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Essays on the Link Between Alcohol Consumption and Youth Fertility

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ESSAYS ON THE LINK BETWEEN ALCOHOL CONSUMPTION AND YOUTH FERTILITY

A Dissertation
Presented to
the Graduate School of
Clemson University

In Partial Fulfillment
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Doctor of Philosophy
Economics

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by
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ABSTRACT

In the first chapter, I use exogenous variation in state minimum legal drinking ages to examine the relationship between restrictions on teen alcohol consumption and youth fertility. Using individual level data, I find that a decrease in the minimum drinking age during the late 1970s and 1980s leads, surprisingly, to a decrease in pregnancy rate among 15-17 year-old white women. The pregnancy rate among 15-17 year-old black women, on the other hand, significantly increases with the decrease in the drinking age. I find similar racial variations for unwanted pregnancies among 15-17 years old. The differentiated response to changes in eligibility requirements persist for 18-20 year-old women. I find evidence of a compositional change toward wanted pregnancies associated with the decrease in drinking age for 18-20 year-old white women; the eligibility restrictions have only a statistically weak effect on fertility of 18-20 year-old blacks and Hispanics. These effects can only be found in individual level data. Analysis of state-level aggregate fertility rates fails to reveal these important racial differences.

In the second chapter, I study the effect of alcohol consumption on youth fertility. Alcohol consumption is often believed to be a cause of risk-taking behaviors. Despite a well-established correlation between alcohol intake and various risk-taking sexual behaviors, the causality remains unknown. I attempt to establish a causal effect of alcohol use on the likelihood of pregnancy among youth using a variety of models ranging from a fully parametric to a semi-parametric discrete factor approximation method. Using data on 17-28 year-old women from the National Longitudinal Survey of Youth, I find that even after controlling for unobserved heterogeneity alcohol consumption increases the likelihood of pregnancy by 4.7 percentage points. This positive effect was observed in the semi-parametric model where the cumulative distribution of heterogeneity was approximated by a 4-point discrete distribution. Quantitatively similar but statistically weaker estimates were obtained from the two-stage least squares model and the bivariate probit model. Finally, models that ignore the effect of unobserved heterogeneity failed to establish this relationship.

DEDICATION

To my family who believed in me and always has been proud of me.

To all who supported me and stayed close through good and bad times, to those who played a significant part in my life but are not with us and cannot share the joy, to strangers who helped in need.

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CHAPTER ONE

THE EFFECT OF MINIMUM LEGAL DRINKING AGE RESTRICTIONS ON TEENAGE FERTILITY

Introduction

Numerous studies associate teenage alcohol consumption with increased motor vehicle accident mortality, sexually transmitted diseases, date rape, and other risky behaviors with long term consequences. I analyze the effect of alcohol consumption restrictions on teen pregnancy, birth, and abortion rates using changes in the minimum legal drinking age. Understanding the causes of teen childbearing is crucial for designing effective public policy. Among other adverse long-term consequences, teen childbearing lowers human capital accumulation for teen mothers (and their children) and their lifetime earnings.

The causal effect of teen alcohol use on teen pregnancy is thought to be mediated through risky sexual behavior. Excessive alcohol consumption induces risk-taking through impaired judgment; thus alcohol consumption could lead to risky sex.[1] Several studies report that sexually active teens under the influence of alcohol are less likely to use contraception (Markowitz et al., 2005) and hence are more likely to experience an unintended pregnancy. The increase in the number of pregnancies could be reflected in an increased number of abortions rather than live births; unintended pregnancies are more likely to be terminated than planned pregnancies (Finer and Henshaw, 2006). If easy availability of alcohol leads to a higher likelihood of unintended pregnancy among

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[1] The association between alcohol consumption and risky sex is not well established in the literature. See Section “Literature review: Alcohol consumption and teenage fertility” for more details.

teenagers, then there should be an observable increase in births and abortions. Strict restrictions on alcohol availability, on the other hand, will be associated with a decrease in the number of pregnancies, births, and abortions. This hypothesis, however, has received only weak empirical support. Dee (2001) reports that an increase in the legal drinking age decreases state level birth rates among black teens but does not have an effect on white teens.

Some studies suggest that risky sexual behavior depends on the intensity of alcohol intake per unit of time and the context in which alcohol is consumed (O'Hare, 2005). For example, moderate alcohol consumption in a bar has different implications than binge drinking at a party. Legal restrictions that limit adolescent freedom to consume alcohol might create a rebellious response expressed in increased efforts to acquire alcohol and binge drinking instead of moderate drinking.[2] Experimental and irresponsible drinking are associated with unsafe and unwanted sexual behavior (Naimi et al., 2003). If more restrictions on alcohol consumption increase the likelihood of heavy drinking, then there could be a relatively large number of unintended pregnancies and abortions in the presence of a high legal drinking age and a decrease when restrictions are relaxed. These are the opposite effects that many policy-makers might expect.

I use variations in state-level legal drinking age restrictions for beer consumption between 1973 and 1988 to identify the impact of drinking eligibility restrictions on the fertility of young women. I examine aggregate, state-level data for this time period, as well as individual level data from the 1979 cohort of the National Longitudinal Survey of

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[2] See Allen et al. (1994) for a literature review. Chaloupka and Wechsler (1996) show that underage drinking and binge drinking by female students is relatively price inelastic.

Youth (NLSY). I limit my analysis to legal age consumption restrictions for beer as it is the most popular alcoholic beverage among youth.

The period 1973-1988 provides a unique opportunity for research due to exogenous variation in the minimum drinking age across states. Prior to 1988, legal drinking age restrictions were regulated at the state-level creating considerable variation across states, with the lowest age requirement set at 18 years and the highest at 21 years of age. Between 1970 and 1975, the number of states with a legal drinking age below 21 years increased from 18 to 39 states. However, under the threat of losing Federal highway funding, by January 1988 the minimum drinking age was raised and set uniformly across the United States to 21. The pattern and degree of increase vary across time and states, allowing me to separate the effects of alcohol consumption eligibility restrictions on incidences of teen pregnancy, birth, and abortion. Table 1.1 summarizes the changes in the legal drinking age for beer by state from 1970 to 1990, and Figure 1.1 shows the composition of states by drinking age and variation in drinking age across time. Additionally, in 1973, after the Supreme Court ruling in *Roe v. Wade,* abortions became legal on the national level, significantly reducing the cost of unintended pregnancy for women nationwide.[3]

I use two distinct identification strategies. First, I estimate a difference-in-difference model for aggregate pregnancy, birth, and abortion rates using older women as a control group. Second, I estimate a discrete-time hazard model using the micro-level

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[3] For details regarding abortion laws see Gold (2003) and Vestal (2006). Teen childbearing rates in the period 1973-1988 might have been affected by the introduction of the pill in the 1960s. Despite being the most effective method of contraception used by the sexually active teens in the 1970s, this type of contraception has also a high misuse rate among teens (see Jones and Forrest (1989)).

data in conjunction with variations in the legal drinking age across states and time periods. At the individual level, two measures of eligibility restrictions are used: an indicator of whether a woman resides in a state with a low drinking age (18 or 19 years) and an indicator of whether a woman can legally drink. Using predicted probabilities, I evaluate the effect of the decrease in the legal drinking age and the effect of becoming legally eligible to drink on the probability of becoming pregnant for the first time separately for 15-17 and 18-20 year-old white, black, and Hispanic women. I repeat the analysis for two types of first pregnancies: a first pregnancy that will end in birth and a first pregnancy that will end in abortion. Identifying the effects of the decrease in the drinking age is of high priority in light of ongoing debate on lowering the legal drinking age.[4]

The novel contribution of my paper to the existing alcohol/teenage fertility literature is that I use micro-level data. Evidence presented in the few related studies that examine the relationship between alcohol restrictions and teen fertility is drawn from aggregate level data (e.g., Dee, 2001 and Sen, 2003). The NLSY micro-level panel allows for the reconciliation of state-level alcohol policy variables with individual decisions to give birth or terminate pregnancy, emphasizing the role of individual characteristics not captured or adequately explained by aggregate data. In addition, in contrast to the literature focused on pregnancy outcomes (i.e., births and abortions), I explicitly model the effect on teen pregnancies. Another advantage of disaggregated data is that I can

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[4] In 2009 CBS News “60 Minutes” aired an episode devoted to the debate: http://www.cbsnews.com/stories/2009/02/19/60minutes/main4813571.shtml (accessed on September 30, 2010).

analyze different race-age groups. This is not feasible with aggregate data as abortions are not systematically reported by state, year, race, and age.

Results from disaggregated data indicate that a decrease in the legal drinking age increases the annual probability of becoming pregnant for the first time by 3.7 percentage points among underage black women. This is a substantial effect given that the base annual probability for this age group is 7.6 percent. The opposite effect is observed for underage white women, though the association is weaker.

Being in a state with a low drinking age and becoming eligible to drink significantly increases the probability of a first pregnancy that will end in birth and decreases the probability of a first pregnancy that will end in abortion for white 18-20 year-old women but not their black and Hispanic peers. The strict restrictions appear to alter the composition of pregnancies toward unwanted pregnancies. At least two causal mechanisms are possible. First, restricting legal alcohol consumption might increase the incentive to binge instead of drinking moderately, with binge drinking being more likely to lead to unwanted and unprotected sex than less intense drinking. Second, easy eligibility restrictions expand the set of activities that 18-20 year-old teens can do freely without the fear of being caught. For example, if teens are eligible to go to bars they will do so instead of gathering at someone’s house. While plausible, verifying these type of effects is beyond the scope of this study.

Estimation results from the difference-in-difference model using aggregate data provide no strong evidence that a legal drinking age of 18 or 19 years affects aggregate teen pregnancy, birth, and abortion rates. The corresponding estimated effects are weak in both a statistical and a substantive economic sense. Aggregation fails to uncover effects that differ across race-age groups. Therefore, proper policy analysis should rely more on disaggregated, rather than aggregated, data.

Based on the results from disaggregated data, I conclude that easing alcohol consumption restrictions increased fertility rates among underage black women but not their white and Hispanic peers. For older women, eligibility restrictions have a statistically significant effect only on the fertility of white women. Estimates of the effects for older black and Hispanic women are quite imprecise. Overall, my findings suggest that a sharp increase in teen pregnancy and abortion rates in the 1970s (depicted in Figure 1.2) cannot be explained by changes in the legal drinking age restrictions.[5]

Literature review: Alcohol consumption and teenage fertility

Teen demand for alcoholic beverages responds to changes in prices of alcoholic beverage (through changes in the alcohol tax rates) and to other restrictions such as eligibility criteria for purchase and consumption of alcoholic beverages.[6] Most studies conclude that both increases in taxation and increases in restrictions on alcohol consumption lead to a reduction in teen consumption of alcohol.[7]

Despite the positive association between alcohol use and risky sexual behavior among teenagers reported in numerous studies, the causal nature of the relationship

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[5] The high pregnancy rates among the U.S. teenagers in the 1970s and 1980s are mostly attributed to slow adoption of contraception methods per se (see Miller and Moore (1990) and Santelli et al. (2006)).

[6] Wagenaar et al. (2009) provide an overview of estimates of the price elasticity of demand for alcoholic beverages. Wagenaar and Toomey (2002) summarize results of all studies published from 1960 to 2000 on the effects of minimum drinking age laws.

[7] See for example Grossman et al. (1994), Coate and Grossman (1988); for exception see Dee (1999).

remains unknown.[8] Results drawn primarily from aggregate data can only assume that occasions of alcohol use and risky sex coincide; event specific studies, however, do provide some evidence in favor of an association for young heterosexuals. Some studies report that alcohol use may lower contraception use among sexually active teens, and, hence, increase the probability of an unplanned pregnancy (e.g., Grossman and Markowitz, 2002; Markowitz et al., 2005; Hingson et al., 1990 and Rees et al., 2001).

A few recent studies based on aggregate data have emphasized the relationship between alcohol consumption restrictions and teen fertility. Using a "difference-in-difference-in-difference" model, Dee (2001) finds that the nationwide increase in the minimum drinking age to 21 reduced the birth rate among black teens by roughly 5.5 percent; the effect on white teens is mostly statistically insignificant and "implausibly" signed. Dee suggests that underlying differences in patterns of sexual behavior and alcohol consumption could explain variation in racial childbearing patterns and race-specific responses to changes in drinking age.

Sen (2003) investigates the effects of beer taxes and other alcohol-related policies, including the state's minimum drinking age, on teen pregnancy outcomes (i.e., abortion and birth). The results suggest that an increase in the beer tax rate has a significant negative effect on aggregate state-level teen abortion rates. Higher tax rates are associated with higher teen birth rates, but the estimates lack statistical significance. Additionally, these results are sensitive to the choice of covariates.[9] The minimum legal

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[8] For the extensive literature review see Rashad and Kaestner (2004) and Donovan and McEwan (1995).

[9] For example, Sen reports that if state fixed effects are used instead of region fixed effects then the estimated effects become statistically insignificant. Thus, in this case one can conclude that higher tax rates do not affect teen childbearing rates.

drinking age does not appear to have a robust, statistically significant impact either on teen birth rates or abortion rates. One should be cautious with the interpretation of these results as her study relies on only four years of data (i.e., 1985, 1988, 1992 and 1996), and only the period from 1985 to 1988 involves variation in the minimum drinking age.[10]

Both Dee (2001) and Sen (2003) use state-level panel data on birth rates and abortion rates. The main disadvantage of this approach is that it does not permit a thorough analysis of the effects of external factors on individual decision making. Results presented by Dee (2001) only partially support the hypothesis that a low drinking age leads to higher childbearing rates.

