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Does Fertility Behavior Spread among Friends?

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Abstract

By integrating insights from economic and sociological theories, this article investigates whether and through which mechanisms friends' fertility behavior affects an individual's transition to parenthood. By exploiting the survey design of the Add Health data, our strategy allows us to properly identify interaction effects and distinguish them from selection and contextual effects. We use a series of discrete-time event history models with random effects at the dyadic level. Results show that, net of confounding effects, a friend's childbearing increases an individual's risk of becoming a parent. We find a short-term, curvilinear effect: an individual's risk of childbearing starts increasing after a friend's childbearing, reaches its peak approximately two years later, and then decreases.

Keywords

fertility, transition to parenthood, Add Health, social interactions, peer effect

Several fertility studies highlight the importance of diffusion and social interaction processes for childbearing behavior (e.g., Bongaarts and Watkins 1996; Montgomery and Casterline 1996). Humans are social actors who make decisions and act while embedded in a web of social relationships with kin and peers, and demographers are increasingly acknowledging the role of interpersonal interactions in shaping fertility decision making (Bernardi 2003; Kohler 2001).

At the macro level, researchers often turn to diffusion and social interaction theories to explain fertility differentials across time and place (Bongaarts and Watkins 1996; Kohler, Billari, and Ortega 2002, 2006; Montgomery and Casterline 1996; Myrskylä and Goldstein 2013). Persistent diversity of fertility behavior between countries, regions, or over time may be due to social interaction effects that amplify the behavioral impact of certain socioeconomic and institutional changes (i.e., social multiplier effects) or maintain long-term behavioral differences across areas (i.e., multiple equilibria and path dependence [Billari 2004]). However, acknowledging the importance of social interaction for fertility patterns has not translated into a satisfactory body of empirical research at the micro level, mainly due to a lack of suitable data and the difficulty in modeling and properly identifying social interaction effects (Manski 1993, 1995). The existing meager research on the effect of social networks on fertility is based primarily on data from developing countries and mostly investigates contraception use (Behrman, Kohler, and Watkins 2002; Kohler, Behrman, and Watkins

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2001). Only a few studies focus on advanced societies, and these are mainly small-scale qualitative works (e.g., Bernardi 2003; Bernardi, Keim, and Von der Lippe 2007; Keim, Klärner, and Bernardi 2009). A more rigorous quantitative approach to the topic is emerging, however. A few studies have engaged in quantitative analyses to show that social interactions among siblings (Kuziemko 2006; Lyngstad and Prskawetz 2010), co-workers (Ciliberto et al. 2010; Hensvik and Nilsson 2010), and peers belonging to the same ethnic-religious group (Manski and Mayshar 2003) shape an individual's fertility decisions. Moreover, Aparicio Diaz and colleagues (2011) adopted an innovative approach to explain fertility changes, applying an agent-based simulation model to assess the importance of social interdependencies among individuals.

Although one would expect friends to have an influence on each others' family formation behaviors, cross-friend effects on fertility have not yet been scientifically examined. Therefore, our aim is to examine whether and how high school friends' fertility behaviors affect an individual's transition to parenthood. In doing so, we adopt an analytic strategy that allows us to properly identify interaction effects while ruling out possible confounding factors.

Overall, our article provides two distinct yet interrelated contributions to the literature. First, we propose an innovative strategy to deal with identification issues typical of social interaction processes. By exploiting the network panel survey design of the Add Health data, we use a dynamic model that disentangles selection and contextual effects from friends' influence effects. The second contribution relates to the theoretical mechanisms underlying the effects of social influence on fertility behavior among friends. Our theoretical framework integrates knowledge from sociology and economics to specify pathways via which cross-friend effects influence fertility behavior. In identifying the different processes through which fertility behavior may become contagious among friends, we enrich existing literature by extending social interaction research outside the kinship network.

THEORETICAL FRAMEWORK

Building on diffusion and social interaction theories (Bernardi 2003; Bongaarts and Watkins 1996; Kohler 2001; Montgomery and Casterline 1996), we begin from the assumption that individuals' life course decision making, such as whether to become a parent, is driven not only by personal characteristics and relevant contextual factors, but also by the characteristics and behaviors of the people with whom they interact.

According to socialization theories, an individual's behavior is shaped by interactions with relevant socialization sources (Oetting and Donnermeyer 1998). Existing fertility research identifies the family as the main socialization source. Studies emphasize the importance for childbearing choices of socialization processes that operate through the direct transmission of fertility behaviors and attitudes from parents to children at a very early stage in life (Barber 2000; Murphy and Wang 2001; Rijken and Liefbroer 2009; Thornton 1980) or through later intra-family interactions, such as those among siblings (Lyngstad and Prskawetz 2010). However, socialization occurs not only within the kinship network (Mathews and Sear 2013) but outside it as well, through social exchange and interaction with peers and friends. In today's individualized societies, friends may be equally or more important than siblings and other family members, mainly for two reasons. First, declining fertility has led to smaller families—that is, more singletons and fewer siblings. Siblings' roles have likely been replaced by close friends. Second, friends are freely chosen by an individual. According to the second demographic transition perspective (Lesthaeghe and Van de Kaa 1986), voluntary relationships have gained in importance compared to ascribed family relationships. Therefore, we expect interactions with friends may play a crucial role in individuals' fertility decision making.

This article focuses on the transition to parenthood in early adulthood. Keeping in mind that the transition to first birth in the United States happens at a relatively young

age (according to the National Center for Health Statistics, in 2008 the mean age at first birth was 25 [National Vital Statistics Reports 2010]), young adults are a suitable sample for investigating whether and how the transition to parenthood is affected by cross-friend interactions. Some studies emphasize that peer social networks shape behaviors during early adulthood (Veenstra and Dijkstra 2011). These studies focus on peer effects on health (on obesity, see Christakis and Fowler [2007] and Fowler and Christakis [2008]; on smoking behavior, see Mercken and colleagues [2009] and Pollard and colleagues [2010]) and other individual outcomes (on delinquency, see Knecht and colleagues [2010]; on sexual behavior, see Ali and Dwyer [2010] and Sieving and colleagues [2006]) and show how these behaviors spread within a network. Building on this literature, we believe cross-friend effects on fertility may be particularly strong among young adults. Fertility in advanced societies, such as the United States, is mainly controlled by contraception; having children is thus usually a matter of choice. Nonetheless, we acknowledge that having a child can also be the result of an unintended pregnancy. The U.S. unintended pregnancy rate is significantly higher than the rate in many other developed countries. About half (49 percent) of pregnancies in the United States each year are unintended, and approximately half of these end in abortion (Guttmacher Institute 2012).

