Learning from Teen Childbearing Experiences of Close Friends: Evidence Using Miscarriages as a Natural Experiment[1]

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Abstract: This study builds on the peer effects in adolescent fertility literature by examining close friends and using miscarriages as a natural experiment to reduce potential confounding due to peer selection, simultaneity of peer influence, and shared environment. Our identifying assumption is that, conditional on a friend's pregnancy, the occurrence of a friend's miscarriage is an exogenous negative fertility shock that is uncorrelated with the unobservable factors. The study utilizes fertility and friendship nominations data from the core sample of Add Health. A total of 838 women had a friend with at least one teen pregnancy; of whom 647 had a friend who had a teen birth and 172 had a friend whose pregnancy ended in a miscarriage. A series of balancing and falsification tests support our identifying assumption of no correlation between the woman's characteristics and the occurrence of a friend's miscarriage in the pregnant friend subsample. The results suggest the existence of a sizable negative local treatment effect on teen childbearing among best friends. Multinomial logistic regression and IV results with controls for own and friend's fertility history, extensive set of socio-demographic controls, local peer network structure, and school-level fertility measures suggest that a friend's teen birth is associated with a 7-11 percentage point *reduction* in the likelihood of own teen childbearing. There is also evidence that this effect operates through a learning mechanism by changing attitudes toward early childbearing and reducing unwanted pregnancies.

Keywords: Negative Peer Effects, Teen Childbearing, Learning, Natural Experiment, Miscarriage.

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I. Introduction

The teenage birth rate in the United States is the highest among all developed countries (United Nations, 2010). Each year, close to a half a million US girls age 15 through 19 have a child (Hamilton et al. 2010), and almost three quarters of these births result from pregnancies that were unintended (Harrison et al. 2012). Federal programs aimed at preventing teen pregnancy were projected to cost the US government close to $200 million in 2010 alone (Department of Health and Human Services 2009) – yet reducing teen pregnancy rates presents a significant policy challenge.

A growing body of empirical literature is consistent with the notion that adolescents engage in behaviors similar to those of their peers, and there are a number of reasons why this may be the case. First, theories of the mechanisms underlying peer influence – knowledge externalities (i.e. learning from peers or their experiences), network externalities (e.g. increasing returns to scale in joint childrearing with peers), and social norms (e.g. peer childbearing reducing the social stigma of teen childbirth) – all suggest a positive peer effect. Second, empirical estimates of peer effects can be biased upward due to, for example, peer selection or shared environmental influences, and few of the existing studies offer research designs capable of credibly isolating the true causal peer effect from these confounding influences.

The key contribution of the present study is the novel finding of a negative local treatment effect of teen childbirth of a close friend on own likelihood of teen pregnancy and childbearing. While often not found in empirical research, *negative* peer correlations in behaviors have some compelling theoretical motivations, one of which is the knowledge externality

generated from learning the consequences of peer behaviors[2]. Indeed, in some behaviors, such as teen childbearing, we might imagine the possibility of a large amount of learning about the difficulties of being a teen mother if a high school friend has a child. This knowledge externality may lead to negative correlations in peer behaviors within peer groups. We present evidence consistent with the notion that the negative effect appears to operate through a learning mechanism by changing attitudes toward teen motherhood and reducing pregnancy and childbearing. Our finding is highly policy relevant because it suggests that policies that are successful in reducing teenage childbearing may be partially offset in their overall effects due to the unintended negative spill-over effect of limiting learning opportunities from peer's childbearing experiences (i.e. reducing knowledge externalities).

II. Background Literature

Negative consequences of teen childbearing are well documented and include, among others, lower educational attainment and increased participation in welfare programs (Angrist and Evans 1996; Chevalier and Viitanen 2003; Fletcher and Wolfe 2009; Levine and Painter 2003). The children of teen mothers are at a higher risk of premature birth and low birth weight, reduced educational attainment, and they are more likely to be incarcerated as adults (Martin et al. 2010; Mathews and MacDorman 2010). Furthermore, the daughters of teen mothers are significantly more likely to have a teen childbirth themselves (Manlove et al. 2008; Hoffman and Scher 2008).

Studies found that adolescents may be susceptible to peer influence along multiple margins of fertility choice, from initiation of sexual activity (Fletcher 2007; Richards-Shubick 2011; Ali and Dwyer 2011), to pregnancy (Evans et al. 1992; Fletcher and Yakusheva 2012), to,

[2] Network externalities could also generate negative peer correlations in behavior if the behaviors were subject to congestion effects.

ultimately, childbearing (Case and Katz 1991; Kuziemko 2006; Monstad et al. 2011). This tendency toward adoption of peers' fertility-related behaviors was found to exist in a variety of peer group settings including neighborhoods (Case and Katz 1991; Evans et al. 1992), classmates (Fletcher 2007; Richards-Shubick 2011; Fletcher and Yakusheva 2012), co-workers (Hensvik et al. 2011), siblings (Kuziemko 2006; Monstad et al. 2011), and close friends (Ali and Dwyer 2011).

Our understanding of the mechanism of social transmission of adolescent childbearing is rather limited. Empirical evidence of the role of knowledge externalities as a conduit for peer influence in teen pregnancy, the key finding of this study, has been particularly limited in the existing literature. Only one existing study finds some evidence consistent with the notion of knowledge externalities between sisters (Kuziemko 2006). However, there is a significant body of theoretical and conceptual developments outside of the peer effects literature, particularly in the context of contraceptive and other fertility information dissemination and its contribution to declining fertility and other demographic trends (Behrman et al. 2001; Munshi and Myaux, 2006; Montgomery and Casterline, 1996). Evidence consistent with network externalities in peer influence (i.e. increase in the net benefit of childbearing when your peer has a child through, for example, economies of scale in joint childrearing) has been documented by a small number of peer effect studies examining, for example, correlation in timing of childbearing among co-workers (Hensvik et al. 2011) and siblings (Kuziemko 2006). Most peer effect studies argue for social norms as the leading mechanism behind social contagion in teen pregnancy, whereby exposure to high rates of adolescent pregnancy reduces the "stigma cost" of being a teenage mother (Case and Katz 1991; Fletcher and Yakusheva 2012). While these mechanisms of peer

influence are likely not mutually exclusive, being able to distinguish between them is key to designing successful teen pregnancy prevention policy.

The sign of the peer effect in fertility depends on the mechanism through which peer influence is transmitted. In particular, when correlation in peer behaviors occurs through the learning mechanism, its sign is theoretically undetermined. Shlag (1998) demonstrates situations where the optimal choice under uncertainty stipulates to not imitate behaviors of individuals whose realized outcomes are worse than oneself and imitate those whose realized outcomes are better (with probability proportional to the difference in realizations). Under this rule, observing a friend have a teen childbirth will increase a woman's likelihood of becoming a teen mother herself if she perceives her friend's fertility experience as being positive and better than her own, and decrease her chances of becoming a teen mother if she views it as having substantial negative consequences. On the other hand, existing theories and empirical finding on social norms and network externalities are characterized by conformity of peer behavior, or increased propensity of an individual to choose behaviors similar to those of their peers, even in the face of a negative payoff (Banerjee 1992; Bikhchandani et al.1998; Case and Katz 1991; Hansvik et al. 2011; Richards-Shubik 2011; Fletcher and Yakusheva 2012).

Difficulties in establishing the mechanism of peer influence aside, estimating the magnitude of reduced-form peer influence presents an significant empirical challenge in itself as the causal peer effect is often muddled by unobserved peer selection, simultaneity of peer influence, and exposure to common contextual effects (Manski 1993). Existing studies use a number of empirical approaches from variations of combined fixed effects and instrumental variable models (Evans et al. 1992; Richards-Shubik 2011; Ali and Dwyer 2011; Fletcher 2007; Fletcher and Yakusheva 2012), to exploiting the timing of outcomes (Kuziemko 2006, Hensvik

et al. 2011). One recent study utilizes a natural experiment, a school-level educational reform in Norway, to measure the impact of the intervention targeting the older sister on the fertility outcomes of the younger sister (Monstad et al. 2011).