Most economic studies that deal with teenage abortions focus on estimating the demand for abortion services. These studies primarily examine the response of abortion rates to changes in parental involvement laws (e.g., parental consent and notification laws) and restrictions on Medicaid funding or availability of reproductive services.[11] Medicaid funding restrictions reduce teen birth rates (Kane and Staiger, 1996) and abortion rates (Haas-Wilson, 1996 and Medoff, 2007). Estimated effects of parental notification laws are less consistent and sensitive to model specification and data employed.[12] For example, alongside the strong negative association between parental notification laws and minors' abortion rate in South Carolina, Joyce and Kaestner (1996) report a rise in the proportion of minors from South Carolina who obtained an abortion in

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[10] In 1985 20 states had drinking age for beer set below 21; in 1988 and after there were none.

[11] For more details see Medoff (2007), Matthews et al. (1997), Joyce and Kaestner (1996), and Gius (2007).

[12] Evidence in favor of a negative association between parental notification laws and childbearing is found in Medoff (2008, 2007), Joyce et al. (2006), Levine (2003), Bitler and Zavodny (2001), Haas-Wilson (1996), Kane and Staiger (1996), Ohsfeldt and Gohmann (1994); evidence in favor of no association is reported in Blank et al. (1996) and Henshaw (1995).

another state. Thus, the observed effect might be sensitive to the inclusion of measures that capture mobility between states.

I use variation in state minimum drinking age restrictions across time and states to assess the effects of restrictions on teen pregnancy, births, and abortion in 1974-1988. To capture the relationship between alcohol consumption eligibility restrictions and teen fertility, I estimate a difference-in-difference model using aggregated state-level data and a discrete-time hazard model using the micro-level data set. The former allows me to assess the usefulness of aggregate data and compare my results with the literature; the latter approach allows me to incorporate individual characteristics in the analysis.

Analysis of aggregated data: Difference-in-difference model

An initial simple test of whether changes in the minimum drinking age affect teen childbearing can be performed using a difference-in-difference (DID) estimation and state-level data. The effect of eligibility restriction on teen pregnancy, birth, and abortion is identified using pregnancy, birth, and abortion rates for older women as a control group.[13]

I constructed annual state level pregnancy rates for the 15-19 and 25-29 age groups as the sum of births, fetal deaths, and legally induced abortions to females in that age group, for each year in the period 1974 through 1988 using data available from the

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[13] I use two control groups: women 20-24 and 25-29 years old. Results are not highly sensitive to the choice of the control group. For example, when using 20-24 as a control group, the estimates of interest have the same sign and lack statistical significance in all models. Since differences are subtle, I discuss only results for 25-29 control group. Results for 20-24 control group are reported in Appendix A.

Vital Statistics Reports and Abortion Surveillance Reports.[14] The number of births in a given year does not precisely reflect the number of pregnancies conceived in that year. Given that pregnancy normally lasts for nine months, only babies conceived in the first quarter of the year will be born in that same year; those conceived later will be born in the next year. Hence, number of pregnancies can be computed as:

$$Pregnancies_{gst} = \tfrac{1}{4}\, Births_{gst} + \tfrac{3}{4}\, Births_{gst+1} + Fetal\ deaths_{gst} + Abortions_{gst}\,, \quad (1.1)$$

where g stands for the age group, s indexes states and t indexes years.[15]

Estimates based on these pregnancy rates are likely to be underestimated due to the lack of uniform reporting requirements of fetal deaths and abortions across states. Most states require reporting of fetal death at gestations of 20 weeks or more. Thus, the reported number of fetal deaths does not include deaths that occurred prior to 20 weeks of gestation for majority of states. Some states do not report abortions by age groups or do not report them at all or on a continuous basis.[16] Therefore, the constructed panel contains numerous missing values for abortion rates as well as pregnancy rates (193 missing observations out of a possible 765 in each age group). In addition, abortion data are not available by state, year, age group, and race. Therefore for analyzes of abortion and pregnancy rates, unlike Dee (2001), I cannot estimate separate DID models for each race.

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[14] Usually the number of pregnancies is calculated as a sum of abortions and births in a given year (Levine (2003)) or as a sum of abortions, births, and miscarriages in a given year, where miscarriages are assumed to be 20% of births and 10% of abortions (e.g., the Alan Guttmatcher Institute's (AGI) definition).

[15] Using the alternative formula: $\text{Pregnancies}_{gst} = \text{Births}_{gst+1} + \text{Fetal deaths}_{gst} + \text{Abortions}_{gst}$ did not significantly alter pregnancy rates or the DID model estimates. The latter are reported in Appendix B.

[16] For details on fetal deaths reporting see Kowaleski (1997); for abortion reporting see CDC/NCHS Handbook on the Reporting of Induced Termination of Pregnancy, http://www.cdc.gov/nchs/data/misc/hb_itop.pdf. AGI collects abortion statistics by state of residence. These data are considered to be more precise but they are not available by age group and therefore cannot be incorporated in the analysis.

Average fertility rates for 15-19, 20-24, and 25-29 year-old women are reported in Table 1.2. It appears that for all age groups fertility rates are higher in states with the legal drinking age set to 18 or 19 years. However, most of these cross-state differences are statistically significant only for 15-19 age group. For example, teen pregnancy rate in states with the legal drinking age set to 18 or 19 years is about 5 pregnancies per 1,000 teenage women higher than in states with the legal drinking age set to 20 or 21. A slightly smaller difference is observed for teen birth rate (about 2 births per 1,000 teens). The question is whether these differences will be observed after controlling for state socio-economic characteristics.

The baseline model for pregnancy, birth, and abortion is given by

$$\begin{aligned} Y_{gst} = \beta_0 + \beta_1 TEENS_{st} + \beta_2 DA\_18or19_{st} + \beta_3 (TEENS*DA\_18or19)_{st} \\ + \gamma X_{gst} + \lambda_s + \tau_t + \varepsilon_{gst} , \qquad (1.2) \end{aligned}$$

where g indexes age groups, s indexes states and t indexes years 1974 through 1988.

The dependent variable is the natural logarithm of the pregnancy rate or birth rate or abortion rate per 1,000 women in the corresponding age group in state-year. A dummy variable, *TEENS*, separates the treatment group – women 15-19 years old – and the control group – women 25-29 years (i.e., it equals 1 for 15-19 year-old women or 0 for 25-29). The variable *DA_18or19* indicates whether the prevailing legal drinking age for beer in state s at time t is set to 18 or 19 years.

The estimate of the effect of a drinking age restriction set to 18 or 19 on teen childbearing rate is given by

$$\beta_3 = E[(Y_{gst}| \, TEENS=1, DA\_18or19=1) - (Y_{gst}| \, TEENS=1, DA\_18or19=0)] -$$
$$E[(Y_{gst}| \, TEENS=0, DA\_18or19=1) - (Y_{gst}| \, TEENS=0, DA\_18or19=0)]. \qquad (1.3)$$

This coefficient indicates whether teen pregnancy, birth, and abortion rates increased, decreased or remained relatively unchanged in the presence of a low drinking age relative to the change in the control group (25-29 year-old women or 20-24 year-old women). If relaxing drinking age restrictions triggers risky sexual behavior then pregnancy, birth, and abortion rates for 15-19 year-old women would increase relative to the control group in response to a low drinking age, implying a positive β_3.

The vector X_{gst} includes the state unemployment rate, percentage of black population in the state, per gallon state beer tax in 2000 dollars, per capita personal income in 2000 dollars, the maximum Aid to Families with Dependent Children (AFDC) benefit level for a family of four in 2000 dollars, and controls for the presence of Medicaid funding restrictions for abortion and enforced parental involvement laws for minors.[17] Descriptive statistics of the variables included in the model is reported in Table 1.3. Appendix C provides description of variables and corresponding data sources.

The non-uniform nature of changes in drinking age across states could cause the phenomenon of "border hopping" where teenagers attempt to avoid restrictions in their home state by crossing state boundaries to obtain alcohol in a neighboring state with relatively friendly alcohol policies (Figlio, 1995). To account for border hopping for each state *s*, I include a variable that equals the number of border states that have a lower

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[17] I would like to thank Rebecca Blank for generously sharing abortion policy data.

minimum drinking age than state *s*. A similar measure is used to account for the border hopping associated with the presence of parental notification laws.[18]

Following the abortion demand literature I include the number of abortion providers, which is an endogenous variable, in equation (1.2). Following the approach of Bank et al. (1996), I use a standard two-stage least squares procedure to correct for endogeneity using state characteristics as determinants of abortion services and the number of non-Ob/Gyn physicians in the state as my only instrument.[19] The estimates of the first stage equation are reported in Appendix E and are mostly similar to estimates reported in the literature.[20]

I also test whether the effect of covariates included in X_{gst} differs across treatment and control groups and conclude that three variables (i.e., income, unemployment rate, and the border effect of parental involvement laws) have different effects on the pregnancy rates of younger and older women. I repeat the test for birth and abortion rates. I conclude that the effect of the unemployment rate, number of abortion providers, and number of borders restricted for alcohol differs across age groups for birth rates. The effect of the unemployment rate and share of black population differs across age groups

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[18] The alternative measure – a weighted average of the legal drinking age policies in all states that border state *s*, where weights correspond to the length of the border line between state *s* and each border state – yields similar results. These results are reported in Appendix D. A slightly modified measure – a weighted average of the legal drinking age policies in all states that border state *s*, where weights correspond to the (inverse) distance between the capital of the state s and the capital of each border state – is used in Blank et al. (1996).

[19] Blank et al. (1996) used two instruments: the total number of non-Ob/Gyn physicians and the total number of hospitals. The latter instrument raises concerns as it is likely correlated with the demand for abortion services. After Roe v. Wade many hospitals expanded their abortion services which might have had an effect on the demand for abortions. For discussion see Bond and Johnson (1982).

[20] Contrary to Blank et al., (1996), my results indicate that state demographic characteristics are significant determinants of the number of abortion providers in the state. I also find no evidence that enforced parental involvement laws have effect on the number of providers. The difference is not surprising given that we use slightly different set of covariates and instruments.

for abortion rates. To address this issue I add interactions terms between the treatment group and above mentioned variables to equation (1.2).

Finally, λ in equation (1.2) represents a vector of state fixed effects that captures all time invariant factors that affect pregnancy and abortion rates, and τ is a vector of time fixed effects that captures factors that are common across all states in a given time period.[21]

Table 1.4 contains DID estimates for pregnancy rates (Panel A), birth rates (Panel B), and abortion rates (Panel C); reported standard errors are clustered by state. For each dependent variable, I estimate several models starting with the simplest one containing only indicators for the treatment group, the event, and the interaction between treatment group and event. Then I gradually add state and year fixed effects, then covariates, and finally interaction terms. I test the joint significance of the additional terms in the most "complex" model and in all cases I reject the null. Therefore, I focus on the results from those models (specifications (4), (8), and (12) for pregnancy, birth, and abortion rates correspondingly).

The coefficient of interest from a public policy point of view, β_3, is reported in Row (3) and indicates that there is no evidence that a low drinking age has an impact on teen pregnancy or birth rates. These estimated effects are not significant in a statistical or

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[21] Using a model without fixed or random effects as the baseline for the comparison, I use an F-test to test for the presence of fixed effects and the Breusch and Pagan Lagrange Multiplier test to test for the presence of random effects. In both cases I reject the null. Next, I use the Hausman test and reject the null hypotheses that unobserved effects and explanatory variables are uncorrelated in some specifications but not all. Since in some specifications random effects model yields inconsistent estimates I use fixed effects.

economic sense.[22] The results from Panel C, Row (3), Column (12) indicate that the presence of the legal drinking age of 18 or 19 increases teen abortion rates by 6.9 percent compared to the change in the control group (women 25-29 years old). However, this result is not robust and sensitive to the choice of control group (see Appendix A, Panel C, Row (3)) and the choice of covariates (see Appendix D, Panel C, Row (3)).

The estimates of other parameters reported in Table 1.4 Panels A through C are as expected. Consistent with the previous literature, enforced parental involvement reduces pregnancy and birth rates. Both income and AFDC benefits increase fertility rates indicating that children are a normal good. A higher percent of blacks in a state population is associated with higher pregnancy rates. The increase in unemployment rates increases teen pregnancy and birth rates and decreases teen abortion rates. The number of abortion providers has the expected positive sign indicating that the variety of options available to pregnant women has an impact on her sexual behavior and contraception decision. Surprisingly, the presence of a Medicaid funding restriction for abortion for low income women does not affect pregnancy and birth rates but increases abortion rate. State beer tax and border effects of parental involvement laws and legal drinking age do not appear to have a significant effect on fertility rates.

Analysis of disaggregated data: Discrete-time hazard model

The DID estimates do not provide any evidence that lower drinking age restrictions have a strong positive impact on aggregate teen pregnancy, birth, and

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[22] For example, there are on average 85.15 pregnancies per 1,000 15-19 year-old women. The change of 0.3 percent would not significantly alter this rate.

abortion rates. However, Dee's (2001) findings suggest that there is a differential response to changes in the minimum drinking age across racial groups, which might not be revealed by aggregated data.

I take the analysis further using disaggregated data from the National Longitudinal Survey of Youth (NLSY). This allows me to separate the effects, not only by race, but also by age of the individual. The novel contribution of this paper to the existing literature is that I use individual level data to evaluate the effect of drinking age restrictions on the probability of becoming pregnant for the first time (first pregnancy). Additionally, I estimate the effect on probabilities of two types of first pregnancies: a first pregnancy that will end in birth (birth model) or a first pregnancy that will end in abortion (abortion model). I assess magnitude of the effects using a discrete-time hazard model.

Data

I use the 1979 cohort of the NLSY that consists of a nationally representative random sample of young men and women who were 14 to 22 years old in 1979 and oversamples of young blacks, Hispanics, poor whites, and members of the military. In addition to the vast amount of personal information, the NLSY provides detailed retrospective mobility and fertility histories, including information on geographic residence and pregnancy outcome. I use mobility history to identify the location (state and county) of each woman at every point in time after she was born. I use the detailed fertility history to track the timing of the first pregnancy and its outcome (birth, abortion, miscarriage/stillbirth).