Having a child (or not) is the outcome of several interrelated decisions and behaviors, ranging from committing to a union to having sex, using contraception, and having an abortion. Each action may be influenced by peers' and friends' behaviors. For example, accidental and unwanted pregnancies may be outcomes of risky sexual behaviors—such as no or ineffective contraception use, especially among teens and young adolescents—which research shows are shaped by peers' behavior (East 1998; East and Jacobson 2001). Using Add Health data, Kim and colleagues (2011) found that having a friend who engages in sexual intercourse increases the risk of unprotected intercourse among adolescents. Similarly, peers and friends may influence one's decision to have an induced abortion. Although our theoretical focus here is on the mechanisms via which peers and friends may influence an individual's deliberate choice to have a child, we must take into account that children can be the result of unintended pregnancies. We thus perform separate analyses of childbirths resulting from intended and unintended pregnancies.[1] Unfortunately, due to data constraints we cannot investigate unintended pregnancies ending in abortion.

Current fertility research identifies two main mechanisms by which social interaction works: social influence and social learning. The first process identifies how consensus within a peer group can constrain attitudes and behavior; the second refers to how individuals gain knowledge from others (Kohler et al. 2001; Montgomery and Casterline 1996). Friends play a crucial role in both mechanisms. Social influence among friends may be explained by social comparison (Festinger 1954) and descriptive norms (Cialdini, Reno, and Kallgren 1990). According to the theory of social comparison, individuals adapt their behavior to match others they consider to be in similar social positions or with whom they share characteristics. High school friends clearly belong to this comparative group. Similarly, Cialdini and colleagues (1990:1015) describe the importance of descriptive norms on individuals' conduct. These norms are defined as "what is typical or *normal,* thus, what most people do," and, subsequently, this becomes what is most "sensible to do." In line with this argument, Rindfuss, Morgan, and Swicegood (1988) show that norms play a primary role in shaping the transition to first birth and its timing in the United States. Individuals who have several friends with children may thus be more likely to have a child, too. Although social norms constructed and maintained in large social groups may be an independent and separate mechanism with respect to social influence, the small scale of the high school friendship networks we investigate leads us to consider social norms as part of the social influence dynamic.

Friends are also a source of social learning. Alongside siblings (Axinn, Clarkberg, and Thornton 1994; East 1998), friends offer behavioral examples. Friends' childbearing experiences can provide relevant information about how to face the transition to parenthood and deal with the ensuing substantial life changes (Bernardi 2003).

In addition to social influence and social learning, economic theories also highlight how diffusion processes in fertility can be explained by cost-sharing mechanisms (Kuziemko 2006). Having a child is associated with uncertainty and costs, both monetary and non-monetary (e.g., opportunity costs for a career or maintaining a particular social lifestyle). Uncertainty and non-monetary costs may be particularly high in the transition to first birth, because this is a completely new life state—parenthood (Billari, Philipov, and Testa 2009). As Lyngstad and Prskawetz (2010) show, a sibling's recent childbearing has a strong positive effect on first-birth rate, whereas this effect is almost negligible for the second birth. We extend this reasoning to the high school friendship context. We assume that having friends with whom individuals can share their experiences as parents may reduce the uncertainty associated with parenthood. Friends share not only practical information but also their feelings and worries. Moreover, experiencing this unique life transition alone within a peer group likely leads to higher relational costs. Becoming a parent is a radical change in lifestyle that strongly affects one's amount and nature of leisure time, including time spent with friends. The opportunity to experience parenthood with friends makes this transition less costly from a relational perspective. With life changes in a social group synchronized or shared, the risk of being left alone or lagging behind diminishes. Based on the social interaction mechanisms outlined earlier, we expect that friends' childbearing can trigger individuals' decisions to have their first baby. Because we assume that social learning and cost-sharing mechanisms are important factors influencing the parenthood decision-making process, we expect stronger cross-friend effects on childbirths resulting from intended pregnancies. However, we do not exclude childbirths resulting from unintended pregnancies, because they are measured retrospectively in the survey and therefore may be influenced by the outcome itself.

Hypothesis 1: A friend's childbearing has a positive effect on an individual's entry into parenthood (i.e., first birth).

Cross-sibling effects on fertility have a specific time pattern: the contagion effect is very strong and increases in the first 12 (Lyngstad and Prskawetz 2010) to 24 (Kuziemko 2006) months after the sibling's childbearing. This influence then declines, becoming negligible after three years.

We expect to find a similar time pattern among friends, which we attribute to individuals' cost-sharing strategies. As mentioned earlier, when friends transition to parenthood together, it may reduce the inevitable relational costs. Therefore, individuals should become parents around the same time as their friends. By synchronizing one's life path with a friend's, people can coordinate these important life changes. We should thus find a strong short-term influence, which is likely to become negligible over the long term.

Hypothesis 2a: The effect of a friend's childbearing on an individual's risk of becoming a parent is short term.

Hypothesis 2b: The effect of a friend's childbearing on an individual's risk of becoming a parent is inverse U-shaped. An individual's parenthood risk increases in the period following a friend's childbearing; after reaching this peak, the risk starts to decrease.

While acknowledging a few studies on contraceptive use in developing countries (Behrman et al. 2002; Kohler et al. 2001) and Bernardi's (2003) qualitative analysis, current research lacks quantitative studies on the role of friendships and cross-friend effects on

fertility. The primary reason rests with the nature and process of friendship formation. Friendships are voluntary relationships, meaning individuals freely select their friends. This selection can be direct, with individuals choosing friends based on similarities in behavior and attitudes (Lazarsfeld and Merton 1954), or indirect, where people enter social settings (e.g., schools or workplaces) and then bond with similar people because they share a social context (Feld 1981, 1982). The first selection mechanism (hereafter *selection*) is widely explained in terms of homophily, which assumes similarity in behavior as a cause of interpersonal relationships (McPherson, Smith-Lovin, and Cook 2001). The second is a correlation between similarity in behavior and friendship formation. It arises from confounding contextual effects, as people who live in (and sometimes deliberately choose) the same social context will also share similar characteristics (hereafter *contextual effect*).

These selection and contextual effects make it difficult for researchers to disentangle the role of social influence (*influence* defined as a "pure" social interaction effect) from other factors that may affect both friendship formation and fertility decisions. Variables that should measure social interaction effects may be correlated with unobserved forces that affect an individual's probability of having a child as well as bonding with a specific friend (Kravdal 2003). To avoid bias in the estimates, suitable model specifications and exclusion criteria are needed (Manski 1993, 1995). The relevance of this identification problem is evident in the active and ongoing debate on possible empirical strategies to disentangle selection and contextual effects from influence (Bramoullé, Djebbari, and Fortin 2009; Christakis and Fowler 2007; Cohen-Cole and Fletcher 2008; Fletcher 2012; Steglich, Snijders, and Pearson 2010 [note that in this literature, selection, contextual effects, and influence effects have several different definitions]). Given that this issue remains very much open, we propose an innovative way of addressing some of the methodological difficulties. We aim to investigate cross-friend effects on fertility behavior, net of selection and contextual effects.

