the ratio or odds ratio of proportions equals one or that the difference in proportions equals zero at the 1% level.

Table 5: Within-school Propensity Score Matching and College Attendance

Two-by-two matrix of possible college attendance
Entries are proportions of matched pairs with similar or dissimilar college attendance by 1994 (roughly age 20).
N = 470 pairs

	Young women who would not soon become unwed mothers (Matched control group)	
Mothers-to-be (treatment group)	**Did not attend College**	**Attended College**
Did not attend College	0.272	0.373
Attended College	0.115	0.240

Proportion attending college at age 20

		[95% conf. interval]		
Teen mothers	0.355			
Matched Controls	0.613			
Difference	-0.257 **	-0.318	-0.197	
Ratio	0.580 **	0.507	0.663	
Odds ratio	0.309	0.223	0.421	(exact)
McNemar's $\chi^2(1)$	63.93 **			

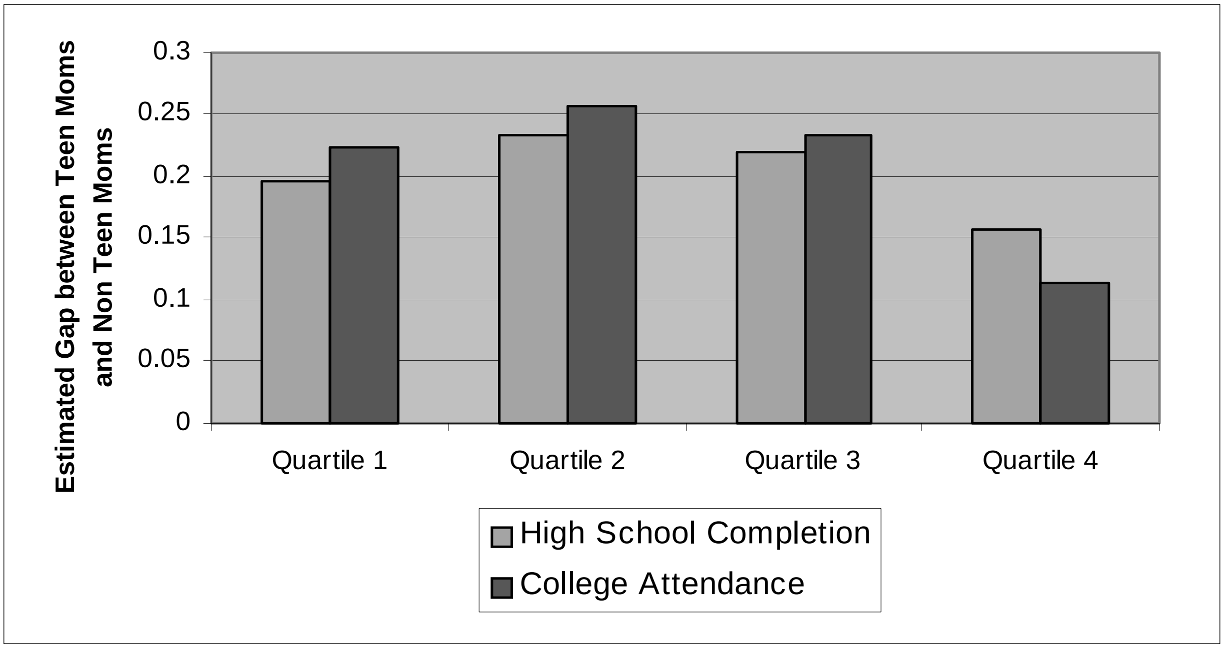
See notes to Table 4.

Table 6: Comparing Within-school and Closest Anywhere Matching

	Within-school Matching	Closest Anywhere Matching
Close Matches Within-school (N = 470 pairs)		
A) Gap in Dropout Rate	0.221	0.217
B) Gap in College Attendance	-0.257	-0.230
No Close Matches Within-school (N = 370 pairs)		
C) Gap in Dropout Rate	0.330	0.176
D) Gap in College Attendance	-0.354	-0.143
	Composite Estimator	
Full Sample (N = 840 pairs)		
E) Gap in Dropout Rate	0.201	
F) Gap in College Attendance	-0.207	

Note: For the Composite Estimator, if a close match (estimated probability of teen pregnancy of control and match < .1) is available within the school sample, then that match is chosen; if not the closest match anywhere is chosen.

Figure 2: Effect Sizes of Teen Motherhood out of Wedlock, Estimated Separately for each Quartile of the Predicted Probability of Teen Motherhood out of Wedlock



Note: Quartile 1 is the most advantaged, and Quartile 4 is the most disadvantaged, as measured by the predicted probability of having a child out of wedlock.

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Appendix 1: Do schools matter?

The literature on neighborhood effects almost always finds clustering of poor youth outcomes (Jencks and Peterson 1991; Brooks-Gunn, et al., 1997). This clustering is due to some combination of families sorting themselves into neighborhoods, the influence of neighborhoods and families on youth, and the peer influences of youth on each other. Our method does not separate out these various channels, but implicitly controls for all of them. This section shows that such controls can be important.

Whatever makes schools and neighborhoods correlate with youth outcomes is not well captured by standard observable controls. For example, in predicting the value added of schools in terms of increases in test scores, schools vary substantially, yet standard measures of school quality capture only a small portion of that variability (Hanushek, Rivkin, Taylor, 1996). Similarly, neighborhoods appear to vary enormously in terms of predicting the outcomes of youth, but observable qualities of a neighborhood explain only a small portion of that variance (Solon, Page, and Duncan, 1999).