The identification of pregnancy incidence relies on information regarding the reported number of pregnancies and their outcomes. Abortions are underreported in the NLSY data, especially in the earlier survey years (Jones and Forrest (1992)). For example, Udry et al. (1996) report that blacks and Hispanics are significantly less approving of abortion in a variety of circumstances than whites, and these differences translate into different propensities to report. In order to address this issue I estimate models separately for whites, blacks, and Hispanics.

The timing of events becomes of high priority when one attempts to study the effect of the change in the state policy on individual decisions. The move to the new location, the pregnancy, and the change in the drinking age can happen at any time during the year. To make my analysis as precise as possible, I convert the NLSY data set into a panel where the unit of observation is a person-month. Combining retrospective information and data obtained from the annual surveys for 1979-1988, I construct person-month information for each woman. Appendix F contains a brief description of data manipulations.

Each female enters my data set in the month when she turns 15 years old. For every month after entry, I know whether she became pregnant or not, her state of residence, and the legal drinking age in that state. Once she turns 21 years old she exits the data set, as past this age drinking age restrictions are not binding. Further restrictions include exclusion of women with incomplete fertility history, women serving in military, women in the poor white oversample, and women who had their first before their 15th birthday.[23] Appendix F provides more detailed description of restrictions applied to the sample. The final sample includes 337,680 monthly observations on 4,690 females. Half of my sample is white women, one-third is black, and the rest are Hispanics.

The person-month data set can be viewed as transition data in which women move from one state (being not pregnant) to another (becoming pregnant). I describe the risk of first pregnancy in terms of survivor and hazard functions. Table 1.5 presents the narrative history of the pregnancy occurrence and its outcome over time for all females older than 15 years and younger than 21 described as annual hazard and annual survival probabilities. The risk of first pregnancy is related to the age: both the number of first pregnancies and the share of first time pregnant women in the sample increase with age. Among 4,690 females at risk of first pregnancy, almost 5% became pregnant while being 15 years old, among all 16 years old at risk – 7%, etc. Examining the sample survival probabilities, we see that 95% of all women did not have their first pregnancy at age 15, 81% - did not experience a pregnancy by their 18th birthday, and slightly more than half of the sample did not have a first pregnancy by their 21st birthday. I treat all women who did not have their first pregnancy before their 21st birthday – 2,718 women or 58% of my data set – as censored observations. About 75% of all first pregnancies that occurred to 15-20 year-old women ended in birth and approximately 16% were terminated.

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[23] The exclusion of poor white oversample does not alter results for pregnancy model discussed in Section "Results"; results for birth and abortion models become slightly weaker in the statistical sense which are also discussed in Section "Results". A comparison of probit estimates for white sample and sample that includes both whites and poor whites are reported in Appendix G.

Inspection of composition of pregnancies aggregated by age, race, and outcome reported in Appendix H reveals that on average about a quarter of all first pregnancies among white women is terminated (compared to about 10% among Black women and 13% among Hispanics). The majority of Black women and Hispanic women in my dataset had a live birth (on average 82% of Black and 78% of Hispanics). For white women this number is much smaller (on average 66%).

Model specification

The data identify the month but not the day when pregnancy occurs. This suggests grouping observations into discrete (monthly) time intervals. Given the nature of the observed data, I use the discrete-time hazard model.[24] Vast literatures exist on discrete-time models of event history data (e.g., Allison, 1982; Singer and Willett, 2003; Box-Steffensmeier and Jones, 2004; Jenkins, 2008); here, I briefly discuss the main concept of these models.

Recall that I examine whether the legal drinking age requirements affect timing of the first pregnancy among teenagers and its outcome. The occurrence of first pregnancy at time t is a non-repeatable event and intrinsically conditional on not experiencing the event at any time period prior to t. Let T denote the discrete random variable whose values T_i indicate the time period t when the i^{th} female experiences her first pregnancy. The conditional probability that a randomly selected female i in state s will experience

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[24] The appropriate alternative is a discrete-time version of the Cox proportional hazard model using the exact approximation of the partial likelihood function to account for the presence of "ties" in data.

her first pregnancy in period t, given both that the event has yet to be experienced and a set of covariates, is defined as

$$h_{ist} = Pr[T_i = t \mid T_i \geq t, X_{ist}], \qquad (1.4)$$

where h_{ist} denotes the conditional probability of first pregnancy.

For each female the dependent variable that indicates whether she is pregnant for the first time can be represented as a string of zeros (indicating not pregnant) followed by a one (indicating pregnancy). If a female did not have pregnancy prior to age 21 then the dependent variable is represented only by a string of zeros implying that the event has yet to be experienced. The binary nature of the outcome allows one to model the hazard probability as a probit function. Letting $1st\_time\_pregnant_{its}$ denote a binary indicator of the pregnancy status of female i in state s at time t, the discrete hazard can be written as

$$h_{ist} = Pr[1st\_time\_pregnant_{ist} = 1 \mid \text{not pregnant before } t, X_{ist}] = \Phi(\beta' X_{ist}), \qquad (1.5)$$

where Φ is the standard normal distribution function and X is a vector of covariates.

The presence of several age cohorts in my data set and the question at hand determines two notions of time: age-time and calendar time. For each female in my data set I observe the age when she had her first pregnancy (which also corresponds to a certain calendar time t). I normalize age by expressing it in terms of months since birth minus 180 so it corresponds to months since age 15. To account for the effect of calendar time t, I include a full set of calendar time fixed effects. Equation (1.5) can be easily modified to accommodate both notions of time. Let, in addition to the index for calendar time t, I introduce age counter τ that represents the time that woman spends at risk of first pregnancy measured in months (subject to normalization discussed above). Then h_{ist} is

$$h_{ist} =$$

$$Pr[1st\_time\_pregnant_{ist} = 1 \mid not\ pregnant\ before\ t,\ X_{ist}] = \Phi(\beta' X_{ist} + g(\tau_{ist}) + \eta_t), \quad (1.6)$$

where the function $g(\tau)$ can be parameterized as a simple linear, quadratic, etc. function or using more advanced methods like smoothing functions. I use a cubic approximation that will capture the "left over" effect of age on the hazard probability after accounting for covariates. The relative flexibility of the chosen specification allows me to accommodate many possible hazard shapes (e.g., linear, nonlinear, non-monotonic).

Empirically the discrete-time (monthly) hazard probability of first pregnancy (pregnancy model) is given by the following baseline specification

$$Pr[1st\_time\_pregnant_{ist} = 1 \mid not\ pregnant\ before\ t,\ X_{ist}] =$$

$$= \Phi\,(\beta_0 + \delta\, \boldsymbol{ELIGIBILITY\_RESTRICTION_{ist}} + \beta' X_{ist}$$

$$+ \theta_1 AGE_{it} + \theta_2 AGE_{it}^2 + \theta_3 AGE_{it}^3 + \gamma_s + \eta_t), \quad (1.7)$$

where *i* indexes individuals, *s* indexes state of residence, *t* indexes calendar time that corresponds to a combination of month and year, and Φ is the standard normal distribution function.

I use two measures of eligibility restrictions to capture the effect of the legal drinking age on teen fertility: a dummy indicating whether the minimum drinking age in a state of residence is set to 18 or 19 years and an indicator of whether a teen can legally drink in the state of residence. The former addresses the question of whether being in the state with a low legal drinking age affects the probability of first pregnancy among teens, and the latter asks whether being legally eligible to consume alcohol affects the probability of first pregnancy. Some states increased the minimum drinking age while allowing a "grandfather clause," a provision that exempts teens who were previously eligible to drink from new eligibility requirements. If a female is "grandfathered" by the law, my "legally eligible" dummy reflects this nuance.[25] According to Table 1.6 that provides a descriptive statistics for the variables of interest, about 70% of women in my sample were residing in states with the legal drinking age set to 18 or 19 years. About one third of all women in the dataset were legally eligible to drink.

The vector *X* included in (1.7) contains controls for individual and family characteristics (i.e., race, religion in which female was raised, the Armed Forces Qualifications Test (AFQT) scores, whether both parent were present in the household at age 14, and mother's education). Descriptive statistics for these variables are presented in Table 1.6. To control for the state-specific characteristics and time effects, I include a full set of state dummies and year dummies as well as dummies for the calendar month to account for a seasonality effect. Other controls that were considered are the presence of an older sibling, father's education, whether a state enforces parental involvement laws, marital status of the individual, and interaction terms between eligibility restrictions and personal characteristics. Although NLSY collects data regarding the use of contraception before the first pregnancy, this variable contains a large number of non-response values (one third of women included in my data set). Since the inclusion of these variables generally did not alter other results or improve the model's fit, I decided not to include

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[25] For age group 18-20, two measures of eligibility restrictions are highly correlated for two reasons. First, some women are "grandfathered" by the law implying that the new age requirements are not applicable to women who were eligible to drink before the change (2,901 person-month observations or 1.7% of all observations). Second, a 18 year-old woman can be in a state with a low drinking age (e.g. 19 years) but still not eligible to drink (10,284 person-month observations or 6.4% of all observations).

those in the baseline specification. Summary of likelihood ratio test is reported in Appendix I, Panel A.

Next, I take into account the outcome of first pregnancy and estimate hazard of two types of first pregnancies: pregnancy that will end in birth (birth model) and pregnancy that will end in abortion (abortion model) using a specification similar to equation (1.7). For each month-person observation, the dependent variable is an indicator that equals zero if a woman is not pregnant and one if a woman becomes first time pregnant and that pregnancy outcome is birth (abortion). If a woman became pregnant but the outcome is not birth (abortion) then this observation is treated as censored.[26] Similar to the pregnancy model, I perform robustness checks by adding additional covariates and performing a series of likelihood ratio tests.[27] Summary of likelihood ratio test is reported in Appendix I, Panel B and Panel C correspondingly for birth and abortion model.

I can test whether the effect of eligibility restrictions on the probability of first pregnancy and on the probabilities of two types of first pregnancies vary across races. One approach is to add the interaction terms between eligibility restrictions and race dummies to the baseline specification (1.7). However, unlike in a linear model, the interpretation of the interaction terms in a nonlinear model is not straightforward, as the

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[26] This model is equivalent to the unconditional probability of pregnancy with birth (abortion) outcome. I also estimated conditional on pregnancy monthly probabilities of birth or abortion (reported correspondingly in Appendix J and Appendix K). Estimates from the conditional models have low precision due to small sample sizes. The inspection of results from conditional and unconditional models reveals that the estimates of the effect of eligibility restrictions are robust in terms of the sign; the magnitude of the effect varies. The formal test (reported in Appendix L) indicates that in most cases the estimated coefficient on eligibility restrictions do not statistically differ across models. I also calculated the probability of pregnancy with birth (abortion) outcome as a product of the predicted probability of pregnancy (pregnancy model) and conditional on pregnancy predicted probability of birth (abortion). Changes in the average probability of first pregnancy and birth (abortion) outcome are reported in Appendix M.

[27] The vast majority of additional covariates did not improve birth and abortion model fit.

sign and the magnitude of the effect varies with the values of covariates (Ai and Norton, 2003). Estimation of separate equations for white, black, and Hispanic underage women (i.e., 15-17 years old) and white, black, and Hispanic older women (i.e., 18-20 years old) is an acceptable substitute to a single equation with numerous interaction terms (the former is a special case of the latter). I use both approaches with the prime focus on the separate models as segmentation of the data set permits all estimated coefficients to vary across groups.[28] Results for the former are reported in Appendix N, Appendix O, and Appendix P.

Overall, as mentioned before, the eligibility restrictions could have a positive or a negative impact on the probability of first pregnancy. The former will be observed if there is a complimentary relationship between alcohol consumption and risky sex; the latter will be observed if easy availability of alcohol promotes responsible and moderate drinking as opposed to binge drinking. Also drinking age restrictions might affect the composition of the pool of women who become pregnant (wanted versus unwanted pregnancies). In this case, one will observe changes in the probabilities of first pregnancy that will end in birth and abortion, and yet no change in the probability of first pregnancy.

Empirical results are discussed in the next section in the following order: first, I present results from the pregnancy model. Then I evaluate the effects of eligibility

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[28] Due to the fundamental identification problem that confounds the magnitude of the regression coefficients with the amount of residual variation, the equality of coefficients across groups cannot be easily tested by a traditional Chow's test. Hoetker (2004) shows that even small differences in the residual variation have severe consequences. The test proposed by Allison (1999) relies on a crucial restrictive assumption that the regression coefficients for at least one variable do not vary across groups. The alternative test proposed by Long (2009) involves testing equality of predicted probabilities across groups. However, due to a large number of covariates it might not be informative here.

restrictions on the probability of first pregnancy for white, black and Hispanic 15-17 and 18-20 year-old women. Finally, I repeat analysis for birth and abortion models.

Results

The baseline model specified in equation (1.7), excluding race dummies, was estimated separately for each race-age sub-group. All estimated models can be grouped in three groups:

- Specification 1: explores the effect of a low drinking age on 15-17 year-old women;
- Specification 2: explores the effect of a low drinking age on 18-20 year-old women;
- Specification 3: explores the effect of being legally eligible to drink on 18-20 year-old women.

The probit estimates for pregnancy, birth, and abortion models for 15-17 year-old women sub-sample (i.e., Specification 1) are reported in Table 1.7. The probit estimates for pregnancy, birth, and abortion models for 18-20 year-old women sub-sample are reported in Table 1.8 (Specification 2) and Table 1.9 (Specification 3). Standard errors in all models are clustered by state.