This paper relies on a natural experiment, friend's miscarriage, to measure the impact of a quasi-random negative fertility shock to the peer on the fertility outcomes (pregnancy, childbearing) of the focus individual. Our identifying assumption is that conditional on a friend's pregnancy, the occurrence of a friend's miscarriage is an exogenous negative fertility shock that is uncorrelated with the unobservable factors. Under this assumption, miscarriage-based estimates of peer effect are free from selection, reflection, and shared environment biases that many earlier peer effects studies struggle with. If the assumption is violated, our estimates would most likely reflect a lower-bound effect because these selection, reflection and shared environment biases would suggest positive correlations in fertility behaviors.

Use of miscarriage as a strategy to partition random variation in childbirth from systematic variation due to unobservable factors was pioneered by Hotz et al. (1997, 2005). Since then, this identification strategy has been used to measure the impact of a teen parenthood on a host of mother's subsequent outcomes including educational attainment, earnings, and welfare dependence (Hotz et al. 2005; Ashcraft and Lang 2006; Fletcher and Wolfe 2009). In an approach similar to the present study, Fletcher and Wolfe (2011) utilize miscarriages to examine the indirect impact of a teen birth on the teen father. They compare the outcomes of male adolescents whose partner had a teen childbirth to those whose partner's teen pregnancy ended in a miscarriage and find a modest negative effect on educational attainment. Our paper is unique in utilizing the negative fertility shocks of miscarriage of friends to examine peer effects in fertility decisions.

III. Miscarriage as a natural experiment

Miscarriage, also referred to as spontaneous abortion, is defined as loss of the intrauterine product prior to the viability of the fetus, usually before the 20th week of pregnancy (Llewellyn-Jones 1995). According to the American College of Obstetricians and Gynecologists, 10-25% of all known pregnancies end in a miscarriage (American College of Obstetricians and Gynecologists 2011). This number is likely higher because many miscarriages happen very early, before the woman knows she is pregnant.

While the etiology of miscarriage varies, chromosomal abnormalities is the most common factor and studies have found some chromosomal abnormality in close to 50% of all examined first trimester losses (American College of Obstetricians and Gynecologists 2011; Royal College of Obstetricians 1997). Certain systemic medical illnesses (diabetes, thyroid disease, lupus) are believed to be the second leading cause of miscarriage, with as many as a half of pregnancies to women with diabetes ending in miscarriage (Llewellyn-Jones 1995; Lerner 2003). Other frequent risk factors include anatomical or immunological abnormalities causing the mother's body to reject the pregnancy (Llewellyn-Jones 1995; Lerner 2003). There is also a tentative link between certain environmental factors (e.g. pollutants) and miscarriage risk (Green et al. 2009; Sunil 2011). Lastly, substance abuse (cigarette, alcohol, drugs) has been associated with increased miscarriage risk (Baba et al. 2011; Venners et al. 2004; Llewellyn-Jones 1995; Lerner 2003)

Our identification strategy relies on the assumption that miscarriages are correlated with the friend's childbearing status and uncorrelated with unobservable characteristics of the woman. While miscarriages resulting from chromosomal or anatomical abnormalities are plausibly exogenous, some of the other risk factors could violate our identifying assumption. For

example, if women and their friends are exposed to the same environmental factor that put all of them at an increased risk of a miscarriage, the miscarriage-based estimate will be biased upward. In fact, Fletcher and Wolfe (2009) found evidence of systematic variation in miscarriage rates across communities and schools and demonstrated that miscarriage-based estimates of the impact of teen childbirth are reduced when this systematic variation is controlled for with community- or school-level fixed effects. Similar to Fletcher and Wolfe (2009), we find systematic variation in miscarriage rates across schools and control for school-level aggregate fertility outcomes (including miscarriage) in our analysis.

In addition to shared environmental factors, women who are at a higher risk of miscarriage due to underlying health issues (or because they engage in substance abuse) may choose friends with similar characteristics, in which case the estimates will also be subject to peer selection bias. Hotz et al. (1997) constructed bounds, presumably containing the true causal effect, based on a proportion of all miscarriages that are believed to be random, and found their estimates to be robust to potential non-randomness. However, this approach has been criticized on the grounds that the width of the bounds depends critically on the untestable assumption regarding the proportion of all miscarriages that are truly random vs. non-random. In this study, we present a series of tests showing that, conditional on pregnancy, miscarriages are uncorrelated with a host of socioeconomic and demographic characteristics of the mother. Additionally, because we examine the impact on a woman's fertility of her friend's miscarriage, we are able to go a step further than the existing studies and explicitly test whether miscarriages are correlated among peers. If peer selection was driving our miscarriage-based results, this falsification test would produce a significant positive correlation in the likelihood of a miscarriage itself between

friends. We will show that conditional on friend's pregnancy and school-level aggregate fertility measures, miscarriages are not correlated among friends.

Another potential issue with using a miscarriage as an exogenous fertility shock is that some of the miscarriages may be misreported elective abortions. As we discuss in more detail in the data section, the survey was administered in a way that is known to minimize the reporting bias. Nevertheless, we present a falsification test similar to the one described above where we show that miscarriages and abortions are conditionally uncorrelated among friends.

Lastly, the distinction between miscarriages and abortions is not always clean-cut even if miscarriages were always correctly reported and truly random. The reason is that some miscarriages would have been abortions had the pregnancy not been miscarried (and similarly, some abortions would have been miscarriages had the pregnancy not been electively terminated) (Ashcraft and Lang 2006; Fletcher and Wolfe 2009). Because compared to teen moms, women who choose abortion tend to be of a higher socioeconomic status and have better outcomes, the presence of "would-be abortions" in the miscarriage group could introduce an upward bias in the estimate of the effect of a peer's childbirth on own fertility outcomes. Following the approach proposed by Fletcher and Wofle (2009) we deal with this issue by examining late miscarriages (after the 8^{th}, 10^{th}, and 16^{th} week of pregnancy), with the idea that most elective abortion procedures are conducted before the 10^{th} week of gestation.

IV. Data

The data in this study come from the restricted version of the National Longitudinal Study of Adolescent Health (Add Health). Add Health is a school-based, longitudinal study of health-related behaviors of adolescents and their outcomes in young adulthood, stratified by region, urbanicity, school type, size, and ethnic mix. The survey was conducted in multiple

waves. Wave I consists of an in-school questionnaire administered to close to 90,000 students and an in-home component administered to a subsample of about 20,000 students and their parents. The in-home cohort was followed up with a series of in-home surveys, approximately 1 year (Wave II), 6 years (Wave III), and 13 years (Wave IV) later. About 12,000 of Wave I in-home students comprise the main (core) sample that represents a nationally representative sample of adolescents in grades 7 through 12 in the US in 1994-1995 school year, and the rest are special oversamples (well-educated blacks, disabled, siblings, etc.). The present study uses the core sample without oversamples.

One of the distinct features of the Add Health survey is that it is designed to capture friendship data as completely as possible. Each respondent was asked to name their friends during the Wave I in-school and in-home surveys and during the Wave II in-home survey. In addition to the list of friend nominations, the survey is designed to capture the friendship rank, asking about the first friend first, and then asking for up to five male and up to five female friend nominations. The present study pools all three sets of female friend nominations, resulting in up to 15 possible friend nominations per individual. Both the nominating and the nominated individuals are included, regardless of whether or not the nominated individual reciprocated the nomination (i.e. the network ties are undirected). Duplicate nominations are removed after averaging out the within-nomination friendship ranks if they varied. We create three measures based on the three waves of nomination data: number of nominations, friendship rank and whether or not the friendship nomination was reciprocated, to be used as controls for individual-level friend network structure.

Of the 12,105 core sample students surveyed in home at Wave I, approximately half were female and close to 4,500 women were followed at Wave III, when on average they were

22 years old. At Wave III, each participant was asked to complete a pregnancy history questionnaire, including information on the age at which each pregnancy ended and the pregnancy outcome (live birth, abortion, miscarriage, and still birth). To maintain confidentiality and reduce reporting bias, no paper questionnaires were used for this portion of the interview; instead the respondent entered answers on a laptop computer in privacy, after the interviewer had left the room. We use the pregnancy history information to capture a complete set of fertility outcomes that occurred before age 20 for each woman, including all teen pregnancies and pregnancy resolutions (live births, miscarriage, or abortion).