To illustrate the importance of school characteristics vs. fixed effects in predicting a typical outcome in the NELS, we regressed test scores against a long list of measures of the family, youth, and school. (Variables are listed in Table 1. The sample included only schools with at least 10 students.) We normalized the test scores to have a standard deviation of unity.

After extensive controls for the characteristics of the family, the school, and the families whose children attend the school, the standard error of the equation was .911. This corresponds to an R^2 of 17.3 percent. When we replaced the characteristics of the school with a complete set of fixed effects for each junior high school to the regression, the standard deviation of the junior high fixed effects was .51. (This figure is inflated up slightly by sampling error as we have an average of 17 youth per junior high. Adjusting for sampling error does not change the results meaningfully.) The standard error of the equation declined to .795. That is, even after controlling for observables, fixed effects lowered the standard error by more than did a long list of observable characteristics of the family and school.

There are many metrics of "importance" in comparing different sets of variables in a regression (contribution to R^2 when added prior to or subsequent to other variables, etc.). We replicated the above test using several of these metrics. In all cases, even after controlling for a long list of observable factors about a youth and his or her family, the youth's junior high school (and whatever that indicates about the neighborhood and family) was at least as important in predicting tests scores as were all the observable factors.

As with other outcomes, there is substantial clustering of unwed teen motherhood. To see this fact in the NELS sample, consider the roughly 700 junior high schools with between 10 and 22 young women in them. If the 11.9 percent of these young women who were going to become unwed teen mothers were distributed at random, only one seventh of the sample would be at schools where zero young women became teen mothers. In fact, over twice that many attended junior high schools with no teen mothers in the NELS sample. Corresponding to this concentration of schools with fewer teen mothers than predicted by a purely random distribution, far more schools had multiple mothers than would be predicted by sheer chance. This further highlights the importance of controlling for unmeasured school level effects.

Appendix 2: Predicted Probability of a having a child out of wedlock

Conditional Logit Estimates
Fixed effects for each junior high school
(N=3882)

	Odds Ratio	Standard Error
Family Structure		
Single - Female Headed in eighth grade	1.657 *	0.238
Single - Male Headed in eighth grade	1.237	0.509
Stepfather family in eighth grade	1.401 *	0.210
Stepmother family in eighth grade	0.856	0.294
Resided with no Biological Parents in eighth grade	1.682 *	0.309
Divorced during High School	1.132	0.191
Remarried during High School	1.041	0.295
Both a Divorce and Remarriage Occurred During High School	0.943	0.443
Parent died during High School	0.727	0.303
Family in 1988 (Young woman in eighth grade)		
Ethnicity - African American (Omitted is Caucasian)	2.161 *	0.458
Ethnicity - Latino American	1.860 *	0.388
Ethnicity - Asian American	0.437 *	0.148
SES*African American interaction term	0.743 *	0.116
SES*Latino American interaction term	1.056	0.149
SES*Asian American interaction term	1.105	0.287
Parental Involvement in Education	0.847	0.086
Parents and children are involved in clubs	1.008	0.129
Mother's education (z)	1.033	0.077
Father's education (z)	0.912	0.076
Mother was a teen when this daughter was born	1.314 *	0.170
Eighth grade income/needs	0.995	0.067
Father foreign born	1.208	0.258
Mother foreign born	0.674 *	0.140
Oldest child	1.015	0.115
Father's occupation {z}	0.876 *	0.060
Father unemployed	1.142	0.188
Mother's occupation {z}	0.948	0.053
Mother unemployed	1.137	0.121
Religious affiliation - Baptist (Omitted religion is other Protestant)	1.220	0.183

Appendix 2: Predicted Probability of a having a child out of wedlock

Conditional Logit Estimates
Fixed effects for each junior high school
(N=3882)

	Odds Ratio	Standard Error
Religious affiliation - Catholic	1.165	0.178
Religious affiliation - Other religion	1.192	0.207
Religious affiliation - Missing religion	1.121	0.288
Religious affiliation - No religion	1.506	0.421
Religiosity - very religious (Omitted religiosity is "Not at all religious")	0.488 *	0.062
Religiosity - religious	0.753 *	0.110
Religiosity - somewhat religious	0.770 *	0.107
Number of siblings	1.137 *	0.033
More than 50 books in home	0.955	0.125
Has at least one magazine subscription	0.776 *	0.080
Family has a public library card	1.137	0.136
Parents expect the youth to continue in school past high school	0.929	0.126
Young woman in 1988 (That is, in eighth grade)		
Behavioral problems reported by teacher or parents	1.393 *	0.206
Emotional problems	1.095	0.274
Cigarette smoking	1.537 *	0.279
Eighth grade test scores (z)	0.473 *	0.045
Cuts classes at school	1.257	0.187
Often comes to school without a pen/pencil and paper	0.757 *	0.105
Often comes to school without homework	1.281 *	0.160
Often comes to school without books	1.565 *	0.285
Ever held back in school	1.409 *	0.173
Changed schools during elementary school or junior high	1.121*	0.057

Pseudo-R^2 = .212 ***** represents statistically significant at the 5 percent level.

Odds ratio > 1 indicate that variable increases the predicted probability of teen out-of-wedlock birth.