I use estimated coefficients to calculate the predicted probabilities of first pregnancy for each race-age group (reported in Table 1.10). Overall, 15-17 and 18-20 year-old Hispanics and blacks have higher predicted probabilities of first pregnancy compared to their white peers. Higher probabilities of first pregnancy among black teens compared to white teens are consistent with the earlier findings that blacks start sexual activity earlier than whites (Zelnik and Shah, 1983) and Hispanics tend to have higher fertility rates compared to other races (Wendel and Wendel, 2004).

The probit estimates reported in Row (1), Panel A of Table 1.7 and Table 1.8 provide evidence against a strong positive association between low drinking age and teen pregnancies. For example, living in a state with a low drinking age decreases the probability of first pregnancy for 15-17 and 17-18 year-old white and Hispanic women but increases the probability of first pregnancy for their black peers. With the exception of 15-17 year-old black women and 17-18 year-old Hispanics, these estimates lack statistical significance.

To assess the magnitude of the effects of eligibility restrictions across racial groups, I use annual predicted probabilities for each observation in each race-age group to calculate a discrete change in the probability (Δ_i) due to a change in eligibility restrictions.[29] For example, the effect of a decrease in the legal drinking age for woman *i* in a given race-age group and year equals the difference between the predicted probability of first pregnancy while in a state with a low drinking age and the predicted probability of first pregnancy while in a state with a high drinking age:

$$\Delta_i = \textit{predicted annual } Pr[\textit{1st\_time\_pregnant}_{ist} = 1 \mid X_{i,}\, DA{=}18or19] - \textit{predicted annual } Pr[\textit{1st\_time\_pregnant}_{i} = 1 \mid X_{ist,}\, DA{=}20or21] \qquad (1.8)$$

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[29] I use probit estimates to predict individual monthly probabilities of the event. Then I convert individual monthly probabilities into annual probabilities using the following formula:

$$Pr(1^{st} \textit{ time pregnant in year } y) = 1 - [\prod_{m=1}^{12} (1 - Pr(1^{st} \textit{ time pregnant in month } m))]$$

Then I calculate the average effect of the change for a given group: $\overline{\Delta} = \frac{\sum_{i=1}^{N_R} \Delta_i}{N_R}$,

where N_R is number of women in race-age group R. In a similar manner, I calculate the average change in the annual predicted probability of first pregnancy due to becoming legally eligible to drink. The changes in predicted probabilities due to changes in eligibility restrictions by race-age group are reported in Tables 1.11 – 1.13 for the pregnancy, birth and abortion models respectively. The standard errors for the average effect are obtained using a bootstrap method.

According to the upper panel of Table 1.11, the annual average predicted probability of first pregnancy for 15-17 years old in the presence of a high drinking age (20 or 21 years) varies from 5 percent for whites to about 8 percent for blacks and Hispanics. A decrease in the drinking age to 18 or 19 years reduces the predicted probability of first pregnancy for whites on average by 1.3 percentage points. Although blacks and Hispanics have about the same probabilities of first pregnancy in the presence of high drinking age, the reduction in drinking age changes probabilities in opposite directions: the reduction of the legal drinking age increases the probability of first pregnancy for blacks on average by 3.7 percentage points and decreases the probability for Hispanics by 2 percentage points.

Change in predicted probabilities of first pregnancy for 18-20 year-old women due to a decrease in the drinking age is reported in the middle panel of Table 1.11. The reduction of the drinking age has a relatively small effect on white and black women and a relatively large effect on Hispanic women. For example, the annual, average predicted probability for white women decreases by 1.2 percentage points and increases for black women by 2.1 percentage points due to a lower drinking age. The same event lowers the predicted probability for Hispanic women by 16.3 percentage points; the magnitude of the effect is due to a large and imprecise underlying estimate.

The estimates of eligibility restrictions for the birth model (Row (1), Panel B in Table 1.7 and Table 1.8), indicate that the low drinking age decreases the probability of a first pregnancy that will end in birth for 15-17 year-old whites and 15-17 and 18-20 year-old Hispanics but increases for their black peers and 18-20 year-old whites. With the exception of 15-17 year-old Hispanics and 18-20 year-old whites, these estimates lack statistical significance. Further, according to the upper and middle panels of Table 1.12, a decrease in the drinking age generates on average modest changes in the predicted annual probability of first pregnancy that will end in birth for 15-17 year-old Hispanics (a decrease of 4 percentage points) and 18-20 year-old whites (an increase of 2.2 percentage points).

Finally, the Panel C of Tables 1.7 - 1.8 reports estimated probit coefficients for the abortion model. The estimated effects of eligibility restrictions partly reinforce results from the pregnancy model: being in a state with a low drinking age increases the probability of first pregnancy that will end in abortion for 15-17 year-old blacks (the estimated coefficient is 0.372 and is reported in Row (1) of Tables 1.7) and decreases the probability for whites of all ages (the estimated coefficients are -0.311 for 15-17 years old and -0.303 for 18-20 year-old women reported correspondingly in Row (1) of Tables 1.7 and Row (1) of Tables 1.8). It seems that the effect of a low drinking age on

Hispanics varies with age a woman's age, but the relatively large point estimates and standard errors indicate that one should interpret them with caution.

Discrete changes in the average predicted annual probability of first pregnancy that will end in abortion are reported in Table 1.13. The decrease in the legal drinking age reduces the probability of first pregnancy that will end in abortion for both 15-17 and 18-20 year-old white women on average by 1.8 percentage points. On the other hand, the decrease in drinking age has a profound effect on 15-17 year-old blacks: the decrease in drinking age increases probabilities almost three times. But overall the magnitude is quite small.

Probit estimates for a model that includes my second measure of eligibility restrictions, an indicator for whether a woman can legally drink, are reported in Table 1.9. For white women, probit estimates are fairly similar to the ones described above (results in Table 1.9 versus results in Table 1.8). For Hispanic women results are qualitatively similar in terms of the sign, but the magnitudes of the estimated average effects are much smaller. As for 18-20 year-old black women results qualitatively and quantitatively differ across specifications. For example, being legally eligible to purchase alcohol reduces the probability of first pregnancy among 18-20 year-old black women. Becoming eligible to drink reduces the probability of first pregnancy that will end in birth and increases the probability of first pregnancy that will end in abortion. However, the corresponding estimates lack statistical significance.

Analyzing all results together allows one to distinguish two noticeable observations. First, for 15-17 year-old black women, living in a state with a low drinking age significantly increases probabilities of first pregnancy and a first pregnancy that will end in abortion. The corresponding increase in pregnancy and abortion rates is 37 pregnancies and 18 abortions per 1,000 15-17 year-old black women. For white 15-17 year-old women the effects are reversed, but the association is weaker. As for Hispanics, the corresponding estimates lack statistical significance. The differentiated response across races might reflect cultural and behavioral differences as well as other unobservable factors.

Second, for 18-20 year-old white women a low drinking age and legal eligibility to drink significantly increases the probability of a pregnancy that will end in birth and decreases the probability of a pregnancy that will end in abortion. This observation might indicate that there is a compositional change in the pool of women who become pregnant (e.g., there are fewer unwanted and more wanted pregnancies). The compositional change can be due to several factors. First, restricting legal alcohol consumption might increase the incentive to binge instead of drinking moderately. Binge drinking usually takes place in a relatively unsafe environment and is more likely to lead to unprotected sex than less intense drinking. If this is the case, then one would observe fewer unintended pregnancies (and fewer abortions) when eligibility restrictions are relaxed. Second, allow young adults to drink in public places, which may replace private gatherings where intimacy is more likely to occur.

Finally, my results are different from those reported in Dee (2001). Although a low drinking age is positively associated with an increase in the probability of a pregnancy that will end in birth for 15-17 and 18-20 year-old black women, the estimates lack statistical significance. I also find that a low drinking age significantly increases the probability of pregnancy that will end in birth among 18-20 year-old white women and has a negative, though statistically insignificant effect, on 15-17 year-old white women. The difference in results is not astounding given the difference in age groups used in the analyses: Dee analyzes the effect on 15-20 year-old women by race and I analyze the effect on 15-17 and 18-20 year-old women by race. Overall, results reported here indicate that aggregation wipes out variation that might exist across race-age groups.

The effects of other personal characteristics on studied probabilities (reported in Rows (2)-(7) of Tables 1.7 - 1.9) are of secondary interest. Nevertheless, all young Catholics (the excluded group) tend to have lower probabilities of first pregnancy and first pregnancy that will end in birth or abortion compared to atheists, Baptists, and women raised in other religions. With the exception of those raised in a Baptist family, this difference disappears for 18-20 year-old women in both pregnancy and birth models. As expected, women of all races with low AFQT scores are more likely to have a first pregnancy and a first pregnancy that will end in birth, but those who lived in the household with both parents at age 14 are less likely to have a first pregnancy and a first pregnancy that will end in birth. Having an educated mother decreases probabilities of first pregnancy for white and black 15-17 year-old women but does not appear to have an effect on Hispanic women. Mother’s education is inversely related to the probability of first pregnancy that will end in birth and the probability of first pregnancy that will end in abortion for underage white women. Finally, mother’s education is positively related to the probability of first pregnancy that will end in abortion for Hispanic women.

Conclusion

Alcohol consumption is usually thought to be associated with "bad" outcomes. However, this assumption is not always supported empirically (e.g., Bray, 2005; Conlin et al., 2005; Dee, 2001; Zarkin et al., 1998). Changes in the legal drinking age in the 1970s and 1980s, in conjunction with the legalization of abortion, can induce risky sexual behavior and, if so, this will be reflected in higher pregnancy, birth, and abortion rates in years after the decrease in drinking age and vice versa. The evidence presented in the literature indicates that alcohol consumption restrictions affect only black teen birth rates, but not the birth rate of their white peers. Underlying cultural differences and differences in patterns of sexual behavior and alcohol consumption might be part of the explanation. Also, a relatively high legal drinking age may affect a choice of the location where alcohol consumption takes place and intensity of alcohol intake. This could induce binge-drinking among the underage leading to higher pregnancy, birth, and abortion rates after the increase in drinking age. I use two estimation strategies, a difference-in-difference model that relies on aggregate data and a discrete-time hazard model that relies on disaggregated data, to test whether easing alcohol availability, measured in terms of whether a female lives in a state with a low drinking age (i.e., 18 or 19 years) and whether she can legally drink, leads to a change in teen fertility rates.

In addition to state level aggregate data on pregnancy, birth, and abortion rates, I use micro-level data that allows me to reconcile state level alcohol policy variables with personal characteristics and fertility decisions. The analysis with the aggregate data improves the existing literature on alcohol/teen childbearing as I use pregnancy rates instead of traditionally used birth rates. The analysis with micro data, to my knowledge, is novel.

Results from the discrete-time hazard model using disaggregated data indicate that a decrease in the legal drinking age significantly increases fertility rates only for black 15-17 year-old women. For example, a decrease in the drinking age increases the probability of a first pregnancy by 3.7 percentage points. A qualitatively similar effect is observed for the probability of a first pregnancy that will end in birth and the probability of a first pregnancy that will end in abortion (an average increase by 2.5 and 1.8 percentage points correspondingly). This finding is, in spirit, similar to results reported for black women in Dee (2001). For white 15-17 year-old women these effects are reversed, but the association is weaker.

For 18-20 year-old white women, a decrease in the drinking age increases the probability of a first pregnancy that will end in birth and decreases the probability of a first pregnancy that will end in abortion on average by 2 percentage points. A similar situation is observed for white women who can legally consume alcohol compared to their peers who cannot legally drink. Changes in eligibility restrictions have a statistically weak effect on 18-20 year-old black and Hispanic women. These results suggest that eligibility restrictions alter the composition of pregnancies among white women and, yet, have no effect on their black and Hispanic peers. The compositional change perhaps could be caused by a change in the pattern of alcohol consumption behavior, namely the place where the alcohol is consumed and the quantity consumed.

The aggregated data and results from the difference-in-difference model provide no evidence that low drinking age increases teen pregnancy, birth, and abortion rates compared to fertility rates for older women (25-29 years old). For all rates, the effect is statistically weak and close to zero.

Overall, the results only partially support the hypothesis that easy alcohol availability induces risky sexual behavior and increases fertility rates (as observed in black 15-17 year-old women) as 15-17 year-old whites and 18-20 year-old Hispanics are not badly affected by easy alcohol availability. In fact, for these two groups easing alcohol availability lowers the probability of a first pregnancy and a first pregnancy that will end in birth or abortion.

CHAPTER TWO

ALCOHOL CONSUMPTION AND PREGNANCIES AMONG YOUTH

Introduction

For the past several decades, the United States has had the highest teenage pregnancy and birth rates among developed countries (UNICEF, 2001). According to the Youth Risk Behavior Surveillance Surveys conducted for the past two decades, about a quarter of sexually active high school students nationwide report alcohol consumption or drug use before their last sexual intercourse.[30] Given these facts, the public policy question is whether substance use among young adults leads to more pregnancies. I attempt to establish a causal effect of alcohol use on the likelihood of pregnancy among youth using fully parametric and semi-parametric estimation strategies.

Numerous studies cite a positive association between alcohol consumption and various risky sexual behaviors, but fail to provide convincing evidence of causality.[31] The observed association can be easily attributed to the influence of underlying unobserved individual characteristics rather than the influence of alcohol use. In recent years some researchers attempted to address the endogeneity issue by estimating both outcomes simultaneously using a bivariate probit model.[32] However, the bivariate probit model is an appropriate econometric technique only if the heterogeneity term follows a normal distribution (in this case the distribution of error terms will reduce to a joint normal). Otherwise, the procedure will produce inconsistent estimates. A fully

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[30] Between 1991and 2009 slightly more than one third of high school students were sexually active.

[31] For a discussion and excellent review of the literature see Leigh & Stall (1993) and Donovan & McEwan (1995). For a list of more recent studies see Rashad and Kaestner (2004).