We construct school-level aggregate measures of teen fertility (miscarriage, abortion, and birth) by computing the average prevalence of each outcome by school in the full Wave III female sample (or the number of women experiencing a given outcome before age 20 over the total count of female observation for each school). We similarly construct a set of other school-level demographic and socioeconomic controls (proportion of African Americans, parental income, education, etc.) The full list of variables used in our analysis and their descriptions are presented in appendix Table 1.A.

A total of 2,430 women had at least one female friend who was also interviewed in Wave III. Because we focus on comparing women whose friends miscarried to those whose friends carried to term, we further restrict our sample by excluding 1,592 women whose friends did not have a teen pregnancy. The remaining 838 women who had at least one friend with a teen pregnancy comprise our final sample, and 172 of these women had a friend whose teen pregnancy ended in a miscarriage. A total of 237 women had a teen pregnancy themselves, and 177 had a teen birth.

Table 1 presents descriptive statistics stratified by the friend's teen fertility status. Column 1 shows women who will be excluded from our analysis because none of their friends had a teen pregnancy. Columns 2 and 3 show women whose friends had a teen birth and a teen miscarriage, respectively. Women who had a friend with a teen abortion are shown in column 4. Note that the last three columns are not mutually exclusive because women who had friends with multiple teen pregnancies can be in more than one category.

Table 1 shows that, compared to women whose friend miscarried, women whose friend carried a teen pregnancy to term are less likely to have a teen pregnancy themselves, and are noticeably less likely to become a teen mom (17% vs. 21%, p=.11). Except the noted difference in fertility outcomes, women whose friend's teen pregnancy ended in miscarriage and those whose friend had a teen childbirth are otherwise very similar with respect to their socioeconomic and demographic characteristics at both the family and the school level. A series of balancing tests showed none of the differences between the friend birth column and the friend miscarriage column to be statistically significant at the $p<0.10$ level. On the other hand, we observe large differences between women who did not have a friend with a teen pregnancy and women who did, at both the individual and the school level. Overall, the outcomes of women who had friend with a teen abortion are in-between those in column 1 and columns 2 and 3.

V. Estimation

The traditional approach to estimating peer effect utilizes a linear-in-means model that regresses the outcome of the focus individual on the corresponding peer characteristics, usually aggregated at some group-level. Pioneered by Case and Katz (1991), and further developed by Manski (1993, 1995, 2000), this approach has been used in a large number of peer effects studies (see for example Ali and Dwyer 2011, Bifulco et al. 2011; Fletcher and Yakusheva 2012).

However, because our identifying assumption of random miscarriage is valid only conditional on a positive teen pregnancy status, computing friend-group averages would invalidate the assumption in all friend groups that include non-pregnant friends, and limiting the analysis to individuals with all pregnant peers was not feasible due to sample size limitations. Additionally, a linear-in-means model would not allow us adequately model situations where the ego or the alter has multiple pregnancies with different outcomes (e.g. a miscarriage and an abortion).

The present study adopts a conceptually similar, although notably more granular approach. We expand each observation with multiple own teen pregnancies or linked with multiple friends' teen pregnancies by vertically stacking all "own fertility observation × friend's fertility observation" combinations. We then eliminate rows of data where own fertility observations are matched with a non-pregnant friend, as well as those where own pregnancy starts prior to the end of the friend's pregnancy. For example, if woman A had two teen pregnancies (birth at time t; and abortion at time t+1) and nominated two friends, B (miscarriage as time t-1; birth at time t), and C (never pregnant), this observation would be transformed into three dyads: (A's birth & B's miscarriage), (A's abortion & B's birth), and (A's abortion & B's miscarriage); the chronologically implausible link and the link the never-pregnant friend C are excluded. Therefore, the number of times each woman is included in the analysis is equal to

where M_i is the number of woman i's own fertility outcomes (equal to 1 if no teen pregnancy), N_j is the number of friend j's fertility outcomes (excluding no teen pregnancy and chronologically implausible outcomes) and J_i is the number of i's friendship links. We create frequency weights equal to the inverse of the product of the number of individual own fertility observations for each individual, times the number of friend links for every own fertility observation, , times the number of friend's fertility observations for each own fertility

observation- friend link, : ———— . We use these weights, in conjunction with the Core 1 Add Health survey design weight, in all our models. The transformed sample has a total of 1,490 "own fertility outcome × friend's fertility outcome" observations.[3]

The study estimates the following modification of the peer effects model:

$$Y_{ijmn} = aMISC^{F}_{ijmn} + \beta ABRT^{F}_{ijmn} + FH_{im}\gamma + FH^{F}_{ijn}\delta + FH^{F-j}_{ijm}\rho + \phi F_i + R_{ij}\varphi + X_i\theta + S_i\lambda + \varepsilon_{ijmn} \quad (1)$$

where *i* is the individual index (1-775), *j* is the friend nomination index (1-15), and *m* and *n* are the own and friend's fertility outcome index (range of 1 to 6 fertility outcomes). *Y* is own fertility outcome (no pregnancy/ miscarriage/ abortion/ birth). Variables $MISC^F$ and $ABRT^F$ represent the friend's prior fertility resolutions (birth is omitted), with the friend's miscarriage term, $MISC^F$, being our primary variable of interest.

Because our model links each of the own fertility event *m* to each of the friend's fertility events *n* individually, internal consistency of the model requires properly accounting for own fertility history (excluding event *m*) and friend's fertility history (excluding excluding event *n*). Therefore, we control for own fertility history prior to event *m* (number of miscarriages, abortions, and births), *FH*, as well as for the friend's complete fertility history prior to own event *m* and excluding the focus event n FH^F. We also control for a vector of average fertility outcomes of *i*'s friends excluding friend *j* (average number of miscarriages, abortions, and births), FH^{F-j} . Other controls include individual *i*'s number of friendship links (*F)*, a vector of friendship specific variables (friendship rank of friend *j* as nominated by individual *i* and a 0/1 indicator for reciprocated nomination, *R*), individual *i*'s observable characteristics, (age, African

[3] 1,490 = 775 women × 1.156 own fertility outcomes (on average) × 1.262 pregnant friend links (on average) × 1.317 friend's fertility outcomes (on average). Note that 63 women get removed because their pregnancy precedes each of their friends' pregnancies, although they are still included as alters.

American, Hispanic, other non-white, age, parental income, two-parent family, mother's education *X*), and school-level controls (percent African American, average parental income, average mother's education, percent two-parent families, percent teen miscarriage, percent teen abortion, percent teen birth, *S*). We weight all models using a product of the Add Health survey design weights and our contracted inverse frequency weights, and cluster standard errors at the individual level. We use a multinomial logistic regression and compute average marginal effects.

In addition to the reduced form model (1), we also utilize the following instrumental variable approach:

$$Y_{ijmn} = aBIRTH^{F}_{ijmn} + FH_{im}\gamma + FH^{F}_{ijn}\delta + FH^{F-j}_{ijm}\rho + \phi F_i + R_{ij}\varphi + X_i\theta + S_i\lambda + \varepsilon_{ijmn} \qquad (2)$$

where Y is a 0/1 indicator of having a particular type of fertility outcome (pregnancy, miscarriage, abortion, and birth) and *BIRTH* is a 0/1 indicator of friend's birth that is instrumented using miscarriage in the first stage.

Our coefficient of interest in both models (1) and (2) is α, or the so-called endogenous peer effect. A positive significant coefficient of friend's miscarriage in the own-birth equation in model (1) and a negative significant coefficient of the instrumented friend's birth variable in model (2) would suggest that, accounting for confounding due to selection and exposure to common environment, women with friends who had a child are less likely to experience a teen pregnancy and childbirth themselves. On the contrary, conformity with peer behavior will be represented by a negative coefficient in the reduced-form miscarriage model and a positive coefficient in the 2SLS model. Note that due to the use of inverse frequency weights, the magnitude of the coefficient represents the change in own probability of having a teen birth as the proportion of pregnant friends who miscarry changes from 0 to 1.