DATA AND METHOD

Data and Sample

Data come from four waves of the National Longitudinal Study of Adolescent Health (Add Health) in the United States, a panel study of a nationally representative sample of adolescents who were in grades 7 through 12 in Wave I (1995). The Add Health cohort (born between 1976 and 1982) was followed into young adulthood with four in-home interviews (Wave I in 1995, Wave II in 1996, Wave III in 2001 to 2002, and Wave IV in 2008 to 2009), at the end of which the sample was between 26 and 33 years old. Add Health provides an opportunity to combine three different types of information: longitudinal data on respondents' socioeconomic characteristics; information on life course events and trajectories; and data on social context and networks (e.g., family, school, and friendships). These data serve our purpose of investigating the impact of social interaction among friends on the transition to parenthood.

We restricted our sample to women who were at least 15 years old at Wave I, who were observed through approximately age 30. We excluded men from our analysis due to substantial data limitations. As explained by Schoen, Landale, and Daniels (2007) and Amato and colleagues (2008), there is a systematic misreporting of childbirths in the fertility history modules. While we could use information in the household roster to adjust omitted fertility data for women (we followed the procedure described in Schoen and colleagues [2007]), this was impossible for men, who are thus excluded from our study sample.

In Wave I, in-home and in-school questionnaires were administered to 20,745 respondents. In the latter questionnaire, in-school network information was collected and up to 10 friendship ties for each respondent were identified. In Wave III, a follow-up

of the Wave I network module (or *friends module*) was administered to 3,572 respondents, who were in 7th or 8th grade at Wave I. From this group, we included only women ($N = 1{,}903$) who were interviewed in all three previous waves as well as Wave IV (the last wave). We excluded women who dropped out after Wave III ($N = 177$),[2] because the friendship ties we look at were measured at Wave III. Because we investigate how these friendships influence an individual's fertility behavior, our sample must include individuals whose fertility behavior was followed until after the friendship measurement. Our final sample consists of 1,726 individuals.

In the *friends module* of Wave III, respondents were asked a battery of questions about their current relationship with 10 former schoolmates. These 10 people were selected into a respondent's questionnaire by a name generator based on the probability of remaining friends with that respondent.[3] Every schoolmate selected was also part of the study sample. Among each respondent's 10 former schoolmates, we excluded men (for the same reasoning they were excluded from our sample) and those identified as kin (e.g., cousins and siblings) to focus specifically on former schoolmates who were not part of the family network. Using information on friendship status at Wave III, we defined two typologies of network relationship: *peers* (i.e., former schoolmates who have never been friends) and *friends* (i.e., former schoolmates who became friends during high school and remained so over time). Unfortunately, we could only measure friendship status of each dyad at Wave III, whereas we considered the fertility history of each respondent and friend/peer up to Wave IV (around six years later). We therefore assumed that people who were friends at Wave III remained so afterward (hereafter, when we refer to *friend* we mean *friend from high school*). Although this may not be true of all pairs, we consider it plausible that two former schoolmates who have kept in touch for some years after they finished school are willing to invest in their friendship, and it is therefore likely to be long-lasting.

From a respondent's list of 10 former schoolmates, we excluded any individuals who were previously friends with the respondent but did not remain so at Wave III (i.e., former friends). There is no reliable information on the time length of these friendships, so we could not analyze the pattern of influence/selection of former friends. The friendship network we could draw for each respondent using the *friends module* of Wave III represents only a partial view of an individual's entire friendship network, because it includes only friends who were also schoolmates, and, among those, excludes male and kin friends. Although we acknowledge that the composition of an individual's network might, in general, be relevant for an individual's fertility decision making, by focusing on dyads and dyadic influence between friends, and not on the influence from an individual's complete friendship network, this aspect becomes marginal in our conceptualization as well as in the empirical model. We assume that the partial network of friends from high school is a representative selection of an individual's entire friendship network during early adulthood. We discuss implications of this assumption in the conclusion.

Respondents in the sample had an average of 3.5 peers and .8 friends. Our analysis includes 7,256 dyads, among which 1,357 (19 percent) are friendships. In total, 967,231 dyadic spells are included in our analysis. During the considered exposure time, 820 respondents became parents. Among all childbirths, 381 (47 percent) women said the pregnancy was intended, and 439 women said the pregnancy (53 percent) was unintended. These results are consistent with national data available from the Guttmacher Institute (2012).

Empirical Strategy

To test whether a friend's childbearing has a positive effect on an individual's risk of becoming a parent, we engaged in a series of discrete-time event history models with random effects at the dyadic level. Although the inclusion of dyadic random effects allows us

to control for unobservable time-constant factors that affect both members of the dyad (e.g., same experiences during adolescence or similar attitudes and preferences), contextual and selection effects still need further consideration.

To properly disentangle any confounding contextual effects from true influence effects, we exploited the Add Health survey design, using information on the network structure from the *friends module* at Wave III. Similar to Elwert and Christakis's (2008) strategy, which disentangled causation from shared-exposure bias in the "widowhood effect" between spouses by examining both wives and ex-wives, we distinguish dyads of friends from those of peers. We consider two former schoolmates as friends when at least one of the two identified the other as a current friend at Wave III. Peers are defined as pairs of individuals who attended high school together but were never friends. By including and estimating both types of relationships in our analysis, we can separate the effect of shared social context (operationalized by peer effect) from the cross-friend interaction effect.

Our unit of analysis is the unidirectional dyad (i.e., friendship may not be symmetric), from which we aim to model the fertility behavior of one of the two members as a function of the occurrence of the other's childbearing. An individual's outcome is thus repeated for each peer and friend. Moreover, the same individual can act as both respondent *i* and peer/friend *j*. We chose this strategy on the assumption that each dyad in our sample is independent, meaning it may not take into account that friends of the same respondent may also influence each other. We could not include an individual fixed effect in the regression model, because women who were censored (did not experience childbearing during the observation period) would not have been included. However, we performed a permutation test to check whether the assumption of independence between dyads was too restrictive (reported in Part B of the online supplement). This robustness check gave results consistent with those we report here.

We treated selection by making two different assumptions. In the first stage, by virtue of the survey design, we assumed friendship to be exogenous to fertility decision making. Friendships and peer relationships under study were formed when respondents were approximately 12 to 15 years old (Wave I); we could therefore assume their formation was exogenous to the decision to have a child. In other words, the decision to become friends was antecedent to the decision to become a parent. It is unlikely that adolescents choose their friends based on family attitudes and orientations. However, because we followed individuals and friendships over time, a selection issue may arise. Starting at a certain age, people may remain friends only with people who share similar family attitudes. Therefore, in a second stage, we made a less restrictive assumption that friendship may be endogenous to fertility decision making. To control for the fact that the two decisions (i.e., having a child and choosing a certain friend) may be interrelated, we used a simultaneous equation model.