[32] For example see Grossman et al. (2004). Literature review is provided in the next section.

parametric distributional assumption, such as normal, can be easily avoided by approximating the cumulative distribution of the heterogeneity using a discrete distribution with *k* points of support. I consider 2, 3, and 4-support point models with a preference given to the latter model based on the upward-testing approach.[33] This semi-parametric discrete factor approximation method has not yet been used as an identification strategy for the relationship between alcohol use and risky sexual behavior and, therefore, this paper improves the existing literature on this topic.

For the empirical analysis, I use data on young women from the National Longitudinal Survey of Youth 1979 cohort. Due to survey limitations, described later in the text, I am able to use only four years of data for the period 1982-1985. Preliminary analysis of the raw data showed that pregnancy rates among women who reported alcohol consumption are *lower* than rates for women who reported *no* alcohol consumption. When distribution of heterogeneity is approximated by a 4-point discrete distribution, I find that alcohol consumption increases the likelihood of pregnancy by 4.7 percentage points. A positive but slightly smaller effect is found in a model with 3-point discrete distribution.

Results from the single-equation probit model indicate that alcohol consumption has a negative effect on probability of pregnancy though the effect is close to zero. The effect predicted by the bivariate probit model is positive and numerically much larger. However, these results might be driven by model misspecification as both these models are rejected in favor of the less restrictive discrete factor models. The discrete factor

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[33] Described in Mroz (1999).

models indicate that there is unobserved heterogeneity ignored by the single-equation model and the normality assumption embodied in the bivariate probit model does not hold.

Researchers seem to agree that when attempting to establish the effect of alcohol consumption on risky behaviors one should account for the effects of unobserved characteristics. The findings from this paper suggest that one should not only question results drawn from the naïve models that ignore the effects of unobservables but also should be suspicious about the results drawn from models that embody restrictive assumptions regarding the distribution of unobserved heterogeneity (such as a bivariate probit model). In the presence of unobserved heterogeneity, the use of more flexible econometric techniques, such as the discrete factor approximation method, might be desirable and beneficial in expanding our understanding of the true nature of the relationship between alcohol consumption and risky (sexual) behaviors.

Literature review

It is widely believed that alcohol use provokes risk-taking behaviors including risky sexual behaviors such as non-use of contraception during intercourse and sex with multiple or unfamiliar partners. If this is the case, then the hypothesized association between alcohol use and unintended pregnancy seems straightforward. If substance use impairs one's judgment and triggers unsafe sexual behaviors, including non-use of contraception, then the likelihood of pregnancies should be positively affected by alcohol use, after controlling for effects of other observable characteristics.[34]

Despite the undeniable well-established positive correlation between alcohol use and risk-taking sexual activity the causality mechanism nevertheless remains unknown.[35] The unobserved heterogeneity, such as individual attitudes toward risk and the future, thrill and sensation seeking personality, or simply individual preferences, can influence all kinds of risk taking. Furthermore, these unobserved factors can either motivate a person to engage in all kinds of risk-taking behaviors or to engage only in some risk-taking activities while maintaining a strong intolerance regarding other risky activities. Thus, someone with a thrill seeking personality may have a higher propensity to consume alcohol, smoke, and engage in risky sex. However, it is possible that someone who realizes the harmful consequences of risk-taking behaviors still engages in one risky behavior due to personal preferences, beliefs or sexual desires. For example, a person who despises smoking might enjoy alcohol consumption, or someone who seeks thrilling sexual experiences might have a strong opinion against alcohol intake. In either case, the endogeneity problem created by the unobserved heterogeneity poses a difficulty for establishing the causal nature of the relationship empirically.

Several econometric techniques that are intensively used in the literature to identify the causal relationship between alcohol use and risk-taking sexual activity include linear probability, univariate probit, and reduced form models; two-stage least

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[34] However, the reported effect of alcohol on contraception use varies across studies, ranging from a negative association to no association with some studies reporting mixed results. A number of recent studies is examined in Cooper (2002). For a list of earlier studies see National Center on Addiction and Substance Abuse (1999) and Leigh & Stall (1993).

[35] Leigh & Stall (1993).

squares (e.g., Kaestner and Joyce, 2001; Grossman and Markowitz, 2005; Lacruz et al., 2009); and bivariate probit models (e.g., Rees et al., 2001; Sen, 2002 and Grossman et al., 2004).[36] Researchers acknowledge that these procedures can be flawed when the underlying assumptions are not met. For instance, the linear probability and single-equation probit models produce biased estimates in the presence of unaccounted endogeneity. The two-stage least squares estimates often suffer from the problems associated with weak instruments.[37] Finally, although the bivariate probit model addresses the endogeneity problem by estimating both outcomes simultaneously, the consistency of estimates heavily relies on the assumptions regarding the distribution of unobserved heterogeneity and the joint distribution of error terms. Mroz (1999) shows that, in limited dependent variable models where an outcome depends on an endogenous dummy variable, the misspecification of the joint distribution of error terms leads to inconsistent estimates. Additionally, the efficacy of the bivariate probit model requires the presence of valid exclusion restrictions – variables that determine alcohol use but not sexual behavior. Mroz's (1999) study shows that this problem is suppressed in the semi-parametric model where identification could be achieved through the functional form and distributional assumptions.[38]

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[36] The notable exceptions are studies by Acworth et al. (2007) who use the Difference-in-Difference Propensity Score Matching estimator and Grossman et al. (2004) who use the individual, fixed-effects regression model.

[37] French and Popovici (2009) provide a literature review and discuss limitations of this approach.

[38] An alternative estimation that is in spirit similar to the bivariate probit model, but bypasses the importance of exclusion restrictions, is proposed by Altonji et al. (2005). The identification relies on the assumption of equal selection between observed and unobserved variables known as the Equal Selection Rule. Specifically, the correlation between unobservable factors and the endogenous variable equals to correlation between observable factors and the endogenous variable. This technique allows one to calculate the value of correlation term using estimates from the bivariate probit model.

Further, a few studies that attempted to establish the causal effect of alcohol on risky sex using a bivariate probit model report contradicting results. For instance, Rees et al. (2001), using a nationally representative sample of teens ages 11-18 in 1995, find a weak positive correlation between substance use and the probability of being sexual active or having sex without contraception. They also assert that this association is often attributed to the influence of unobservable factors. A similar conclusion is reached in Grossman et al. (2004), who use a nationally representative sample of teens ages 15-17 in 1997. It is suggested that the lower bound of the alcohol use effect on risky sexual behavior should be zero. However, their estimates, from constrained bivaraite probit models and a model suggested in Altonji et al. (2005), indicate that alcohol use significantly reduces the probability of sexual intercourse and risky sex for female respondents. On the other hand, Sen (2002), using a similar sample of teens ages 14-16 in 1997, reports that drinking significantly positively affects the likelihood of sexual intercourse and non-contracepted intercourse. The contradiction is astounding given the similarity of methods and data employed in above mentioned studies. One should be cautious with these results as they are likely to be corrupted by model misspecification as all studies failed to question the validity of underlying assumptions of bivariate probit model.[39] As a result, these studies might not advance our understanding regarding the causal relationship between alcohol consumption and risky sexual behavior and the topic requires further inquiries.

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[39] Rashad and Kaestner (2004) provide a detailed inspection of identification strategies and results of Rees et al. (2001) and Sen (2002).

Challenging findings, as well as assessing precision on estimated effects, reported in Rees et al. (2001), Sen (2002), and Grossman et al. (2004) are beyond the scope of this study.[40] The goal is rather to evaluate performance of a variety of econometric techniques, widely used in the literature and ranging from fully parametric to semi-parametric, while studying the effect of alcohol use on the probability of pregnancy among youth (where pregnancy is considered an indicator of risky sexual behavior). Although the binary choice models are not generally estimated using least squares, I start my analysis with estimation of linear probability (LPM) and two-stage least squares (2SLS) models.[41] Then I proceed with a univariate probit model (Probit) and a standard recursive bivariate probit model (Biprobit). Finally, the validity of the bivariate probit model is tested by implementing a less restrictive semi-parametric discrete factor method. The latter approach has evident advantages as it relaxes the assumption of joint normality: instead, the cumulative distribution of heterogeneity is approximated by a step function. Since the application of this method to the question at hand is new to the literature, specific attention is devoted to the comparison of the bivariate probit model and the model obtained with the help of the discrete factor method. Furthermore, for each model, I calculate a change in the probability of pregnancy associated with the change in consumption of alcohol. Additionally, I calculate the effects of other variables on the probability of pregnancy and the probability of drinking.

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[40] I acknowledge that it would be useful to test the robustness of the results reported in these studies by applying a semi-parametric estimation technique. However, this is not done in this paper for two reasons. First, I use data from 1979 cohort of the National Longitudinal Survey of Youth. This survey covers a different time period and, due to some survey's shortcoming discussed later in the paper, my data sample will include older respondents (17-28 years old). Second, the data available do not permit identifying the events studied in Rees et al. (2001), Sen (2002), and Grossman et al. (2004).

[41] Greene (1998).

Empirical model

A model where two outcomes (i.e., drinking and pregnancy) for a randomly selected individual *i* are modeled simultaneously is summarized below:

$$D_{irt}^{*} = \beta'_{1}X_{1irt} + \gamma'X_{2irt} + \delta_{1r} + \tau_{1t} + \varepsilon_{1irt}\,, \qquad \begin{array}{l} D_{irt} = 1 \text{ if } D_{irt}^{*} > 0 \text{ and} \\ D_{irt} = 0 \text{ if } D_{irt}^{*} \leq 0 \end{array} \tag{2.1a}$$

$$P_{irt}^{*} = \alpha D_{irt} + \beta'_{2}X_{1irt} + \delta_{2r} + \tau_{2t} + \varepsilon_{2irt}\,, \qquad \begin{array}{l} P_{irt} = 1 \text{ if } P_{irt}^{*} > 0 \text{ and} \\ P_{irt} = 0 \text{ if } P_{irt}^{*} \leq 0 \end{array} \tag{2.1b}$$

where *i* indexes individuals, *r* indexes region of residence, *t* indexes calendar year.[42] D_{irt}^{*} and P_{irt}^{*} are latent variables that represent the propensity to consume alcohol and the propensity to become pregnant, respectively. The pregnancy status (P_{irt}) depends on alcohol use (D_{irt}) and a set of personal and household characteristics (X_1). The personal characteristics considered are race, age, Armed Forces Qualifications Test (AFQT) score, marriage status at *t-1*, and an indicator of whether an individual attends college. Household characteristics include religion in which the individual was raised, whether it was a two-parent household, mother's and father's education, and poverty status at *t-1*. I use lagged values of marital status and poverty status as current statuses might be endogenous to both current fertility and alcohol consumption decisions. For example, pregnancy might facilitate marriage and vice versa. The use of lagged values provides some remedy for this issue. However, the use of lagged values makes it harder to interpret the effect on both dependent variables. Yet, a simple omission of mentioned

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[42] Ideally, both equations would include a full set of state fixed effects rather than region fixed effects. However, due to data limitations discussed in the section "Data" as well as data requirements for discrete-factor approximation model, this is not feasible here.

variables from the model might introduce omitted variable bias as for all models these variables are individually and jointly significant.

The individual alcohol consumption (D_{irt}) is determined by a set of personal and household characteristics, same as specified above, and an additional indicator of whether an individual can legally consume alcohol in her state of residence as well as vector of policy variables (X_2) that do not have a direct effect on P_{irt}^*. A vector (X_2) contains the following policy variables: state per gallon beer tax, cigarette tax rate, per capita police expenditure, per capita consumption of distilled spirits, and whether the minimum legal drinking age in a state is set to 21. A full list of instruments tested (with corresponding data sources) is reported in Appendix Q. Chosen exclusion restrictions are in fact statistically significant determinants of alcohol use (some tests of validity of chosen instruments are reported in Appendix R.)[43] To capture the effect of time invariant and location invariant factors, I include a set of year fixed effects (τ) and location fixed effects (δ) in equations (2.1a) and (2.1b).

The key parameter of interest α captures the causal effect of alcohol consumption on pregnancy status, after controlling for the effects of other observable factors. However, depending on the estimation procedure, the sign and especially magnitude of α might not provide meaningful information regarding the estimated effect (Greene, 1998). In the binary choice models, the absolute scale of the estimated coefficients provides a

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[43] Exclusion restrictions were included in equation (2.1b) then a test of joint significance of corresponding estimates was performed. In all cases I failed to reject the null hypothesis. This implies that chosen policy variables are not good predictors of pregnancy status. In addition, I estimated just-identified models, where only one instrument was included in drinking equation (2.1a) and other instruments included in pregnancy equation (2.1b). Then I tested the joint significance of instruments included in (2.1b). This test also confirmed the validity of chosen instruments as in all cases I failed to reject the null.

misleading picture. Therefore, rather than concentrate on interpretation of estimates, I will focus on interpretation of marginal effects.

If the zero-mean error terms in (2.1a) and (2.1b) are uncorrelated one can estimate both equations using two independent probability models (one for each outcome). However, if unobserved factors influence alcohol consumption and pregnancy status through risky sexual behavior, then the univarite probit procedure will produce a biased estimate of parameter α. For the same reason, estimates from the linear probability model will be biased as well. To illustrate the effect of unobserved heterogeneity, let decompose the error terms in (2.1a) and (2.1b) further into correlated and uncorrelated components:

$$\varepsilon_{1ist} = \rho_1 \theta + \upsilon_{1ist} , \tag{2.2a}$$

$$\varepsilon_{2ist} = \rho_2 \theta + \upsilon_{2ist} , \tag{2.2b}$$

where terms θ, υ_{1i}, and υ_{2i} are assumed to have a zero mean and be mutually independent as well as independent of the exogenous variables in the model. The parameter θ reflects a common factor of unobserved selection such as a thrill-seeking personality and personal preferences that can affect both drinking and sexual behaviors in such a way that the latter leads to pregnancy. Terms υ_{1i} and υ_{2i} represent uncorrelated components of unobserved selection that are unique for a given outcome.