Specification (1) also allows conducting two falsification tests. Specifically, if miscarriages were non-random but rather caused by common environmental factors or correlated through friend selection, we would expect a positive significant coefficient of the friend's miscarriage variable in the own miscarriage equation. Additionally, if miscarriages were misreported abortions, we would expect a positive and significant cross-outcome effects, i.e. a positive association between a friend's abortion and own miscarriage. Lastly, we will attempt to examine the extent to which "would be abortion" miscarriages may be confounding our results by restricting our miscarriage instrument to only miscarriages that occurred after the 8^{th}, 10^{th}, and 16^{th} week of pregnancy. In our sample, 90% of pregnancies were electively terminated on or before the 16^{th} week of pregnancy; therefore restricting the miscarriage instrument in this way is likely to significantly reduce any confounding due to spontaneous miscarriage of pregnancies that would have otherwise been terminated.

VI. Results

Table 2 shows our IV results and reduced form results, using miscarriage to identify the impact of a friend's teen childbirth on own teen fertility. Miscarriage has good first stage properties (column 1) with the F-statistic of 179.24. Having a miscarriage reduces the probability of having a teen birth by 74.5 percentage points. The second stage results show a significant negative relationship between friend's teen birth and own childbirth. Specifically, friend's teen birth is associated with a 9.7 percentage point reduction in own probability of having a teen pregnancy ($p<.10$) and an 11 percentage point reduction in own probability of having a teen birth ($p<.05$). The reduced form results support the finding of a negative peer effect in teen childbearing. Specifically, friend's miscarriage increases the probability of own teenage childbirth by 7.2 ($p<.01$) percentage points ($p<.01$). In Table 3, we present estimation results for

a chronologically implausible peer effects model, and find that none of the fertility outcomes are significantly associated with the friend's future fertility events.

Given that the overall prevalence of teen childbirth in the full sample is 13%, the magnitude of the estimate, 7-11 percentage points, represents a non-trivial peer effect. Recall that our identification strategy requires that we focus on peer influences received only from a relatively small proportion of an individual's full reference peer group, i.e. only pregnant friends who either gave birth or miscarried. Therefore, our estimates suggest a potentially much larger magnitude of peer influence if it was captured at the level of an individual's full reference peer group.

<multiplier discussion here>

Some of the other important determinants of teen pregnancy and childbearing are own past fertility history, race, mother's education, and school-level environment measures. Non-white women are significantly more likely to have a teen pregnancy and childbirth, as well as women with less educated mothers. Women exposed to high rates of teen fertility at the school are, not surprisingly, more likely to have a teen pregnancy and childbirth. Lastly, there is a positive association between the likelihood of having a miscarriage and the school-level miscarriage rates, suggesting that unobserved socioeconomic or environmental factors common at the school level may systematically impact miscarriage rates. [4]

[4] Including school-level average fertility outcomes could induce an artificial negative correlation between peer's and own fertility outcomes in small schools (Guryan et al. 2009). Although using all Wave III observations and not just the ones in our final sample should minimize any such bias, we also estimate our models without controls for school level aggregate fertility measures and after dropping schools with less than 100 in-sample observations. Our results are robust in both cases.

Our falsification tests support using miscarriage to identify the effect of a friend's teen birth. The reduced form results (columns 6-9) provide no evidence that, conditional on aggregate school-level fertility measures and other controls, miscarriages may be caused by exposure to shared environment or otherwise positively correlated among friends through unobserved selection, or that they could be misreported abortions. In particular, if friends' miscarriages were correlated with the error term in the fertility equation (either through unobserved environmental factors or due to friend selection), we would expect a significant association between own and friend's likelihood of miscarriage. Furthermore, if many miscarriages are in fact misreported abortions, we would expect there to be a significant association between own miscarriage and friend's abortion. We see little evidence of either as both the coefficient of friend's miscarriage and the coefficient of friend's abortion are insignificant.

In Table 4, we attempt to examine the issue that an unknown portion of miscarriages, even if they are truly random, may not have resulted in childbirth but would instead become elective abortions. As we discuss earlier, the presence of "would-be abortions" in the friend's miscarriage group would bias the estimated peer effect upward, or in our case because the coefficient estimate is negative, it may be biased toward zero. We attempt to test this by restricting our miscarriage instrument to include only miscarriages that occurred after the 8^{th}, 10^{th}, and 16^{th} week of pregnancy. In our sample less than 5% of reported abortions happen after the 16^{th} week of gestation and limiting our instrument to these late miscarriages should eliminate most miscarriages that would have resulted in abortions. The estimates are robust to eliminating all abortions and early miscarriages and consistent with a negative effect of peer childbirth on own teen childbearing.

Next, we attempt to explore the mechanism of peer influence by stratifying our sample based on school-level teen childbearing rates (Table 5). We find that the reduction in own chances of teen pregnancy and childbirth following a friend's childbirth does not occur in schools with high rates of teen childbearing (>25%), in fact in schools where exposure to teen childbearing is high, the direction of peer influence appears to suggest a positive peer effect, or conformity with friend's behaviors. It is possible that the incremental increase in knowledge from a friend's childbearing experience is much smaller in environments with high fertility rates causing the difference in the results.

To further explore this idea, we stratify the results by the characteristics of the friend's partner. We expect that if learning is the mechanism behind the negative peer effect, then the negative impact of a friend's teen childbirth should be smaller when the friend's partner is ready to assume the parenting role and reduce the burden of childbearing. We use two survey questions in an attempt to gauge the propensity of the friend's partner toward participating in childrearing: one asks whether or not the respondent wanted their partner to be their child's parent, and the other one asks whether or not the partner accompanied the responded to pregnancy-related doctor/midwife/nurse appointments. The results are shown in Table 6, and they are consistent with the idea that the negative peer effect in teen childbearing is larger when the childbearing experience of the friend is more difficult. In particular, childbearing of peers who answered no to the questions about their partners has a large negative effect on own likelihood of teen pregnancy and childbearing. On the other hand, women whose friends have a child with a partner who is ready to take on parenting responsibilities are more likely to subsequently get pregnant, although many these pregnancies end in abortions.

Lastly, in Table 7 we utilize attitudes toward teen pregnancy and childbearing data provided in the Add Health data (appendix 2.A).[5] The questions were asked during the in-home Wave I interview of respondents who were at least 15 years old at the time of the interview.[6] The responses were recorded on a scale from "strongly disagree" to "strongly agree" and we define all attitude variables so that higher values correspond with greater degree of agreement with the statement. We also use factor analysis to create a composite of all of the attitudes variables. We present 2SLS results with the friend's teen birth instrumented with miscarriage. The results suggest that women whose friend had a teen birth are more likely to have a negative attitude toward pregnancy. They are significantly more likely to feel that pregnancy would be the worst thing to happen to them, that it would embarrass them, and could lead them to marry a wrong person. These findings also support the knowledge externalities model and the optimal behavioral rule under uncertainty. In particular, the estimates suggest that being friends with a teen mom is associated with increased perceptions of teen childbearing as being a negative outcome, and a tendency toward not repeating the friend's behavior.

While the present study's methodological approach is designed to reduce confounding due to peer selection and shared environmental influences, we point out the following caveats. The focus of the study was peer influences in childbirth, and the study design did not allow examination of how a woman's fertility may be influenced by other behaviors of friends (e.g. sexual behavior). Because we use pregnancy histories collected retrospectively several years after many of the reported pregnancies occurred, recall bias may be an issue. Due to the fact that less than 20% of the original in-school sample were followed through to Wave III resulted in

[5] "Motivations for Risky Behaviors" and "Attitudes toward Pregnancy, STD, and HIV" sections of the Wave I in-home questionnaire.

[6] The age restriction reduces the sample size in this sub-analysis by about one-third. Our main results are robust and in fact the magnitudes are larger in this older sub-sample.

incomplete capture of friendship networks[7]. Lastly, by selecting only individuals with friends who experienced a teen pregnancy, our sample criteria produced a sample that is not representative of the high school population and the results may not generalize to other populations.