In the following sections, we present two different model specifications. The second one advances the first by modeling the time pattern of cross-friend effects. Within both model designs, selection is first treated as exogenous and then assumed endogenous to the fertility process.

Model Specification 1: Modeling Cross-Friend Effects Using Time-Varying Covariates

To model the hazard of having a first birth during month t for individual i having peer/friend j, we used a probit discrete-time hazard function. The hazard function for the probability that respondent i of dyad ij becomes a mother at time t is represented by $h_{ij}(t)$:

$$\Phi^{-1}(h_{ij}(t)) = \alpha D_i(t) + \beta_1 X_i + \beta_2 Z_i(t) + F_{ij}\beta_3 P_j(t) + (1 - F_{ij})\beta_4 P_j(t) + u_{ij} \quad (1)$$

$D_i(t)$ is the baseline hazard, which in our case is a quadratic function at time t of individual i's duration (in age) between entry into the

risk set (age 15) and childbirth: $\alpha D_i(t) = \alpha_0 + \alpha_1(age_i) + \alpha_2(age_i)^2$. X_i and $Z_i(t)$ are observed time-constant and time-varying covariates, respectively, measuring individual *i*'s observable characteristics that affect *i*'s transition to first birth. $P_j(t)$ is a time-varying variable indicating when the other member of the dyad, *j*, had her first child. F_{ij} is a dummy variable whose value depends on the relationship between individuals *i* and *j*. If *j* is a friend of individual *i*, F_{ij} takes the value 1; if *j* is a peer of individual *i* (i.e., just a former schoolmate), F_{ij} takes the value 0. Unobserved time-invariant dyad-specific factors are represented by normally distributed random effect u_{ij}, with zero mean and variance estimated by the model.

To carry out this analysis, we created a dyad-month file and assumed each dyad of female friends is independent. For each of the 7,256 dyads, we set the dependent variable as a dummy that takes the value 1 when individual *i* gives birth and 0 for the other months. We computed this variable using each respondent's fertility history up to Wave IV.

So far, we have assumed friendship formation to be independent of fertility decision making. To relax this assumption, we need to jointly estimate individual *i*'s risk of becoming a parent and the probability of individual *i* being friends with individual *j*. To do so, we used a recursive bivariate probit model, that is, we jointly estimated two probit models with correlated error terms and robust standard error clustered by dyad, in which the binary dependent variable of the second equation is an endogenous regressor in the first equation (Wilde 2000). This model belongs to the class of simultaneous equation models with dummy endogenous variables developed by Heckman (1978). In our model, the first equation predicts individual *i*'s risk of becoming a parent using the same variables as in Equation 1. The second equation predicts the probability of individual *i* being friends with individual *j* based on similarities between *i* and *j* and their geographic distance. Based on homophily theory, people with similar characteristics and backgrounds (we considered similarities in race, parents' education and income, and family type) are more likely to be friends. Moreover, former schoolmates who lived near each other during high school (at Wave I) and afterward (at Wave III) are also more likely to stay in touch and therefore be friends. We assumed individual *i*'s risk of becoming a parent was influenced by her own characteristics and the potential occurrence of friend *j*'s childbearing, but not by dyadic common characteristics (i.e., similarities between friends), which we therefore considered exogenous. These latter characteristics, together with geographic distance, are instead assumed to affect friendship formation. Our simultaneous equation model has the following form:

$$\begin{cases} \Phi^{-1}(h_{ij}(t)) = \alpha D_i(t) + \beta_1 X_i + \beta_2 Z_i(t) \\ \qquad\qquad + F_{ij}\beta_3 P_j(t) + (1 - F_{ij})\beta_4 P_j(t) + \varepsilon_{1ij} \\ \Phi^{-1}(\Pr(F_{ij} = 1)) = \alpha_0 + \alpha_1 H_{ij} + \alpha_2 G_{ij} + \varepsilon_{2ij} \end{cases} \quad (2)$$

$h_{ij}(t)$ is individual *j*'s risk of becoming a parent and $\Pr(F_{ij} = 1)$ is the probability of individual *i* being friends with individual *j*. The error terms of the two equations are correlated, that is, $cov\,[\varepsilon_1; \varepsilon_2] \neq 0$. In the first equation of the two systems, we used the same variable specification as Equation 1. For the second equation, H_{ij} are a set of dummy variables that take the value 1 when individuals *i* and *j* share a given characteristic, and zero otherwise. We considered similarities in race, parents' education and income, and family type (e.g., single-, step-, or both-parent family during adolescence). G_{ij} represents the geographic distance between *i* and *j* and was computed using two dummy variables that take the value 1 when both members of the dyad lived in the same census tract at Waves I and III.

Model Specification 2: Modeling Timing in Cross-Friend Effects

To study the timing of influence on childbearing among friends, we adopted a piecewise approach to model the time pattern of

cross-friend effects on transition to first birth. Specifically, instead of estimating time-varying covariates for a friend's or peer's childbearing (β_3 and $\beta_{4\ \text{in}}$ Equation 1), we used dummy variables: four for each type of possible tie, that is, friendship and peer relationship. These variables take the value 1 if the friend or peer had a child in the past 11 months, 12 to 23 months, 24 to 35 months, and 36 or more months ago. This model has the following form:

$$\Phi^{-1}(h_{ij}(t)) = \alpha D_i(t) + \beta_1 X_i + \beta_2 Z_i(t) + F_{ij}\sum_{k=1}^{4}\gamma_k P_{kj} + (1-F_{ij})\sum_{k=1}^{4}\delta_k P_{kj} + u_{ij} \quad (3)$$

P_{kj} represents a set of four timing dummy variables indicating when friend or peer j gave birth.

Following the same strategy we adopted earlier, within this model specification we relaxed the assumption of exogeneity of friendship. The simultaneous equation model is as follows (see the description of Model 3 for a detailed explanation of the formula):

$$\begin{cases} \Phi^{-1}(h_{ij}(t)) = \Phi^{-1}(h_{ij}(t)) = \alpha D_i(t) + \beta_1 X_i \\ \qquad + \beta_2 Z_i(t) + F_{ij}\sum_{k=1}^{4}\gamma_k P_{kj} \\ \qquad + (1-F_{ij})\sum_{k=1}^{4}\delta_k P_{kj} + \varepsilon_{1ij} \\ \Phi^{-1}(\Pr(F_{ij}=1)) = \alpha_0 + \alpha_1 H_{ij} + \alpha_2 G_{ij} + \varepsilon_{2ij} \end{cases} \quad (4)$$

Control Variables

In addition to controlling for unobserved time-invariant dyad-specific factors (by means of estimating random effects), our analyses also include several observable factors that may confound the effect of a friend's childbearing on the risk of first birth. Specifically, we controlled for relevant sociodemographic individual characteristics, namely, race, parents' education and income, and family type (measured at Wave I). Moreover, besides including age as a measure of the baseline time profile, which we assume to be quadratic, we also included partnership status as a time-varying covariate (respondents indicated as cohabiting or married). Partnership status may strongly affect the risk of becoming a parent, because being in a more (or less) committed partnership may increase (or reduce) the risk of contagion of a friend's fertility behavior.