The identification difficulty stems from the fact that the distribution of the heterogeneity term θ is not known a priory. If θ follows a normal distribution then the model described in equations (2.1a)-(2.2b) becomes a standard recursive bivariate probit model where error terms ε_{1i} and ε_{2i} follow a joint normal distribution with a correlation term ρ (Greene, 2008b). A positive ρ indicates that unobserved factors increase both the probability of alcohol consumption and the probability of becoming pregnant. On the contrary, a negative ρ is likely to imply that unobserved personal preferences increase the probability of one outcome and decrease the probability of the other outcome. As mentioned earlier, the invalid distributional assumption can lead to a model misspecification resulting in implausible estimates. One way to impose the minimum restrictions and avoid the a priory parametric specification of distribution of θ is to approximate it by a step function with *k* points of support (η_k) each of which has a probability π_k:

$$\mathrm{Prob}(\theta = \eta_k) = \pi_k \text{ , k = 1,…K,} \tag{2.3}$$

where $\pi_k > 0$ and $\sum_{k=1}^{K} \pi_k = 1$. After some trivial normalizations, the model parameters α, β_1', β_2', γ, ρ_1, ρ_2, $\{\eta_k\}$, and $\{\pi_k\}$ can be jointly estimated.[44] The Monte Carlo simulations reported in Mroz (1999) reveal that the semi-parametric discrete factor approximation estimator compares favorably to the normal maximum likelihood estimator in terms of precision and bias when the true distribution of the error terms is indeed joint normal. When the true distribution of the error terms is not normal, the semi-parametric discrete factor approximation estimator outperforms the maximum likelihood estimator that relies on incorrect assumption of normality.[45]

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[44] The mean of θ is set to zero, but the scale of θ is not restricted. Also following Mroz (1999) suggestion, one of the factor loadings (ρ_1) is set to 1.

[45] The likelihood functions for both estimators (the bivariate probit and the discrete factor method) are derived in the Appendix S.

Little guidance is provided in the literature on how to choose the number of support points. Mroz (1999) suggests a step-by-step estimation procedure with an upward-testing approach that is adopted in this paper. First, I estimate a model with 1-support point which corresponds to two independent probit models. Its coefficient estimates are used as the initial value in a 2-support point model. Then a likelihood ratio "Chi-square" test is performed to assess a change (increase) in the quasi-likelihood function value. If the one-support point model is rejected in favor of a 2-support point model then I proceed with a 3-support point model using estimated coefficient from the 2-support point model as initial values, and so on. With a relatively small sample size and a relatively large number of right-hand side variables estimation is time consuming; often resulting in numerical difficulties (encountered with a 4-point and higher models). This study stops at the 4-support point discrete distribution. The simulation results in Mroz (1999) indicate that the 4-support point model behaves well in terms of consistency as well as accuracy.

Data

This paper studies the relationship between alcohol use and youth pregnancy using the 1979 cohort of the National Longitudinal Survey of Youth (NLSY79). The NLSY79 contains data on a nationally representative random sample (national sample) of young men and women ages 14-22 in 1979 and supplemental oversamples of young blacks, Hispanics, poor whites, and members of the military. However, the black, Hispanic, and disadvantaged white oversamples, members of the military, and men sample are excluded from the analysis.

Despite the vast amount of personal data, including fertility history and data on geographic location collected annually, the series of questions about alcohol consumption were asked only during the 1982-85, 1988-89, 1992, 1994, and 2002 surveys. The discontinuity of surveys introduces some limitations on the data that I can use in empirical analysis. Overall, after taking into account aging of the cohorts, I decided to use only data from the 1982-85 surveys. This implies that my panel is limited to four years of data and includes women whose ages range from 17 to 28 years.

As outlined in the equations (2.1a) and (2.1b), two outcomes of interest are pregnancy status and alcohol use status in a given year. The NLSY79 provides detailed fertility histories that enable one to identify whether a woman was pregnant or not in a given year. The information about alcohol consumption is somewhat limited. For example, respondents were asked if they had any alcoholic beverages in the past month. Such formulation of the question does not allow one to precisely identify alcohol consumption behavior during a given year. Following the literature, I assume that alcohol use in the preceding month is a reasonable indicator of alcohol use throughout the entire year (Sen, 2002 and Acworth et al., 2007). Among other shortcomings, this generalization creates a problem especially in situations when a pregnant woman was surveyed. Knowing the negative impact of alcohol on the fetus, pregnant women are less likely to consume alcohol. Thus, if a pregnant woman reports no consumption of alcohol in the previous month, there is no way to distinguish whether this is her “typical” behavior or behavior induced by pregnancy. To address this issue I analyzed the sequence of the following dates: month when pregnancy began, month of the interview, and month for which alcohol consumption question was answered. Based on the sequence of events, I identified and eliminated from the dataset 97 person-year observations. These observations represent women who became pregnant at least two months before the interview date and hence were answering alcohol consumption questions while being pregnant.[46] Further, analysis indicates that the majority (57 observations) of these women reported that they did not consume alcohol. The detailed event analysis is reported in Appendix T. The final sample includes 12,035 person-year observations on 3,033 women. Appendix U provides instructions regarding the formation of the sample as well as summarizes all restrictions applied.

Table 2.1 shows summary statistics for variables included in the analysis. Composition wise the majority of women in my dataset are white (80%), 13% are black, and the rest are Hispanic. Across four years of data, on average about 13% of women in the sample became pregnant in a given year. Among all women on average 65% reported alcohol consumption. Comparison of pregnancy rates by status of alcohol consumption, which is reported in Table 2.2, reveals that on average non-drinkers tend to have higher pregnancy rates than women who reported alcohol consumption. Overall these differences are statistically significant.

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[46] Given a degree of details available in the data, another extension of the paper would include assembling a dataset which includes only information regarding the month for which women answered alcohol consumption question. Then one can study the co-occurrence of alcohol consumption and pregnancy for a given month.

Fertility decisions might differ across age cohorts. An ideal extension of this paper would include a sensitivity test which involves estimation using different sub-samples of the data. For example, a restricted sample comprised of women from the youngest five cohorts of the NLSY79 could be used instead of the initial sample. However, given the relatively small size of the initial sample, further decreases in the number of observations generate additional computational difficulties and, therefore, are not considered.

The NLSY79 data identifies state of residence that allows one to control for time invariant, state level unobservable factors. However, the inclusion of state fixed effects creates several complications. First, such action might affect the precision of policy estimates that are included in equation (2.1a). Recall, I assume that youth alcohol consumption in a given state-year is partially determined by policies that regulate youth alcohol consumption such as the minimum legal drinking age, per gallon beer tax, etc. In the presence of state fixed effects, the accurate estimation of the effects of state policy variables requires a substantive within-state variation in these policy variables. For example, during the four-year period only 13 states changed per gallon beer tax and 12 states changed minimum drinking age.[47] A relatively small sample size combined with a modest within-state policy variation will cause the effects of policy variables to be mostly absorbed by the state fixed effects. Second, the inclusion of a large number of right-hand side variables not only slows down estimation but also creates numeric problems for maximum likelihood estimation. I address both issues by using four sub-region dummies

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[47] If policy change was during the course of the year then corresponding policy variable reflects situation that prevailed for the most part of the year.

rather than state dummies. If states within a sub-region share similar cultural values and attitudes then the sub-region fixed effects will be good substitutes for the state fixed effects.[48]

Results

As mentioned earlier, estimated coefficients in the binary models estimated with the maximum likelihood method are not particularly informative. Therefore, the general discussion of these results is omitted (estimates of all parameters for each model are reported in Appendix V). To test the validity of exclusion restrictions included in equation (2.1a), I performed a series of tests of joint significance of corresponding estimates; in all cases the null hypothesis was rejected confirming the validity of the instruments.[49]

The key question is whether alcohol use affects the likelihood of pregnancy among youth. I assess the magnitude of the effect by computing the marginal effect of alcohol consumption on the probability of pregnancy:

Marginal effect =

$$= \text{Probability}\ [\text{Pregnancy}=1 | \text{Drinking}=1, X_1] - \text{Probability}\ [\text{Pregnancy}=1 | \text{Drinking}=0, X_1] \qquad (2.4)$$

Table 2.3 summarizes the average effect of alcohol use on the probability of pregnancy among youth from all estimation techniques considered.

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[48] Although both Rees et al. (2001) and Sen (2002) used nationally representative samples, it appears that neither one included location fixed effects in the model.

[49] The F-test for 2SLS model; the Wald test for Probit model; the Wald test and the likelihood ratio test for Biprobit model; the Wald test for 2, 3, and 4-support point models.

A considerable variation exists across models. For example, the linear probability model, which ignores the potential effect of endogeneity, predicts that alcohol consumption decreases the probability of pregnancy by 0.7 percentage points. This is an opposite effect of the expected relationship between alcohol consumption and pregnancy. The picture changes dramatically once the model is corrected for endogeneity: the estimated effect becomes much larger and the sign flips, indicating that alcohol consumption increases the probability of pregnancy by 5.2 percentage points. However, the estimate lacks statistical significance.

The average effect from the single-equation probit model is almost identical to the one from the linear probability model (the corresponding estimate is -0.6 percentage points). After the model is corrected for endogeneity (i.e., the bivariate probit model), the effect increases significantly and becomes positive (an increase of 5.1 percentage points). Interestingly that quantitatively and qualitatively estimates from the two-stage least squares model and the bivariate probit model are almost identical. The results from the bivariate model also indicate a negative correlation between the errors in equations (2.1a) and (2.1b). Given a fairly large standard error, I fail to reject the null hypothesis that this estimate is statistically different from zero. Despite a quite modest and imprecise correlation estimate, one should not quickly dismiss the bivariate probit model. The value -0.1878 measures the correlation between the outcomes after the influence of other factors included in the model (which *includes* the effect of alcohol consumption) is accounted for (Greene, 2008a). A formal likelihood ratio test indicates that one would not reject the simple single-equation probit model in favor of the bivariate probit model (the test statistics are reported in Table 2.4 Panel A). The bivariate probit model is also rejected when compared to the discrete factor models (2-points and higher). This likely indicates that the normality assumption embodied in the bivariate model does not hold.

However, the single-equation probit model that corresponds to a 1-point support model is rejected in favor of the 2-points and higher discrete factor models. An introduction of the 2-point discrete distribution yields a qualitatively similar effect: the effect of alcohol is negative. Models that involve a better approximation of the cumulative distribution of heterogeneity (3-points and 4-points models) indicate that alcohol consumption has a positive effect on the probability of pregnancy. After controlling for unobserved heterogeneity, the corresponding average "alcohol" effects are an increase of 2.5 percentage points in the probability of pregnancy (3-points model) and an increase of 4.7 percentage points (4-points model). The results of the upward-testing criterion that are reported in Table 2.4 Panel B suggest that one should use the model with 4 points of support.[50]

Table 2.5 presents the average effects of other covariates included in equations (2.1a) and (2.1b) from the 4-point model.[51] In the drinking equation, the numerically strongest effect is associated with the cigarette tax. The average effect of a unit change in the tax rate is +0.1649. This variable, however, is measured in cents with an average of $0.27. Therefore, it might be more informative to look at a 10 cents change rather than a dollar change. An increase in the tax rate by 10 cents raises the probability of drinking by

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[50] Interestingly, the magnitude of the effect from the 4 point model is numerically close to the estimates from the 2SLS model.

[51] Effects from 2-point and 3-point models are reported in Appendix W.

only 1.6 percentage points. This suggests that smoking and drinking are substitutes. Not surprisingly, an increase in the beer tax per gallon decreases the probability of drinking (a 10 cents increase reduces the probability by 2.1 percentage points). Among other variables, the relatively large effects are observed for race indicators, religion in which a woman was raised, and South. All these variables lead to an increase in the probability of drinking, holding all other factors fixed.

In the pregnancy equation, the strongest effects appear to be exerted by the lagged values of marital status and poverty status of women; the corresponding values are -0.1127 and -0.045. However, the interpretation of both might not be informative.

Conclusion

When studying effects of alcohol consumption on risky behaviors, researchers acknowledge that observed positive association could be due to confounding influence of unobserved characteristics (and, therefore, omitted from the model) such as a thrill-seeking personality. Commonly, the attempts to correct for these effects involve estimation of both outcomes (risky sexual behavior and alcohol consumption) simultaneously while allowing for correlation between the error terms (e.g., bivariate probit model). The identification in such model relies on validity of exclusion restrictions. Consistency of estimates in models with limited dependent variables depends on the validity of the underlying assumption about the distribution of the unobserved heterogeneity (in case of the bivariate probit model it is normality). One can easily avoid such strict distributional assumptions by approximating the cumulative distribution of heterogeneity with a step function. One would expect the discrete factor estimator to perform better than the maximum likelihood estimator based on an incorrect specification of joint normality.

I study the effect of alcohol consumption on the probability of pregnancy among 17-28 year-old women using fully parametric techniques popular in the literature and a semi-parametric discrete factor approximation method that has not previously been used in this application. I find that, after approximating the distribution of unobserved heterogeneity with a 4-point discrete distribution, alcohol consumption increases the likelihood of pregnancy by 4.7 percentage points. A qualitatively similar but numerically smaller effect is found in the model with a 3-point discrete distribution. The single-equation probit fails to establish this relationship. Furthermore, both the single-equation probit and the bivariate probit models are firmly rejected in favor of the discrete factor models. The rejection of the latter (the bivariate probit model) indicates that the normality assumption embodied in the bivariate probit model does not hold.