VII. Conclusion

Our findings support the presence of a sizable negative local treatment effect on teen childbearing among best friends. Multinomial logistic regression and IV results with controls for own and friend's fertility history, extensive set of socio-demographic controls, local peer network structure, and school-level fertility measures suggest that a friend's teen birth is associated with a 5-10 percentage point reduction in the likelihood of own teen childbearing. There is also evidence that this effect operates through a learning mechanism by changing attitudes toward early childbearing and reducing unwanted pregnancies. The findings suggest that lowering the rates of teen motherhood could have an unintended spill-over effect of reducing a teen's exposure to peer childbearing and therefore limiting opportunities to learn from peer's experiences. If similar learning mechanisms are operative in other teen decisions (e.g. alcohol use, drug use), our results may point to a general phenomenon that should be considered when designing policies to reduce certain teen behaviors. As effective targeted policies lower rates of teenage childbearing, reductions in the opportunities for social learning within networks may partially counteract the effects of the policy. More comprehensive approaches may be able to both reduce individual teen childbearing outcomes as well as provide information to peers about the consequences of teen childbearing in order to further reduce this outcome among teens.

[7] Recall that Add Health by design only collected longitudinal data on 20,000 of the original 90,000 individuals who participated in the in-school survey. However, those followed were a random subset of the original 90,000 sampling frame.

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Tables

Table 1. Sample characteristics stratified by exposure to friend's fertility

Variable	Pregnant Friend = NO N=5438; Pop. Size=1592	Pregnant Friend = YES N=1904; Pop. Size=838		
		Friend Live Birth=Yes N=1241; Pop. Size =567	Friend Miscarriag = Yes N=288; Pop. Size =106	Friend Abortion = Yes N=375; Pop. Size =165
Had a teen pregnancy	0.17	0.24‡	0.27‡	0.20‡
Had a teen miscarriage	0.02	0.04‡	0.03‡	0.02‡
Had a teen abortion	0.03	0.03	0.03	0.08‡
Had a teen birth	0.11	0.17‡	0.21‡	0.09
Age	16.15	16.24	16.00	15.59
African American	0.16	0.28‡	0.24‡	0.26‡
White	0.77	0.66‡	0.68‡	0.65‡
Asian	0.03	0.01	0.01	0.04
Other race	0.07	0.07	0.12	0.07
Hispanic Ethnicity	0.04	0.05	0.06	0.05
Urban residence	0.25	0.26	0.33	0.28
Suburban residence	0.32	0.23‡	0.19‡	0.36
Rural Residence	0.39	0.47	0.45	0.34
Missing parent's information	0.13	0.17‡	0.18‡	0.16‡
Mother' education: < HS	0.11	0.17‡	0.15‡	0.07
HS	0.29	0.35	0.33	0.22
Some College, no degree	0.09	0.09	0.07	0.09
Associate Degree	0.16	0.13	0.17	0.19
Bachelor Degree	0.13	0.07‡	0.08‡	0.17‡
Graduate/professional degree	0.11	0.04‡	0.07‡	0.13
Two-parent household	0.68	0.60‡	0.60‡	0.63‡
Mother's age	39.71	37.10	37.68	42.82‡
Mother born in USA	0.83	0.81	0.86	0.79

Number of friend nominations	4.30	3.74	3.45	3.72
Average friendship rank	2.69	2.71	2.97	2.65
Reciprocal nomination	0.53	0.51	0.47	0.53
Av.Sch. teen pregnancy rate	0.21	0.27‡	0.26‡	0.25‡
Av.Sch. teen miscarriage rate	0.04	0.05‡	0.06‡	0.04
Av.Sch. teen abortion rate	0.04	0.04	0.05	0.09‡
Av.Sch. Teen live birth rate	0.16	0.22‡	0.19‡	0.15
Av.Sch. % of African Americans	0.19	0.26‡	0.28‡	0.25‡
Av.Sch. Mother's Education	13.86	13.32‡	13.47	14.20
Av.Sch. two-parent household	0.74	0.69‡	0.70‡	0.71

Means are adjusted for research design and Add Health survey sampling design.
‡ different from the "no pregnant friends" group mean at <.05

Table 2. 2SLS and Reduced Form Multinomial Logit Results, pregnant friend sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	2SLS					Multinomial logit			
	Stage I	Stage II							
		Teen Pregnancy	Teen Pregnancy Resolution			No Teen Pregnancy	Teen Pregnancy Resolution		
VARIABLES	Friend's Teen Birth		Teen Miscarriage	Teen Abortion	Teen Birth		Teen Miscarriage	Teen Abortion	Teen Birth
Friend Teen Miscarriage	-0.745***					-0.0607	0.00396	-0.0150	0.0718***
	(0.0252)					(0.0371)	(0.0126)	(0.0244)	(0.0275)
Friend Teen Birth		-0.0971*	-0.00221	0.0155	-0.110**				
		(0.0550)	(0.0182)	(0.0193)	(0.0517)				
Friend Teen Abortion						0.0129	0.00557	-0.00420	-0.0142
						(0.0373)	(0.0104)	(0.0204)	(0.0272)
Past Miscarriages	0.105***	0.209***	0.0608	0.0387	0.109	-0.125***	0.0209	0.0326**	0.0714**
	(0.0346)	(0.0765)	(0.0528)	(0.0327)	(0.0669)	(0.0402)	(0.0133)	(0.0153)	(0.0312)
Past Abortions	0.0193	0.0895	0.0424	0.0492	-0.00208	-0.0525	0.0255	0.00893	0.0181
	(0.0624)	(0.0836)	(0.0528)	(0.0653)	(0.0475)	(0.0559)	(0.0298)	(0.0140)	(0.0471)
Past Births	-0.0194	0.133***	0.0233	0.00873	0.101**	-0.100***	0.0158*	0.0152	0.0691***
	(0.0310)	(0.0452)	(0.0187)	(0.0167)	(0.0402)	(0.0262)	(0.00893)	(0.0150)	(0.0202)
Friend Past Miscarriages	-0.0626	-0.0599**	-0.0190**	-0.00942	-0.0315	0.0779*	-0.0282*	-0.0226	-0.0271
	(0.0610)	(0.0296)	(0.00842)	(0.00831)	(0.0247)	(0.0465)	(0.0155)	(0.0267)	(0.0286)
Friend Past Abortions	-0.0951***	0.0249	0.00417	0.0340	-0.0133	-0.0167	0.00788	0.00901*	-0.000220
	(0.0330)	(0.0384)	(0.0156)	(0.0257)	(0.0260)	(0.0379)	(0.00900)	(0.00535)	(0.0375)
Friend Past Births	0.00602	0.0607***	0.0152	0.00865	0.0369	-0.0524***	0.0127*	0.0119	0.0278**
	(0.0364)	(0.0202)	(0.0102)	(0.0160)	(0.0229)	(0.0160)	(0.00660)	(0.0131)	(0.0138)
Friend Subseq Miscarria	-0.0808	-0.0104	0.00422	-0.0107*	-0.00392	0.245***	0.0131	-0.304***	0.0460**
	(0.0513)	(0.0253)	(0.00999)	(0.00580)	(0.0222)	(0.0487)	(0.00883)	(0.0501)	(0.0189)
Friend Subseq Abortions	-0.126**	0.0131	-0.0210*	0.0609	-0.0268	0.0158	-0.0345	0.0148**	0.00383
	(0.0624)	(0.0553)	(0.0117)	(0.0437)	(0.0287)	(0.0444)	(0.0227)	(0.00700)	(0.0408)
Friend Subseq Births	-0.0307	-0.0626***	-0.00393	-0.00872	-0.0500**	0.0580**	5.81e-06	-0.0158	-0.0422*
	(0.0329)	(0.0236)	(0.00967)	(0.00927)	(0.0214)	(0.0252)	(0.00766)	(0.0161)	(0.0223)
Other Friends' Miscarria	0.0411	0.166	-0.0329	0.144	0.0547	-0.0994	-0.0407	0.0952***	0.0449
	(0.0699)	(0.116)	(0.0210)	(0.0947)	(0.0977)	(0.0797)	(0.0313)	(0.0201)	(0.0643)
Other Friends' Abortions	0.103	-0.0372	-0.0117	-0.0477	0.0222	0.0281	-0.0155	-0.0197	0.00713