RESULTS

Table 1 reports descriptive statistics of the sample, divided into two subsamples: women who experienced childbearing during the observation period and women who had not had a first birth by Wave IV. The two groups differ in their compositional characteristics. Early mothers are more likely to come from a low socioeconomic status, measured in terms of parents' education and family income at Wave I. They are also less likely to have grown up in a family with both biological parents, and they have, on average, more siblings. At Wave III, there were no substantial differences between the two groups in the number of friends or peers, with an average of .8 friends and 3.5 peers. We thus see no evidence of substantial differences in the number of network relationships between the two groups. The median age at first birth for our sample is 27.2 years, in line with the median age at first birth for the overall U.S. population belonging to the same cohorts as individuals in our sample (born between 1976 and 1984).[4]

Table 2 gives a description of the network dyads included in the models. Descriptive results indicate a high degree of similarity among friends in terms of race, parents' education, family type, and parents' income.[5] It shows that people bond with individuals from similar backgrounds. However, common social context is also responsible for a certain degree of homogeneity. Although peers seem to be less alike than friends, the difference in the degree of similarity between dyads of peers and dyads of friends is negligible. This suggests that individuals who share the same context are similar with respect to a large set of demographic and socioeconomic characteristics. Table 2 also presents a summary of

Table 1. Descriptive Statistics of the Sample

	Women Who Did Not Experience Childbearing	Women Who Experienced Childbearing	Total
Parents' Education			
Less than high school	7.4	12.7	9.9
High school or equivalent	27.5	39.0	33.0
Some college	18.4	19.0	18.7
College education or more	39.0	17.8	28.9
Unknown	7.7	11.5	9.5
Family Type			
Living with biological parents at Wave I	64.2	44.3	54.8
Living in a step-family at Wave I	7.7	12.7	10.1
Living with single mother at Wave I	23.3	34.9	28.8
Living with single father at Wave I	1.4	2.7	2.0
Living in other type of family at Wave I	3.3	5.5	4.4
Race/Ethnicity			
Hispanic	8.6	10.6	9.6
Black	22.3	30.7	26.3
Asian	5.4	2.2	3.9
White	63.7	56.5	60.3
Parents' Income			
1st quintile	17.3	28.9	22.7
2nd quintile	16.2	25.6	20.6
3rd quintile	22.0	21.1	21.6
4th quintile	20.9	15.4	18.4
5th quintile	23.6	8.9	16.8
Average Number of Siblings	1.49	1.71	1.6
Average Number of Friends	.82	.78	.8
Average Number of Peers	3.43	3.55	3.5
Median Age at First Birth			27.2
Number of Women Observed	906	820	1,726

geographic characteristics at the dyadic level. Friends exhibit a greater geographic homophily compared to peers at Waves I and III. The average distance between homes for two friends is lower than the average distance between peers. Geographic proximity between friends is also higher during early adulthood. Friends are much more likely to live in the same census tract or block. Therefore, we believe geographic proximity can be used to model the probability of being friends at Wave III.

Results for the probit time hazard of becoming a parent are shown in Table 3, which reports the model estimating a friend's childbearing effect as a time-varying covariate, and Table 4, where the timing of a friend's childbearing is estimated using a piecewise approach.

In Table 3, Model 1 estimates the effect of a friend's childbearing on an individual's risk of having a first child, net of baseline hazard and control variables, but without controlling for selection effects. In line with Hypothesis 1, we find that when a friend becomes a parent, an individual's risk of becoming a parent increases. We also find a positive effect of a peer's fertility on first-birth rate, although smaller than in the case of a friend. This means social context plays a role in shaping

Table 2. Overview of Characteristics of Network Dyads in the Sample

	Peers	Friends	Total Sample
Proportion of dyads with same race	.72	.82	.74
Proportion of dyads with same parental education	.31	.36	.32
Proportion of dyads with same family type	.42	.50	.44
Proportion of dyads with same parental income	.22	.29	.23
Proportion living in the same state at Wave I	1.00	1.00	1.00
Proportion living in the same county at Wave I	.90	.90	.90
Proportion living in the same census tract at Wave I	.28	.39	.30
Proportion living in the same block at Wave I	.09	.17	.11
Proportion living in the same state at Wave III	.78	.79	.78
Proportion living in the same county at Wave III	.51	.52	.51
Proportion living in the same census tract at Wave III	.09	.16	.10
Proportion living in the same block at Wave III	.03	.08	.04
Number of dyads	5,899	1,357	7,256

individuals' reproductive behavior. The duration pattern, as a quadratic function of an individual's age, shows a clear curvilinear shape. The positive effect of older age on first-birth rate is coupled with a small negative effect of age squared, indicating that the effect of an individual's age becomes weaker the older an individual is.

As for the control variables, although they are not large, we observe some significant ethnic differences. Black and Hispanic women are at risk of becoming mothers sooner than white women. In line with previous studies (e.g., Rijken and Liefbroer 2009), we find that people with a greater number of siblings are younger at first birth. Moreover, cohabiting and married individuals are at greater risk of becoming parents than are single individuals. Women who come from families with poor economic status have a higher risk of becoming a parent sooner, compared to women from families with a high economic background. Parents' education has a similar result: people with better-educated parents seem to have their first child later than people who come from families with less education. Presumably, this effect is due to individuals delaying entry into parenthood until after they complete their schooling (Rijken and Liefbroer 2009). Finally, we find that individuals who grew up with both biological parents become parents later than those who lived in a step- or single-parent family during adolescence. Aside from the ethnic differences that seem to disappear once we control for selection, effects of control variables are consistent across all models.

Model 2 of Table 3 reports a simultaneous equation system that allows us to estimate cross-friend effects on fertility net of selection effects. Given a dyad, we jointly estimate the risk of one dyad member becoming a parent and the probability for the dyad members of being friends with each other. We wanted to ensure that similarities in fertility behavior among friends were the result of their interaction and not vice versa. As people get older, they may choose to remain friends with former schoolmates with whom they share similar family attitudes and plans. Model 2 shows that when we control for selection, cross-friend effects on childbearing are even stronger than in the unadjusted models, and ethnic differences disappear. Moreover, a peer's childbearing no longer seems to affect an individual's risk of becoming a mother.