Table 1.1
State minimum legal drinking age for bear on January 1, 1970 and changes in the legal drinking age 1970-1988

State	Legal drinking age for bear on 1/1/1970	Changes in the legal drinking age for beer in the period 1/1/1970 –1/1/1988
Alabama	1/1/1970 – 21	7/1/1975 – 19; 10/1/1985 "with grandfather clause" – 21
Alaska	1/1/1970 – 21	9/1/1970 – 19; 11/1/1984 – 21
Arizona	1/1/1970 – 21	8/1/1972 – 19; 1/1/1985 "grandfather clause" – 21
Arkansas	1/1/1970 – 21	
California	1/1/1970 – 21	
Colorado	1/1/1970 – 18	7/1/1987 – 21
Connecticut	1/1/1970 – 21	10/1/1972 – 18; 7/1/1982 – 19; 10/1/1983 – 20; 9/1/1985 "grandfather clause" – 21
Delaware	1/1/1970 – 21	7/1/1972 – 20; 1/1/1984 "grandfather clause" – 21
DC	1/1/1970 – 18	9/1/1986 "grandfather clause" – 21
Florida	1/1/1970 – 21	7/1/1973 – 18; 10/1/1980 – 19; 7/1/1985 "grandfather clause" – 21
Georgia	1/1/1970 – 21	7/1/1972 – 18; 9/1/1980 – 19; 9/1/1985 – 20; 9/1/1986 – 21
Hawaii	1/1/1970 – 20	3/1/1972 – 18; 10/1/1986 – 21
Iowa	1/1/1970 – 21	4/1/1972 – 19; 7/1/1973 – 18; 7/1/1976 "grandfather clause" – 19; 9/1/1986 "grandfather clause" – 21
Idaho	1/1/1970 – 20	7/1/1972 – 19; 4/1/1987 – 21
Illinois	1/1/1970 – 21	9/1/1973 – 19; 1/1/1980 – 21
Indiana	1/1/1970 – 21	
Kansas	1/1/1970 – 18	7/1/1985 "grandfather clause" – 21
Kentucky	1/1/1970 – 21	

Table 1.1 (Continued)

State	Legal drinking age for bear on 1/1/1970	Changes in the legal drinking age for beer in the period 1/1/1970 –1/1/1988
Louisiana	1/1/1970 – 18	3/1/1987 – 21
Maine	1/1/1970 – 20	6/1/1972 – 18; 10/1/1977 – 20; 7/1/1985 “grandfather clause” – 21
Maryland	1/1/1970 – 21	7/1/1974 –18; 7/1/1982 “grandfather clause” – 21
Massachusetts	1/1/1970 – 21	3/1/1973 – 18; 4/1/1979 – 20; 6/1/1985 “grandfather clause” – 21
Michigan	1/1/1970 – 21	1/1/1972 – 18; 12/1/1978 – 21
Minnesota	1/1/1970 – 21	6/1/1973 – 18; 9/1/1979 “grandfather clause” – 19; 9/1/1986 “grandfather clause” – 21
Mississippi	1/1/1970 – 18	10/1/1986 – 21
Missouri	1/1/1970 – 21	
Montana	1/1/1970 – 21	7/1/1971 – 19; 7/1/1973 – 18; 1/1/1979 – 19; 4/1/1987 – 21
Nebraska	1/1/1970 – 20	6/1/1972 – 19; 7/1/1980 “grandfather clause” – 20; 1/1/1985 “grandfather clause” – 21
Nevada	1/1/1970 – 21	
New Hampshire	1/1/1970 – 21	6/1/1973 – 18; 5/1/1979 – 20; 6/1/1985 “grandfather clause” – 21
New Jersey	1/1/1970 – 21	1/1/1973 – 18; 1/1/1980 “grandfather clause” – 19; 1/1/1983 “grandfather clause” – 21
New Mexico	1/1/1970 – 21	
New York	1/1/1970 – 18	12/1/1982 – 19; 12/1/1985 – 21
North Carolina	1/1/1970 – 18	10/1/1983 – 19; 9/1/1986 – 21
North Dakota	1/1/1970 – 21	
Ohio	1/1/1970 – 18	8/1/1982 – 19; 7/1/1987 “grandfather clause” – 21

Table 1.1 (Continued)

State	Legal drinking age for bear on 1/1/1970	Changes in the legal drinking age for beer in the period 1/1/1970 –1/1/1988
Oklahoma	1/1/1970 – 18	9/1/1983 – 21
Oregon	1/1/1970 – 21	
Pennsylvania	1/1/1970 – 21	
Rhode Island	1/1/1970 – 21	3/1/1972 – 18; 7/1/1980 – 19; 7/1/1981 – 20; 7/1/1984 – 21
South Carolina	1/1/1970 – 18	1/1/1984 – 19; 1/1/1985 – 20; 9/1/1986 – 21
South Dakota	1/1/1970 – 19	7/1/1972 – 18; 7/1/1984 – 19; 4/1/1988 – 21
Tennessee	1/1/1970 – 21	5/1/1971 – 18; 6/1/1979 – 19; 8/1/1984 "grandfather clause" – 21
Texas	1/1/1970 – 21	8/1/1973 – 18; 9/1/1981 – 19; 9/1/1986 – 21
Utah	1/1/1970 – 21	
Vermont	1/1/1970 – 21	7/1/1971 – 18; 7/1/1986 "grandfather clause" – 21
Virginia	1/1/1970 – 21	7/1/1974 – 18; 7/1/1981 – 19; 7/1/1985 "grandfather clause" – 21
Washington	1/1/1970 – 21	
West Virginia	1/1/1970 – 18	7/1/1983 – 19; 7/1/1986 – 21
Wisconsin	1/1/1970 – 18	7/1/1984 – 19; 9/1/1986 "grandfather clause" – 21
Wyoming	1/1/1970 – 21	5/1/1973 – 19; 7/1/1988 –21

Source: Wagenaar (1981), O'Malley and Wagenaar (1990), and the National highway traffic safety administration (NHTSA) online report.

Table 1.2
Difference in means

		Legal drinking age is 18 or 19	Legal drinking age is 20 or 21	Difference
15-19 year-old women				
Pregnancy rate	Mean	87.40	82.58	4.82^{+}
per 1,000 women	Std. Dev.	40.87	19.28	
Birth rate	Mean	53.82	51.61	2.21*
per 1,000 women	Std. Dev.	14.35	12.98	
Abortion rate	Mean	33.72	30.86	2.86
per 1,000 women	Std. Dev.	37.13	16.63	
20-24 year-old women				
Pregnancy rate	Mean	156.34	152.37	3.97
per 1,000 women	Std. Dev.	36.14	24.79	
Birth rate	Mean	118.64	115.68	2.96^{+}
per 1,000 women	Std. Dev.	24.61	23.66	
Abortion rate	Mean	38.69	35.79	2.90
per 1,000 women	Std. Dev.	41.57	19.54	
25-29 year-old women				
Pregnancy rate	Mean	138.62	137.82	0.81
per 1,000 women	Std. Dev.	21.54	18.88	
Birth rate	Mean	114.89	116.17	-1.28
per 1,000 women	Std. Dev.	17.39	18.40	
Abortion rate	Mean	23.15	20.78	2.36
per 1,000 women	Std. Dev.	28.36	12.07	

** significant at 1%; * significant at 5%; $^{+}$ significant at 10%

Birth rate in a given year *t* and state *s* reflects the number of pregnancies conceived in that year that ended in births and is calculated as: (1/4 Births$_{gst}$ + Births$_{gst+1}$)/(female population$_{gst}$). For discussion see Section "Analysis of aggregated data: Difference-in-Difference model".

Table 1.3
Descriptive statistics for variables used in the DID estimation

	Obs	Mean	Std. Dev.	Min	Max
Age 15-19					
Pregnancy rate per 1000 women [a]	572	85.15	32.69	44.53	322.36
Birth rate per 1000 women [a]	765	52.81	13.78	27.32	94.90
Abortion rate per 1000 women [a]	572	32.38	29.41	0.31	255.29
Age 20-24					
Pregnancy rate per 1000 women [a]	572	154.48	31.39	103.76	359.50
Birth rate per 1000 women [a]	765	117.29	24.21	65.42	213.41
Abortion rate per 1000 women [a]	572	37.33	33.16	0.37	281.24
Age 25-29					
Pregnancy rate per 1000 women [a]	572	138.25	20.33	100.18	251.42
Birth rate per 1000 women [a]	765	115.48	17.86	62.04	205.58
Abortion rate per 1000 women [a]	572	22.04	22.31	0.28	184.91
Age group invariant variables					
Legal drinking age is 18 years	2295	0.35	0.48	0	1
Legal drinking age is 19 years	2295	0.19	0.40	0	1
Legal drinking age is 20 years	2295	0.05	0.23	0	1
Legal drinking age is 21 years	2295	0.40	0.49	0	1
State per capita personal income, 2000 dollars	2295	21312.09	3663.56	13452.72	36694.64
Max AFDC, 2000 dollars	2295	735.09	278.53	170.50	1590.77
State unemployment rate	2295	6.91	2.22	2.20	17.44
Percent of black population	2295	10.70	12.64	0.23	75.54
Beer tax rate per gallon, 2000 dollars [b]	2259	0.37	0.35	0.03	2.69
Number of abortion providers	2295	51.82	85.88	1	608
Number of non-Ob/Gyn physicians	2295	8411.46	10995.20	284	70562
Age group variant variables					
Medicaid restrictions	2295	0.51	0.48	0	1
Parental consent and notification laws	2295	0.03	0.17	0	1
Number of unrestricted border states for consent	2295	4.23	1.79	0	8
Number of unrestricted border states for beer	2295	3.31	2.32	0	8

[a] Statistic is restricted to the age group.

[b] The number of observations differs for this variable due to missing values for beer tax in Hawaii (before 1986 the tax rate was calculated as a percentage of wholesale price).

Table 1.4
Difference-in-Difference estimates, control group women 25-29 years old (1974-1988)

Panel A:

		Dependent variable			
		logarithm of PREGNANCY rate			
		(1)	(2)	(3)	(4)
(1)	Teens (treatment group)	-0.523**	-0.523**	-0.494**	-0.529
		(0.04)	(0.04)	(0.06)	(2.82)
(2)	Drinking age 18 or 19	0.004	-0.047	0.001	-0.003
		(0.03)	(0.04)	(0.03)	(0.03)
(3)	***Teens × da_18or19***	***0.011***	***0.011***	***-0.012***	***-0.033***
		(0.06)	(0.06)	(0.06)	(0.06)
(4)	Medicaid funding restrictions			0.011	0.011
				(0.01)	(0.02)
(5)	Enforced parental consent and notification			-0.167^{+}	-0.162*
				(0.09)	(0.08)
(6)	Log real personal income, 2000$			0.505**	0.502*
				(0.16)	(0.21)
(7)	Log real max AFDC, in 2000 $			0.103*	0.100*
				(0.04)	(0.04)
(8)	Unemployment rate			-0.012*	-0.026**
				(0.01)	(0.01)
(9)	Percent of black population			0.015**	0.014**
				(0.01)	(0.01)
(10)	Log predicted abortion providers			0.071	0.049
				(0.14)	(0.14)
(11)	Log state beer tax, In 2000 dollars			-0.023	-0.023
				(0.05)	(0.05)
(12)	# of unrestricted border states for parental consent			0.007	0.033
				(0.02)	(0.03)
(13)	# of unrestricted border states for alcohol			-0.002	-0.017
				(0.02)	(0.01)
(14)	Teens × (Unemployment rate)				0.026*
					(0.01)
(15)	Teens × (Unrestricted for consent)				-0.021
					(0.02)
(16)	Teens × (Income)				-0.008
					(0.28)
(17)	Constant	4.918**	4.773**	-1.334	-1.147
		(0.02)	(0.03)	(1.55)	(1.88)
(18)	State, year fixed effects	no	yes	yes	yes
(19)	R square	0.61	0.83	0.85	0.85
(20)	Number of observations	1144	1144	1120	1120

** significant at 1%; * significant at 5%; + significant at 10%. Standard errors clustered by state are in parentheses. I use the F-test to test model (4) v. (1) and reject the null.

Table 1.4 (Continued)
Panel B:

		Dependent variable			
		logarithm of BIRTH rate[52]			
		(5)	(6)	(7)	(8)
(1)	Teens (treatment group)	-0.833**	-0.833**	-0.820**	-1.113**
		(0.05)	(0.05)	(0.07)	(0.18)
(2)	Drinking age 18 or 19	-0.013	-0.041	-0.016	-0.012
		(0.03)	(0.04)	(0.04)	(0.04)
(3)	***Teens × da_18or19***	***0.05***	***0.05***	***0.014***	***0.003***
		(0.06)	(0.06)	(0.06)	(0.05)
(4)	Medicaid funding restrictions			-0.006	-0.006
				(0.01)	(0.01)
(5)	Enforced parental consent and notification			-0.152^{+}	-0.165*
				(0.08)	(0.07)
(6)	Log real personal income, 2000$			0.217	0.230
				(0.15)	(0.14)
(7)	Log real max AFDC, in 2000 $			0.097*	0.094^{+}
				(0.05)	(0.05)
(8)	Unemployment rate			-0.014**	-0.033**
				(0.00)	(0.01)
(9)	Percent of black population			0.001	0.002
				(0.01)	(0.01)
(10)	Log predicted abortion providers			0.008	0.001
				(0.07)	(0.06)
(11)	Log state beer tax, In 2000 dollars			-0.042	-0.046
				(0.05)	(0.05)
(12)	# of unrestricted border states for parental consent			0.029	0.045^{+}
				(0.03)	(0.02)
(13)	# of unrestricted border states for alcohol			-0.011	-0.023
				(0.02)	(0.02)
(14)	Teens × (Unemployment rate)				0.040**
					(0.01)
(15)	Teens × (Unrestricted for alcohol)				0.011
					(0.02)
(16)	Teens × (Providers)				-0.006
					(0.03)
(17)	Constant	4.745**	4.913**	2.106	2.105
		(0.02)	(0.03)	(1.35)	(1.35)
(18)	State, year fixed effects	no	yes	yes	yes
(19)	R square	0.77	0.87	0.87	0.88
(20)	Number of observations	1530	1530	1506	1506

** significant at 1%; * significant at 5%; + significant at 10%. Standard errors clustered by state are in parentheses. I use the F-test to test model (8) v. (5) and reject the null.