	(0.0845)	(0.0868)	(0.0134)	(0.0457)	(0.0636)	(0.0715)	(0.0215)	(0.0319)	(0.0523)
Other Friends' Births	-0.0794*	0.117*	0.00276	-0.0322*	0.146***	-0.0484	-0.00128	-0.0507	0.100***
	(0.0474)	(0.0589)	(0.0205)	(0.0170)	(0.0532)	(0.0473)	(0.0186)	(0.0396)	(0.0271)
fn==2	0.0558**	0.00617	-0.00888	-0.0209	0.0359	0.00525	-0.00871	-0.0249	0.0284
	(0.0281)	(0.0332)	(0.0145)	(0.0196)	(0.0298)	(0.0322)	(0.0106)	(0.0216)	(0.0270)
fn==3	0.00573	0.0141	-0.0165	-0.00750	0.0381	-0.00700	-0.0133	-0.0182	0.0385
	(0.0330)	(0.0324)	(0.0133)	(0.0174)	(0.0268)	(0.0317)	(0.0122)	(0.0174)	(0.0255)
fn==4	0.00853	-0.0332	-0.0205	-0.0161	0.00338	0.0400	-0.0203	-0.0208	0.00107
	(0.0313)	(0.0343)	(0.0134)	(0.0165)	(0.0260)	(0.0402)	(0.0152)	(0.0206)	(0.0278)
fn==5	0.0359	-0.0273	-0.0239*	-0.000625	-0.00281	0.0502	-0.0260*	-0.0163	-0.00790
	(0.0339)	(0.0340)	(0.0129)	(0.0183)	(0.0277)	(0.0375)	(0.0138)	(0.0175)	(0.0297)
Number of nominations	0.00341	0.0123*	0.00190	0.00560**	0.00479	-0.0148**	0.00187	0.00771**	0.00521
	(0.00682)	(0.00620)	(0.00325)	(0.00256)	(0.00569)	(0.00634)	(0.00339)	(0.00310)	(0.00577)
Reciprocated nomination	-0.00139	-0.0481**	-0.0156*	-0.00957	-0.0229	0.0527**	-0.0165**	-0.0116	-0.0247
	(0.0300)	(0.0231)	(0.00817)	(0.0127)	(0.0198)	(0.0228)	(0.00721)	(0.0139)	(0.0189)
African American	0.0367	0.0270	0.0244*	-0.00764	0.0102	-0.0258	0.0226**	-0.00738	0.0105
	(0.0369)	(0.0394)	(0.0131)	(0.0225)	(0.0270)	(0.0384)	(0.0108)	(0.0268)	(0.0239)
ASIAN	0.152	0.0964	-0.0135	0.0704	0.0395	0.187**	-0.281***	0.0476**	0.0461
	(0.132)	(0.0855)	(0.0238)	(0.0797)	(0.0285)	(0.0930)	(0.0887)	(0.0221)	(0.0398)
Other Race	0.0140	0.0189	-0.00912	0.00485	0.0231	-0.0296	-0.00876	0.0197	0.0186
	(0.0521)	(0.0539)	(0.0138)	(0.0319)	(0.0514)	(0.0433)	(0.0249)	(0.0178)	(0.0404)
Hispanic	0.0562	0.0368	-0.00677	0.0124	0.0311	-0.0332	-0.00504	0.0107	0.0276
	(0.0514)	(0.0572)	(0.0145)	(0.0294)	(0.0424)	(0.0472)	(0.0179)	(0.0263)	(0.0314)
Age in years	0.0154*	-0.0218***	-0.00561***	-0.00399	-0.0122*	0.0240***	-0.00559**	-0.00564	-0.0128*
	(0.00905)	(0.00801)	(0.00197)	(0.00337)	(0.00644)	(0.00837)	(0.00279)	(0.00387)	(0.00663)
Maternal Education	-0.00984**	-0.00698**	-0.000281	0.000483	-0.00719***	0.00155	0.000224	0.00255	-0.00433
	(0.00437)	(0.00315)	(0.00132)	(0.00178)	(0.00270)	(0.00405)	(0.00204)	(0.00171)	(0.00315)
Two-parent Family	0.0367	-0.00120	0.00511	-0.0117	0.00536	-0.00376	0.00647	-0.0124	0.00972
	(0.0278)	(0.0283)	(0.0162)	(0.0132)	(0.0276)	(0.0288)	(0.0174)	(0.0121)	(0.0265)
Mother's Age	-0.000203	-0.000162*	-2.46e-05	-2.15e-05	-0.000115**	0.00278*	-0.000431	-0.00107***	-0.00127
	(0.000250)	(8.80e-05)	(3.05e-05)	(3.00e-05)	(5.31e-05)	(0.00168)	(0.000805)	(0.000358)	(0.00113)
Mother born in USA	0.0725*	0.114***	0.0118	-0.00402	0.106***	-0.132**	0.0206	0.00423	0.107*
	(0.0430)	(0.0324)	(0.0126)	(0.0205)	(0.0338)	(0.0634)	(0.0140)	(0.0185)	(0.0549)
Suburban Residence	-0.0228	0.0160	-0.00814	0.00603	0.0181	-0.00230	-0.0113	-0.00361	0.0172
	(0.0319)	(0.0356)	(0.0124)	(0.0177)	(0.0326)	(0.0354)	(0.0133)	(0.0128)	(0.0326)
Rural Residence	-0.0538*	0.000860	0.00755	-0.0132	0.00652	0.0157	0.00630	-0.0284	0.00639

	(0.0310)	(0.0322)	(0.0154)	(0.0149)	(0.0336)	(0.0317)	(0.0119)	(0.0192)	(0.0291)
Sch. Avg. Mother Ed.	0.0636	-0.0343	-0.0409*	-0.00249	0.00911	0.0177	-0.0319	0.00243	0.0118
	(0.0698)	(0.0598)	(0.0229)	(0.0322)	(0.0422)	(0.0535)	(0.0220)	(0.0365)	(0.0389)
Sch. Avg. %Black	-0.0203	0.0319**	0.0122***	-0.000102	0.0198*	-0.0306**	0.0116**	0.00210	0.0169*
	(0.0217)	(0.0137)	(0.00416)	(0.00547)	(0.0103)	(0.0135)	(0.00451)	(0.00632)	(0.0103)
Urban School	-0.0850	0.0380	0.0168	-0.000262	0.0214	-0.0119	0.00946	-0.0144	0.0168
	(0.0612)	(0.0495)	(0.0297)	(0.0205)	(0.0453)	(0.0487)	(0.0293)	(0.0230)	(0.0453)
Sch. Avg. %Teen Misc	-0.101	0.666	0.316*	0.180	0.170	-0.721*	0.276*	0.277	0.169
	(0.523)	(0.449)	(0.181)	(0.181)	(0.385)	(0.395)	(0.150)	(0.201)	(0.355)
Sch. Avg. %Teen Abort	-2.564***	0.320	-0.0232	0.665***	-0.322	-0.250	-0.0412	0.326**	-0.0342
	(0.404)	(0.274)	(0.0892)	(0.182)	(0.270)	(0.299)	(0.0870)	(0.136)	(0.263)
Sch. Avg. %Teen Birth	0.849***	0.695***	0.165**	-0.0704	0.601***	-0.572***	0.146**	-0.0746	0.501***
	(0.248)	(0.226)	(0.0748)	(0.109)	(0.166)	(0.218)	(0.0700)	(0.111)	(0.157)
Constant	0.805**	-0.139	-0.0992	0.0488	-0.0891				
	(0.327)	(0.220)	(0.0611)	(0.0876)	(0.191)				
Observations	1,490	1,490	1,490	1,490	1,490			1,490	
R-squared	0.459	0.124	0.043	0.093	0.084				

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 3. Falsification test, chronologically implausible results