Models 3 and 4 in Table 3 report results for childbirths resulting only from intended or unintended pregnancies, respectively. Note that the effect of a friend's childbearing on an

Table 3. Coefficient Estimates of the Probit Discrete-Time Hazard of Becoming a Parent, Using a Friend's Childbearing as a Time-Varying Covariate

	1. All Childbirths	2. All Childbirths	3. Intended Childbirths	4. Unintended Childbirths
Friend becomes mother	.130**	.137***	.152**	.075
	(.046)	(.040)	(.049)	(.057)
Peer becomes mother	.052*	.026	.024	.017
	(.025)	(.020)	(.026)	(.026)
Age in years	.431***	.338***	.377***	.381***
	(.046)	(.030)	(.043)	(.043)
Age squared	−.009***	−.007***	−.007***	−.009***
	(.001)	(.001)	(.001)	(.001)
Race (ref. white)				
Black	.054*	.033	−.020	.069**
	(.026)	(.018)	(.026)	(.023)
Hispanics	.079*	.034	.009	.054
	(.038)	(.026)	(.035)	(.033)
Number of siblings	.053***	.039***	.045***	.024***
	(.009)	(.005)	(.007)	(.007)
Parents with college education (ref. parents with lower education)	−.129***	−.081***	−.182***	−.092***
	(.026)	(.017)	(.021)	(.020)
Living with biological parents at WI (ref. living in a single-parent family or step-family)	−.200***	−.135***	−.050*	−.093***
	(.026)	(.016)	(.023)	(.022)
Parental income (ref. 5th quintile)				
1st quintile	.420***	.267***	.280***	.220***
	(.054)	(.029)	(.040)	(.039)
2nd quintile	.471***	.315***	.313***	.275***
	(.053)	(.028)	(.038)	(.037)
3rd quintile	.348***	.235***	.162***	.247***
	(.046)	(.027)	(.037)	(.035)
4th quintile	.218***	.153***	.137***	.143***
	(.043)	(.028)	(.038)	(.038)
Marriage	.387***	.304***	.299***	.274***
	(.046)	(.040)	(.050)	(.052)
Cohabitation	.249***	.205***	.068*	.293***
	(.024)	(.021)	(.031)	(.026)
Constant	−8.226***	−6.648***	−7.621***	−6.928***
	(.582)	(.312)	(.452)	(.427)
Same race/ethnicity		.239***	.239***	.239***
		(.052)	(.052)	(.052)
Same parental education		.108*	.109*	.109*
		(.045)	(.045)	(.045)
Same type of family at WI		.132**	.132**	.133**
		(.043)	(.043)	(.043)
Same census tract at WI		.176***	.176***	.176***
		(.049)	(.049)	(.049)
Same census tract at WIII		.159*	.158*	.159*
		(.070)	(.070)	(.070)
Constant		−1.192***	−1.191***	−1.192***
		(.051)	(.051)	(.051)
N of dyadic spells	557,485	557,485	556,215	556,319
σ_u	.469			
	(.063)			
ρ		−.032**	−.009**	−.047**
Log likelihood	−14960.702	−291267.172	−283547.138	−284277.528

Note: Standard errors are in parentheses.
*$p < .05$; **$p < .01$; ***$p < .001$ (two-tailed test).

individual's risk of having a first child is significantly positive for women who were planning to become pregnant. Friend and peer effects on unintended pregnancies are weaker and do not reach statistical significance. Nevertheless, the direction of the effect size is consistent with the other models. The cross-friend influence for intended pregnancies is even stronger than for the entire sample. This result is in line with what we anticipated, showing that the risk of giving birth due to an unintended pregnancy does not significantly increase after a friend's childbearing.

The second equation, which was used in Models 2, 3, and 4, estimates the probability of being friends for a pair of former schoolmates, and it is very well predicted by homophily. People of the same race who have similar parental education and family type are more likely to be friends. Moreover, the closer individuals live, the greater the likelihood of being friends.

To investigate the time pattern of cross-friend effects on an individual's risk of becoming a parent, we adopted a piecewise approach. Models reported in Table 4 estimate the effect of a friend's or peer's childbearing within 11 months, 12 to 23 months, 24 to 35 months, or 36 or more months. Following the same strategy used in the previous model specification (Table 3), we first estimated a model controlling only for possible contextual effects (i.e., peers' effect) but not for selection (Model 1). Then, we used a simultaneous equation model to adjust for selection (Model 2).

In Model 1, estimates show that the friend effect starts to become significant one year after a friend's childbearing. This increases until reaching its peak around three years later, when it then starts to decline. Put another way, a woman is more likely to become a mother between one and three years after a friend has her first child (see Figure 1).

The influence of a peer's childbearing is much smaller and seems to be U-shaped (see Figure 1). There is a small immediate effect, which may be a context effect rather than a real influence. Peers of the same age who come from the same social context are likely to experience life transitions at a similar time. We also observe a peer effect over a longer term, after three years, which may be an indication of peer social pressure. With an increase in age, more people will have experienced childbearing. Women who see many people their age with children may feel pressured, and may thus become more likely to have a child.

When selection bias is taken into account, Model 2 shows that a friend's influence effect is even more immediate. As Figure 2 shows, friends' influence reaches a peak at around two years, then declines. When we control for selection, in the same way as the previous model (Table 3), peer and ethnic effects are no longer significant.

These findings support our second hypothesis by providing evidence of a short-term, inverse U-shaped cross-friend effect on an individual's risk of first birth. This pattern clearly resembles the one found for cross-sibling effects on fertility (Kuziemko 2006; Lyngstad and Prskawetz 2010). Whereas sibling effects seem to be strongest less than one year after childbirth, cross-friend effects are somewhat more delayed (Lyngstad and Prskawetz 2010). The more immediate influence of siblings may be due to cost-sharing dynamics being stronger within the family network.

As in Table 3, Models 3 and 4 of Table 4 refer to the two subsamples of women who had children from intended or unintended pregnancies, respectively. As before, cross-friend effects are strong and significant only for women who had an intended pregnancy. For this group, results are consistent with estimates for the entire sample, showing that a friend's influence is immediate and inverse U-shaped.

In all the models where we estimate a dyadic random effect (σ_u in Model 1, Tables 3 and 4), we find a significant unobserved heterogeneity. This means there are unobserved dyad-specific factors that influence an individual member of the dyad's risk of becoming a parent. Moreover, our simultaneous equation models (Models 2, 3, and 4, Tables 3 and 4) show a significant, although small,

Table 4. Coefficient Estimates of the Discrete-Time Hazard of Becoming a Parent, Modeling the Timing of a Friend's Childbearing Using a Piecewise Approach