	2SLS					Multinomial logit			
	Stage I	Stage II							
		Teen Pregnancy	Teen Pregnancy Resolution			No Teen Pregnancy	Teen Pregnancy Resolution		
VARIABLES	Friend's Teen Birth		Teen Miscarriage	Teen Abortion	Teen Birth		Teen Miscarriage	Teen Abortion	Teen Birth
Friend Teen Miscarriage	-0.743***					-0.0272	-0.0156	0.0140	0.0237
	(0.0307)					(0.0314)	(0.0128)	(0.0183)	(0.0257)
Friend Teen Birth		-0.0367	0.0142	-0.0270	-0.0229				
		(0.0433)	(0.0121)	(0.0259)	(0.0343)				
Friend Teen Abortion						0.0140	-0.0316*	0.00371	0.0139
						(0.0370)	(0.0191)	(0.0151)	(0.0258)
Observations	1,551	1,551	1,551	1,551	1,551	1,551			
R-squared	0.474	0.135	0.038	0.100	0.148				

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 4. Reduced form results excluding all friend's abortions and early miscarriages

	>8 weeks				>10 weeks				>16 weeks			
VARIABLES	No teen pregnancy	Teen Misc	Teen Abort	Teen Birth	No teen pregnancy	Teen Misc	Teen Abort	Teen Birth	No teen pregnancy	Teen Misc	Teen Abort	Teen Birth
Friend Teen Miscarriage	-0.0759**	0.00807	-0.00209	0.0699**	-0.103**	-0.0151	0.0354*	0.0825**	-0.118***	0.00963	0.0133	0.0947***
	(0.0360)	(0.0134)	(0.0129)	(0.0312)	(0.0401)	(0.0122)	(0.0203)	(0.0358)	(0.0352)	(0.0142)	(0.0127)	(0.0333)
Observations	1,097				1,073				1,014			

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 5. Reduced form multinomial logit estimates stratified by school-level exposure to teen childbearing

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Schools teen birth rate >25%				School teen birth rate ≤ 25%			
VARIABLES	No teen pregnancy	Teen Miscarriage	Teen Aborti n	Teen Birth	No teen pregnancy	Teen Miscarriage	Teen Abortion	Teen Birth
Friend Teen Miscarriage	0.0781	-0.0235	-0.00035	-0.0542	-0.0593*	-0.00733	-0.0366	0.103***
	(0.0498)	(0.0379)	(0.0232)	(0.0516)	(0.0358)	(0.0111)	(0.0244)	(0.0275)
Observations	509				981			

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 6. Reduced form multinomial logit estimates stratified by friend's view of their parter

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Yes				No			
VARIABLES	No teen pregnancy	Teen Miscarriage	Teen Abortion	Teen Birth	No teen pregnancy	Teen Miscarriage	Teen Abortion	Teen Birth
Did friend want partner to be their child's parent?								
Friend Teen Miscarriage	0.150***	0.0104	-0.230***	0.0691**	-0.0950*	0.00971	-0.0221	0.107***
	(0.0571)	(0.0215)	(0.0604)	(0.0352)	(0.0491)	(0.0156)	(0.0235)	(0.0388)
Observations	841				649			
Did friend's partner go along to pregnancy-related doctor's visits?								
Friend Teen Miscarriage	0.129***	0.0197	-0.212***	0.0634*	-0.0903**	-0.0105	-0.0103	0.111***
	(0.0501)	(0.0182)	(0.0499)	(0.0375)	(0.0455)	(0.0128)	(0.0220)	(0.0364)
Observations	825				665			

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 7. 2SLS results of own attitudes toward pregnancy on friend's childbirth, instrumented with friend's miscarriage

VARIABLES	(1) Factor Score	(2) Worst Thing	(3) Risk	(7) Embarras Fam	(8) Embarras Self	(9) Quit School	(10) Marry Wrong	(11) Grow Up Fast
Friend Teen Birth	0.170*	0.106**	-0.0172	0.0159	0.0903*	0.0208	0.0959*	0.0593
	(0.0994)	(0.0527)	(0.0525)	(0.0761)	(0.0576)	(0.0638)	(0.0540)	(0.0723)
Past Miscarriages	0.121	0.0371	0.0129	0.0700	0.0340	0.0519	0.0423	0.0518
	(0.119)	(0.0513)	(0.0613)	(0.0621)	(0.0673)	(0.0965)	(0.0742)	(0.0769)
Past Abortions	-0.00809	-0.0302	-0.0182	0.131**	0.0121	0.0194	-0.271***	-0.0562
	(0.101)	(0.0512)	(0.0485)	(0.0525)	(0.0490)	(0.0769)	(0.0403)	(0.0743)
Past Births	-0.343***	-0.0648	-0.00393	-0.140***	-0.135***	-0.113***	-0.0608*	-0.0629
	(0.0907)	(0.0461)	(0.0454)	(0.0359)	(0.0496)	(0.0399)	(0.0362)	(0.0638)
Friend Past Miscarriages	-0.0228	-0.0220	-0.0907	0.0404	-0.0721	0.169***	-0.0262	-0.0227
	(0.149)	(0.0556)	(0.0609)	(0.0580)	(0.0626)	(0.0634)	(0.0660)	(0.0621)
Friend Past Abortions	0.0578	0.0266	-0.0129	-0.0256	0.0438	-0.0289	-0.00782	0.0502
	(0.0753)	(0.0226)	(0.0436)	(0.0549)	(0.0347)	(0.0508)	(0.0416)	(0.0365)
Friend Past Births	-0.126*	0.0207	-0.0433	-0.0516	-0.0784***	-0.0969***	0.00542	-0.0121
	(0.0680)	(0.0206)	(0.0260)	(0.0404)	(0.0285)	(0.0268)	(0.0388)	(0.0304)
Friend Subseq Miscarria	-0.00545	0.0584	-0.115	-0.0517	-0.0895	0.00415	0.00771	0.127**
	(0.136)	(0.0518)	(0.0862)	(0.0665)	(0.103)	(0.0713)	(0.116)	(0.0504)
Friend Subseq Abortions	0.00688	-0.0223	-0.196*	0.00410	0.0547	-0.0139	0.142*	-0.0662
	(0.165)	(0.0656)	(0.0988)	(0.0847)	(0.0865)	(0.0974)	(0.0772)	(0.0901)
Friend Subseq Births	-0.0433	-0.00709	-0.000176	-0.0597	-0.00238	-0.0470	-0.0232	0.0141
	(0.0630)	(0.0225)	(0.0302)	(0.0374)	(0.0296)	(0.0407)	(0.0312)	(0.0405)
Other Friends' Miscarria	0.313	0.0278	-0.0822	0.0416	0.188	-0.101	-0.0137	0.178
	(0.355)	(0.0891)	(0.155)	(0.152)	(0.150)	(0.0863)	(0.179)	(0.151)
Other Friends' Abortions	0.0986	-0.0549	0.000905	0.0765	0.0697	0.102	0.131	-0.0561
	(0.265)	(0.0792)	(0.0974)	(0.105)	(0.0997)	(0.135)	(0.125)	(0.0953)
Other Friends' Births	-0.0411	0.0493	0.0561	-0.0612	-0.0926	0.0127	0.0662	0.0764
	(0.165)	(0.0623)	(0.0565)	(0.0865)	(0.0946)	(0.0837)	(0.0942)	(0.0572)
fn==2	-0.0975	-0.0279	0.0598	-0.0361	-0.0791	0.0574	-0.0253	-0.00877
	(0.114)	(0.0353)	(0.0492)	(0.0588)	(0.0592)	(0.0635)	(0.0518)	(0.0447)
fn==3	0.0588	-0.0307	0.0388	0.0363	0.00863	-0.00731	0.0446	0.0871**
	(0.0869)	(0.0372)	(0.0470)	(0.0502)	(0.0520)	(0.0562)	(0.0612)	(0.0415)
fn==4	0.0866	-0.00895	-0.00906	-0.00414	0.0369	-0.0465	0.0460	0.106**
	(0.107)	(0.0391)	(0.0521)	(0.0547)	(0.0540)	(0.0555)	(0.0514)	(0.0496)
fn==5	0.181*	0.0145	0.0909*	0.0431	0.0445	0.163***	0.0413	0.112***
	(0.0991)	(0.0330)	(0.0543)	(0.0475)	(0.0579)	(0.0582)	(0.0613)	(0.0388)
Number of nominations	-0.0235	-0.00809	-0.00597	-0.00610	0.000143	-0.0439***	-0.000186	-0.00872
	(0.0209)	(0.00739)	(0.00990)	(0.0120)	(0.0111)	(0.0126)	(0.0120)	(0.0108)
Reciprocated nomination	0.0111	-0.00251	0.0759	0.0376	-0.0380	0.0454	-0.0226	0.00922

	(0.100)	(0.0395)	(0.0497)	(0.0470)	(0.0472)	(0.0547)	(0.0572)	(0.0476)
African American	-0.307**	-0.00335	-0.0213	-0.0632	-0.114	-0.0961	-0.168**	-0.165***
	(0.127)	(0.0397)	(0.0636)	(0.0727)	(0.0700)	(0.0703)	(0.0687)	(0.0491)
ASIAN	0.121	0.0932*	0.0979	0.0255	0.0197	0.228***	0.378**	-0.182**
	(0.192)	(0.0534)	(0.107)	(0.0556)	(0.145)	(0.0753)	(0.153)	(0.0788)
Other Race	-0.361**	0.113***	-0.120	-0.144**	-0.185	-0.0590	-0.0562	-0.205***
	(0.169)	(0.0416)	(0.0987)	(0.0707)	(0.125)	(0.117)	(0.0956)	(0.0771)
Hispanic	0.333**	-0.0639	0.0914	0.176***	0.169	0.113	0.00787	0.115**
	(0.141)	(0.0464)	(0.0623)	(0.0585)	(0.103)	(0.0805)	(0.0827)	(0.0492)
Age in years	-0.0947**	-0.00648	0.000188	-0.0453*	-0.0255	-0.0417*	-0.0563***	-0.0323
	(0.0451)	(0.0146)	(0.0202)	(0.0231)	(0.0237)	(0.0214)	(0.0190)	(0.0232)
Maternal Education	0.0112	0.00484	8.03e-05	0.00533	0.00491	-0.000136	0.00141	0.00292
	(0.0103)	(0.00316)	(0.00644)	(0.00530)	(0.00620)	(0.00608)	(0.00586)	(0.00496)
Two-parent Family	0.134	0.0365	0.0582	0.0637	0.0592	0.0534	0.0362	-0.00810
	(0.0970)	(0.0344)	(0.0477)	(0.0604)	(0.0450)	(0.0420)	(0.0459)	(0.0480)
Mother's age	0.000403**	0.000114*	6.52e-05	0.000227**	0.000289***	-0.000480***	-0.000320***	0.000199**
	(0.000166)	(5.93e-05)	(9.86e-05)	(8.93e-05)	(8.26e-05)	(7.67e-05)	(7.84e-05)	(7.83e-05)
Mother born in US	-0.0720	-0.0338	0.0493	-0.0710	0.0116	-0.0674	0.0423	-0.0448
	(0.118)	(0.0473)	(0.0943)	(0.0743)	(0.0724)	(0.0714)	(0.0924)	(0.0569)
Suburban Residence	-0.0126	-0.00693	-0.0415	-0.0211	0.0129	0.0378	-0.00747	-0.00421
	(0.121)	(0.0437)	(0.0605)	(0.0644)	(0.0603)	(0.0487)	(0.0613)	(0.0496)
Rural Residence	0.0127	0.0151	0.0356	0.0326	0.0193	-0.0336	-0.0448	-0.0417
	(0.152)	(0.0549)	(0.0535)	(0.0729)	(0.0717)	(0.0545)	(0.0623)	(0.0658)
Sch. Avg. Mother Ed.	-0.177	0.0254	-0.0585	-0.198*	-0.0593	0.0426	0.227**	-0.0371
	(0.224)	(0.0686)	(0.0889)	(0.108)	(0.102)	(0.136)	(0.112)	(0.0869)
Sch. Avg. %Black	0.0663	-0.00223	0.0233	0.0226	0.0176	0.0186	-0.0176	0.0531**
	(0.0690)	(0.0189)	(0.0212)	(0.0281)	(0.0307)	(0.0391)	(0.0300)	(0.0241)
Urban School	0.165	0.0694	0.0941	0.162	0.114	-0.00725	-0.180	-0.104
	(0.220)	(0.0718)	(0.0881)	(0.113)	(0.112)	(0.102)	(0.112)	(0.110)
Sch. Avg. %Teen Misc.	-0.756	-0.631	0.0792	-0.445	-0.256	0.276	-0.487	0.290
	(1.510)	(0.452)	(0.717)	(0.717)	(0.818)	(0.961)	(0.891)	(0.714)
Sch. Avg. %Teen Abort.	0.500	0.157	-0.0363	0.344	-0.0194	-0.665	-0.532	0.591
	(1.128)	(0.348)	(0.591)	(0.523)	(0.666)	(0.612)	(0.613)	(0.502)
Sch. Avg. %Teen Birth	-0.341	-0.232	0.317	-0.0534	-0.188	-0.231	-0.890*	0.250
	(0.732)	(0.256)	(0.366)	(0.376)	(0.336)	(0.462)	(0.475)	(0.335)
Constant	0.683	1.011***	0.331	1.233**	0.916	1.030	1.670***	0.628

	(1.271)	(0.372)	(0.422)	(0.531)	(0.650)	(0.717)	(0.588)	(0.540)
Observations	849	870	870	854	858	853	857	858
R-squared	0.148	0.031	0.061	0.124	0.118	0.118	0.106	0.091

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Appendix

Table 1.A. Variables description and sample range

Variable	Variable Description	Sample Range	
Teen Pregnancy	=1 if at least one teen pregnancy	0	1
Teen Miscarriage	=1 if at least one teen miscarriage	0	1
Teen Abortion	=1 if at least one teen abortion	0	1
Teen Birth	=1 if at least one teen birth	0	1
Age in years	Age in months divided by 12	12.7	20.5
African American	=1 if african American	0	1
Hispanic	=1 if hispanic	0	1
Other Race	=1 if other non-white	0	1
Two-parent Family	=1 if two-parent family	0	1
Maternal Education	=8 if less than 9th grade; =10 if 9-12 grades, no HS diploma; =12 if HS diploma; =13 some college, no degree; =14 if less than 4-year degree; =16 if college degree; =20 if graduate or other professional degree	1	20
Number of friend nominations	Total count of non-duplicate friend links	1	13
Reciprocal nomination	=1 if nominated peer also nominated the respondent	0	1
Nomination Rank	Friendship nomination rank	1	5
School-level Teen Misc. Rate	School-level average teen miscarriage rate, based on full Wave III sample	0	0.15
School-level Teen Abort. Rate	School-level average teen abortion rate, based on full Wave III sample	0	0.25
School-level Teen Birth Rate	School-level average teen birth rate based on full Wave III sample	0	0.6
School-level %Af. American	School-level percentage of African americans based on full Wave III sample	0	1
School-level Avg. Par. Fam. Inc.	School-level average annual parental family income based on full Wave III sample and Wave I income data	0.8	7.81
School-level Avg. Maternal Educ	School-level average maternal education level based on full Wave III sample and Wave I income data	3	8.11
School-level % Two-parent family	School-level percent two-parent households based on full Wave III sample and Wave I income data	0	1

2.A. Add Health pregnancy attitudes questions, Wave I.

Getting pregnant at this time in your life is one of the worst things that could happen to you. (Section 8)

Imagine that sometime soon you were to have sexual intercourse with someone just once, but were unable to use any method of birth control for some reason. What is the chance that you would get pregnant? (Section 8)

If you got pregnant, it would be embarrassing for your family. (Section 17)

If you got pregnant, it would be embarrassing for you. (Section 17)

If you got pregnant, you would have to quit school. (Section 17)

If you got pregnant, you might marry the wrong person, just to get married. (Section 17)

If you got pregnant, you would be forced to grow up too fast. (Section 17)