	1. All Childbirths	2. All Childbirths	3. Intended Childbirths	4. Unintended Childbirths
Friend (0 to 11 months)	.076	.112	.180	−.000
	(.084)	(.078)	(.094)	(.117)
Friend (12 to 23 months)	.178*	.197*	.258**	.068
	(.084)	(.077)	(.090)	(.120)
Friend (24 to 35 months)	.181*	.178*	.227*	.072
	(.091)	(.085)	(.099)	(.130)
Friend (36+ months)	.120	.107*	.072	.114
	(.063)	(.053)	(.065)	(.077)
Peer (0 to 11 months)	.087*	.071	.060	.055
	(.041)	(.036)	(.050)	(.047)
Peer (12 to 23 months)	−.024	−.040	−.054	−.027
	(.049)	(.044)	(.060)	(.057)
Peer (24 to 35 months)	.004	−.005	−.023	.016
	(.048)	(.043)	(.058)	(.056)
Peer (36+ months)	.080*	.038	.038	.027
	(.032)	(.026)	(.032)	(.037)
Age in years	.438***	.339***	.377***	.383***
	(.047)	(.030)	(.043)	(.043)
Age squared	−.009***	−.007***	−.007***	−.009***
	(.001)	(.001)	(.001)	(.001)
Race (ref. white)				
Black	.054*	.033	−.020	.068**
	(.027)	(.018)	(.026)	(.023)
Hispanics	.080*	.034	.009	.054
	(.038)	(.026)	(.035)	(.033)
Number of siblings	.053***	.039***	.045***	.025***
	(.009)	(.005)	(.007)	(.007)
Parents with college education (ref. parents with lower education)	−.129***	−.081***	−.182***	−.092***
	(.026)	(.017)	(.021)	(.020)
Living with biological parents at WI (ref. living in a single-parent family or step-family)	−.202***	−.135***	−.050*	−.093***
	(.027)	(.016)	(.023)	(.022)
Parental income (5th quintile)				
1st quintile	.423***	.267***	.280***	.220***
	(.054)	(.029)	(.040)	(.039)
2nd quintile	.474***	.315***	.313***	.275***
	(.054)	(.028)	(.038)	(.037)
3rd quintile	.351***	.235***	.162***	.247***
	(.047)	(.027)	(.037)	(.035)
4th quintile	.219***	.153***	.136***	.144***
	(.043)	(.028)	(.038)	(.038)
Marriage	.388***	.304***	.299***	.275***
	(.046)	(.040)	(.050)	(.052)
Cohabitation	.250***	.206***	.069*	.293***
	(.024)	(.021)	(.031)	(.026)
Constant	−8.309***	−6.658***	−7.624***	−6.946***
	(.596)	(.313)	(.453)	(.430)
Same race/ethnicity		.239***	.239***	.239***
		(.052)	(.052)	(.052)

(continued)

Table 4. *(continued)*

	1. All Childbirths	2. All Childbirths	3. Intended Childbirths	4. Unintended Childbirths
Same parental education		.108*	.109*	.109*
		(.045)	(.045)	(.045)
Same type of family at WI		.132**	.132**	.133**
		(.043)	(.043)	(.043)
Same census tract at WI		.176***	.176***	.176***
		(.049)	(.049)	(.049)
Same census tract at WIII		.159*	.158*	.159*
		(.070)	(.070)	(.070)
Constant		−1.192***	−1.191***	−1.192***
		(.051)	(.051)	(.051)
N of dyadic spells	557,485	557,485	556,215	556,319
σ_u	.475		567145.049	568610.379
	(.064)			
ρ		−.032**	−.009*	−.047**
Log likelihood	−29959.8	−582585.6	−283543.525	−284276.190

Note: Standard errors are in parentheses.
*$p < .05$; **$p < .01$; ***$p < .001$ (two-tailed test).

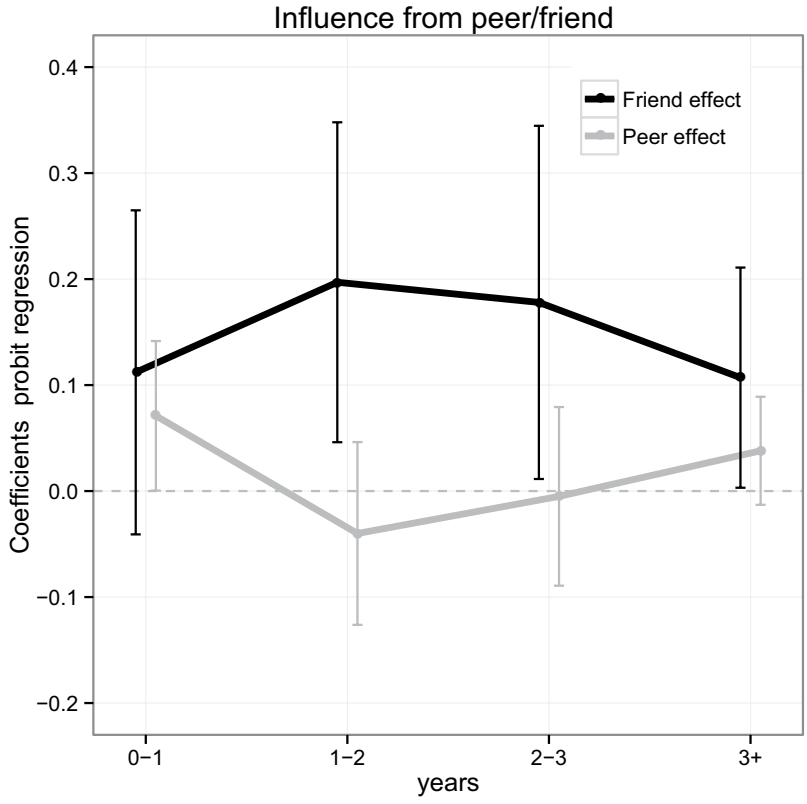

Figure 1. Estimates from a Discrete Model (Model 1 of Table 4) of a Friend's/Peer's Childbearing Effect on an Individual's Risk of Becoming a Mother in the Four Years After the Friend's/Peer's Childbearing

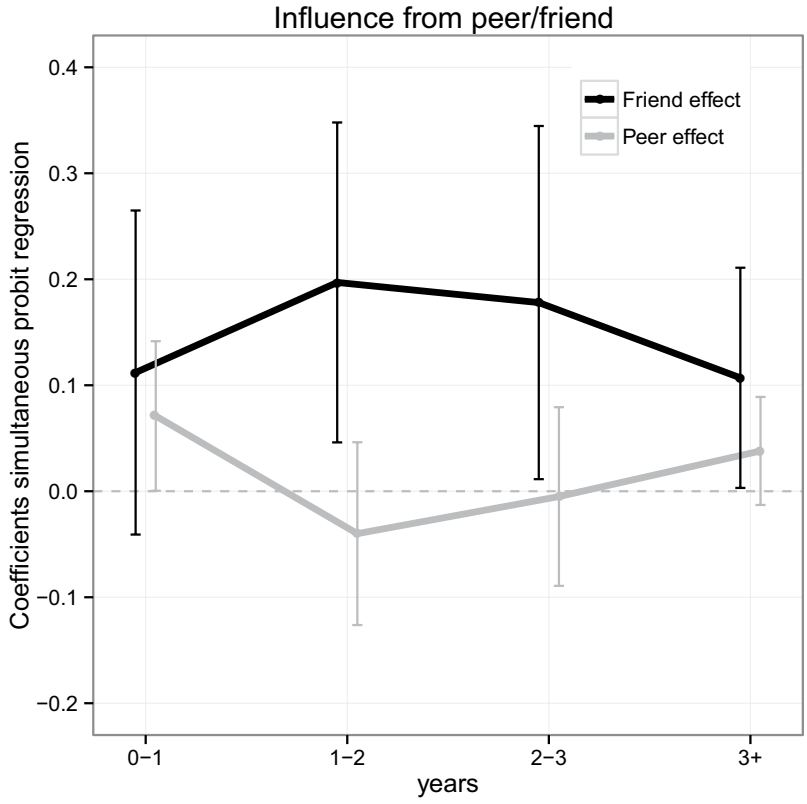

Figure 2. Estimates from a Simultaneous Equation Model (Model 2 of Table 4) of a Friend's/Peer's Childbearing Effect on an Individual's Risk of Becoming a Mother in the Four Years after the Friend's/Peer's Childbearing

negative correlation (ρ). This can be explained as a signal of the fact that the decision to remain friends with a certain former schoolmate may be marginally endogenous to the decision to have a child at a certain moment in life.

CONCLUSIONS

The aim of this article was twofold. First, we attempted to contribute to existing research on the impact of social interactions on fertility by exploring the mechanisms underlying fertility diffusion effects among friends. Studies of the influence of friendship on fertility decision making are lacking, and empirical efforts to identify processes through which social interaction works are scarce. Our second contribution is at a methodological level. We proposed an innovative strategy that makes use of the panel survey design to properly identify social interaction effects and disentangle them from possible confounding effects.

We anticipated that a friend's childbearing experience may be an important source of learning, because it provides relevant and useful information about how to face the transition to parenthood. Moreover, a friend's behavior can be a source of influence because people compare themselves to their friends. Drawing on economic theories, we argued that fertility influence among friends may also be due to cost-sharing strategies. The transition to parenthood brings high relational costs and extensive life changes. Synchronizing childbearing with friends may reduce the risk of being left behind by friends who already have a child.

Using four waves of Add Health data, we employed a series of discrete-time event

history models with random effects at the dyadic level. By exploiting the Add Health network design, we could distinguish dyads of actual friends from simply former schoolmates (defined as peers) and, therefore, people who simply shared the same social context. This allowed us to estimate cross-dyad childbearing effects for both types of pairs, separating true cross-friend interaction from contextual effects. Moreover, to distinguish selection from influence (people may remain friends with those who share similar family attitudes and plans), we used a simultaneous equation model. In this, we jointly estimated the probability of an individual being a current friend with the other person in the dyad and the risk for a member of the dyad becoming a parent.

Results showed that, net of selection and contextual effects, a friend's childbearing positively influences an individual's risk of becoming a parent. We found this effect to be short-term and inverse U-shaped: an individual's risk of childbearing starts increasing after a friend's childbearing, reaches a peak around two years later, then decreases. Moreover, we found that a friend's childbearing does not seem to affect unintended pregnancies. This finding is in line with our expectation that social interaction mechanisms, in particular social learning and cost-sharing dynamics, play a primary role in the rational decision-making process leading to childbearing.

We acknowledge some limitations in the present study. First, the data we used did not allow us to look at an individual's complete network. We relied on the assumption that the partial network of friends from high school is a representative selection of an individual's entire friendship network during early adulthood. Although we believe it is reasonable to assume that former schoolmates play a relevant role in a young adult's network, we do miss the complete picture. We acknowledge this assumption is weaker for women who remain in education, who connect to new friends at a college or university and possibly move to another city. By looking only at high school classmates, we do not assume that new friends (i.e., friends acquired since high school) do not matter; rather, we believe we make a conservative estimation of friend effects, which might, at most, underestimate friend effects on fertility.

Our analytic strategy also led us to make another restrictive assumption, in which we considered each dyad in our sample to be independent. Although we consider this to be a limitation, we are confident that it was not detrimental to our analysis. As a robustness check, we relaxed this assumption and ran a permutation test, which obtained consistent findings (see Part B of the online supplement).

We could undertake this study thanks to the availability of network-based panel data from Add Health. Such datasets are scarce, especially in Europe. We hope that studies like this demonstrate the importance of social interaction effects on fertility and, in turn, stimulate the collection of new network data on a large, international scale.

Making use of real data, we aimed to test in a rigorous way theories about the influence of social interactions on fertility, showing that friendships strongly shape individuals' decisions to have children. We believe our study contributed important insights into the mechanisms by which friendship networks influence individuals' fertility behavior. We offered a comprehensive theoretical framework that identifies pathways and processes through which cross-friend effects affect the decision to have a child. Moreover, in testing our theory, we provided a robust analytic strategy for dealing with the identification of social interaction effects.

Future research should address whether social interaction has different effects on fertility for different social groups (e.g., by education or race). We hope that future studies can take into account social stratification while studying social interaction effects. Moreover, a natural extension of this research would be to look at effects on men. Finally, as the family formation process consists of several closely interrelated decisions (e.g., leaving the parental home, forming a union, and having children), it would be interesting to

investigate whether cross-friend effects also work via other family formation decisions, such as marriage.

Data

This research uses data from Add Health, a program project directed by Kathleen Mullan Harris and designed by J. Richard Udry, Peter S. Bearman, and Kathleen Mullan Harris at the University of North Carolina at Chapel Hill, and funded by grant P01-HD31921 from the Eunice Kennedy Shriver National Institute of Child Health and Human Development, with cooperative funding from 23 other federal agencies and foundations. Special acknowledgment is due Ronald R. Rindfuss and Barbara Entwisle for assistance in the original design. Information on how to obtain the Add Health data files is available on the Add Health website (http://www.cpc.unc.edu/addhealth). No direct support was received from grant P01-HD31921 for this analysis.

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Notes

1. The intention to have a child is measured retrospectively in the Add Health survey using this question: "Thinking back to the time just before this pregnancy, did you want to have a child then?"
2. We carried out an attrition analysis using a logit model to test whether the non-response pattern was random. Attrition is not significantly associated with key sociodemographic variables, namely, age, race, parents' education and income, and family type (pseudo-R square = .0083).
3. Probable friends were chosen based on two types of information collected in Wave I: attribute similarity between ego and alter (i.e., the former schoolmate) and relative network position of ego and alter. The predicted probability of being friends was based on a dyad-level logistic regression. Further details provided by the Add Health team can be found in Part A of the online supplement (http://asr.sagepub.com/supplemental).
4. Our calculation from a random 1 percent sample of the American Community Survey of 2008 indicates that the median age at first birth of women born between 1976 and 1984 is 28 years. Data are available from the International Public Microdata Series (IPUMS) (Ruggles et al. 2010).
5. Dummy variables measuring similarities are based on the same categories shown in Table 1.

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