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[52] For each age group *g*, birth rate in a given year *t* and state *s* reflects the number of births conceived in that year and is calculated as: $(1/4\ \text{Births}_{gst} + \text{Births}_{gst+1})/(\text{female population}_{gst})$.

Table 1.4 (Continued)
Panel C:

		Dependent variable			
		logarithm of ABORTION rate			
		(9)	(10)	(11)	(12)
(1)	Teens (treatment group)	0.405** (0.03)	0.405** (0.03)	0.434** (0.04)	0.649** (0.08)
(2)	Drinking age 18 or 19	-0.109 (0.14)	-0.051 (0.05)	0.005 (0.05)	0.002 (0.05)
(3)	***Teens × da_18or19***	***0.022*** (0.04)	***0.022*** (0.04)	***0.05*** (0.03)	***0.069**** (0.03)
(4)	Medicaid funding restrictions			0.133^{+} (0.07)	0.133^{+} (0.07)
(5)	Enforced parental consent and notification			-0.036 (0.06)	-0.053 (0.06)
(6)	Log real personal income, 2000$			1.051^{+} (0.53)	1.058* (0.53)
(7)	Log real max AFDC, in 2000 $			0.678^{+} (0.35)	0.679^{+} (0.35)
(8)	Unemployment rate			0.033 (0.03)	0.046 (0.03)
(9)	Percent of black population			-0.051 (0.06)	-0.049 (0.06)
(10)	Log predicted abortion providers			1.008** (0.35)	1.024** (0.35)
(11)	Log state beer tax, In 2000 dollars			0.04 (0.10)	0.038 (0.10)
(12)	# of unrestricted border states for parental consent			-0.017 (0.02)	-0.02 (0.03)
(13)	# of unrestricted border states for alcohol			0.012 (0.01)	0.017 (0.01)
(14)	Teens × (Unemployment rate)				-0.026** (0.01)
(15)	Teens × (Black)				-0.003** (0.00)
(16)	Constant	2.912** (0.09)	0.506** (0.07)	-9.83 (7.71)	-10.081 (7.72)
(17)	State, year fixed effects	no	yes	yes	yes
(18)	R square	0.10	0.86	0.89	0.89
(19)	Number of observations	1144	1144	1120	1120

** significant at 1%; * significant at 5%; + significant at 10%. Standard errors clustered by state are in parentheses. I use the F-test to test model (12) v. (9) and reject the null.

Table 1.5
Timing of the first pregnancy and its outcome aggregated by years of age for 15-20 year-old women

				Hazard function		**Survivor function**	
Age in years	Females at risk	Had the 1st **pregnancy**	Censored	Estimated annual **hazard** probability	Standard error	Estimated annual **survival** probability	Standard error
15	4690	222	0	0.047	0.003	0.953	0.003
16	4468	328	0	0.073	0.004	0.883	0.005
17	4140	353	0	0.085	0.004	0.808	0.006
18	3787	406	0	0.107	0.005	0.721	0.007
19	3381	389	0	0.115	0.005	0.638	0.007
20	2992	274	2718	0.092	0.005	0.580	0.007

Age in years	Females at risk	Had the1st pregnancy and gave **birth**	Censored	Estimated annual **hazard** probability	Standard error	Estimated annual **survival** probability	Standard error
15	4690	175	47	0.037	0.003	0.963	0.003
16	4468	260	68	0.058	0.004	0.907	0.004
17	4140	265	88	0.064	0.004	0.849	0.005
18	3787	296	110	0.078	0.004	0.782	0.006
19	3381	293	96	0.087	0.005	0.715	0.007
20	2992	187	2718	0.063	0.004	0.670	0.007

Age in years	Females at risk	Had the 1st pregnancy and **terminated**	Censored	Estimated annual **hazard** probability	Standard error	Estimated annual **survival** probability	Standard error
15	4690	36	186	0.008	0.001	0.992	0.001
16	4468	48	280	0.011	0.002	0.982	0.002
17	4140	63	290	0.015	0.002	0.967	0.003
18	3787	64	342	0.017	0.002	0.950	0.003
19	3381	61	328	0.018	0.002	0.933	0.004
20	2992	43	2718	0.014	0.002	0.920	0.004

Table 1.6
Descriptive statistics for variables used in the discrete-time hazard estimation

Variable		**Mean**	**Std. Dev.**	**Min**	**Max**	**Observations**
Drinking age is 18 or 19 [a]	overall	0.70	0.46	0	1	N = 333637
	between		0.42	0	1	n = 4685
	within		0.20	-0.29	1.69	T-bar = 71.21
Legally eligible to drink (adjusted for grandfather clause)	overall	0.32	0.47	0	1	N = 333637
	between		0.22	0	1	n = 4685
	within		0.42	-0.52	1.31	T-bar = 71.21
Black	overall	0.29	0.45	0	1	N = 337680
	between		0.45	0	1	n = 4690
	within		0.00	0.29	0.29	T = 72
Hispanic	overall	0.20	0.40	0	1	N = 337680
	between		0.40	0	1	n = 4690
	within		0.00	0.20	0.20	T = 72
White	overall	0.51	0.50	0	1	N = 337680
	between		0.50	0	1	n = 4690
	within		0.00	0.51	0.51	T = 72
Raised in Baptist family	overall	0.30	0.46	0	1	N = 336816
	between		0.46	0	1	n = 4678
	within		0.00	0.30	0.30	T = 72
Raised in other religion	overall	0.31	0.46	0	1	N = 336816
	between		0.46	0	1	n = 4678
	within		0.00	0.31	0.31	T = 72
Raised as Atheist	overall	0.03	0.17	0	1	N = 336816
	between		0.17	0	1	n = 4678
	within		0.00	0.03	0.03	T = 72
Raised in Catholic family	overall	0.36	0.48	0	1	N = 336816
	between		0.48	0	1	n = 4678
	within		0.00	0.36	0.36	T = 72
AFQT score below mean	overall	0.56	0.50	0	1	N = 322920
	between		0.50	0	1	n = 4485
	within		0.00	0.56	0.56	T = 72
Mother's education (years)	overall	10.76	3.25	0	20	N = 319176
	between		3.25	0	20	n = 4433
	within		0.00	10.76	10.76	T = 72
Both parents are in the household at age 14	overall	0.68	0.46	0	1	N = 337032
	between		0.46	0	1	n = 4681
	within		0.00	0.68	0.68	T = 72
Presence of older siblings	overall	0.78	0.41	0	1	N = 317664
	between		0.41	0	1	n = 4412
	within		0.00	0.78	0.78	T = 72
Father's education (years)	overall	10.88	4.01	0	20	N = 287856
	between		4.01	0	20	n = 3998
	within		0.00	10.88	10.88	T = 72

Table 1.6 (Continued)

Variable		**Mean**	**Std. Dev.**	**Min**	**Max**	**Observations**
Contraception use before 1st pregnancy	overall	0.44	0.50	0	1	N = 231552
	between		0.50	0	1	n = 3216
	within		0.00	0.44	0.44	T = 72
Age 15	overall	0.17	0.37	0	1	N = 337680
	between		0.00	0.17	0.17	n = 4690
	within		0.37	0	1	T = 72
Age 16	overall	0.17	0.37	0	1	N = 337680
	between		0.00	0.17	0.17	n = 4690
	within		0.37	0	1	T = 72
Age 17	overall	0.17	0.37	0	1	N = 337680
	between		0.00	0.17	0.17	n = 4690
	within		0.37	0	1	T = 72
Age 18	overall	0.17	0.37	0	1	N = 337680
	between		0.00	0.17	0.17	n = 4690
	within		0.37	0	1	T = 72
Age 19	overall	0.17	0.37	0	1	N = 337680
	between		0.00	0.17	0.17	n = 4690
	within		0.37	0	1	T = 72
Age 20	overall	0.17	0.37	0	1	N = 337680
	between		0.00	0.17	0.17	n = 4690
	within		0.37	0	1	T = 72
Currently married	overall	0.11	0.31	0	1	N = 337680
	between		0.20	0	1	n = 4690
	within		0.23	-0.88	1.09	T = 72
Previously been married	overall	0.01	0.11	0	1	N = 337680
	between		0.07	0	0.930556	n = 4690
	within		0.09	-0.92	1.00	T = 72
Never been married	overall	0.88	0.32	0	1	N = 337680
	between		0.22	0	1	n = 4690
	within		0.24	-0.10	1.87	T = 72
Enforced parental notification/consent law [b]	overall	0.02	0.12	0	1	N = 334267
	between		0.08	0	1	n = 4690
	within		0.09	-0.78	1.00	T-bar = 71.27

[a] Source: Wagenaar (1981), O'Malley and Wagenaar (1990), and the National Highway Traffic Safety Administration website. If a woman was outside of the USA then the variable was assigned a missing value.

[b] Source: Merz (1995), Haas-Wilson (1996), Greenberger and Connor (1992), New (2004), and NARAL website.

Table 1.7
Probit coefficient estimates for pregnancy, birth, and abortion models, 15-17 year-old women (Specification 1)

Dependent variable in **pregnancy model**: pregnancy status that equals 1 if pregnant, 0 otherwise
Dependent variable in **birth model**: equals 1 if 1st time pregnant and that pregnancy ended in birth, 0 otherwise
Dependent variable in **abortion model**: equals 1 if 1st time pregnant and that pregnancy ended in abortion, 0 otherwise

		Panel A: Pregnancy model			***Panel B: Birth model***			***Panel C: Abortion model***		
		Whites	*Blacks*	*Hispanics*	*Whites*	*Blacks*	*Hispanics*	*Whites*	*Blacks*	*Hispanics*
(1)	***Drinking age***	***-0.101***	***0.161^{+}***	***-0.114***	***-0.046***	***0.128***	***-0.264****	***-0.311*****	***0.372*****	***0.339***
	18 or 19	(0.11)	(0.10)	(0.12)	(0.12)	(0.10)	(0.12)	(0.09)	(0.09)	(0.31)
(2)	Raised in	0.252*	0.159^{+}	0.331^{+}	0.248**	0.101	0.33^{+}	0.189	0.558*	0.033
	Baptist family	(0.08)	(0.09)	(0.20)	(0.08)	(0.10)	(0.19)	(0.12)	(0.27)	(0.55)
(3)	Raised in other	0.086	0.237**	-0.068	0.034	0.184*	-0.177	0.152*	0.607^{+}	0.315
	Religion	(0.06)	(0.09)	(0.14)	(0.07)	(0.09)	(0.21)	(0.07)	(0.32)	(0.22)
(4)	Raised as	0.217*	0.339**	0.391*	0.187^{+}	0.252*	0.332	0.213		0.648**
	Atheist	(0.08)	(0.12)	(0.17)	(0.11)	(0.11)	(0.25)	(0.14)		(0.16)
(5)	AFQT score	0.211*	0.144*	0.226**	0.296**	0.214**	0.301**	0.025	-0.139	0.014
	below mean	(0.05)	(0.06)	(0.08)	(0.07)	(0.06)	(0.09)	(0.07)	(0.14)	(0.15)
(6)	Mother's	-0.047**	-0.034	-0.01	-0.05**	-0.044**	-0.025^{+}	-0.028*	0.06*	0.064**
	education	(0.01)	(0.01)**	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.03)	(0.01)
(7)	Both parents are	-0.135*	-0.219**	-0.107*	-0.174**	-0.228**	-0.096	-0.019	-0.127	-0.175^{+}
	in the household	(0.05)	(0.04)	(0.05)	(0.06)	(0.04)	(0.06)	(0.07)	(0.13)	(0.09)
(8)	Constant	-2.431*	-2.738**	-3.163**	-2.327**	-2.599**	-2.881**	-2.699**	-4.177**	-4.232**
		(0.20)	(0.21)	(0.51)	(0.34)	(0.26)	(0.29)	(0.32)	(0.56)	(0.62)
(9)	Age polynomial	yes	yes	yes	yes	yes	yes	yes	yes	yes
	State, calendar time fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
	# of observations	73608	37694	25285	71143	37313	24476	64867	20277	13054

** significant at 1%; * significant at 5%; + significant at 10%. Standard errors clustered by state. Person-month observations. Excluded category for religion is women raised in Catholic families.

Table 1.8
Probit coefficient estimates for pregnancy, birth, and abortion models, 18-20 year-old women (Specification 2)

Dependent variable in **pregnancy model**: pregnancy status that equals 1 if pregnant, 0 otherwise
Dependent variable in **birth model**: equals 1 if 1st time pregnant and that pregnancy ended in birth, 0 otherwise
Dependent variable in **abortion model**: equals 1 if 1st time pregnant and that pregnancy ended in abortion, 0 otherwise

		Panel A: Pregnancy model			***Panel B: Birth model***			***Panel C: Abortion model*** [a]		
		Whites	*Blacks*	*Hispanics*	*Whites*	*Blacks*	*Hispanics*	*Whites*	*Blacks* [b]	*Hispanics*
(1)	***Drinking age***	***-0.056***	***0.074***	***-0.503*****	***0.167***$^+$	***0.066***	***-0.424***	***-0.303***$^+$	***4.173*****	***-1.160***$^+$
	18 or 19	(0.08)	(0.19)	(0.19)	(0.10)	(0.22)	(0.36)	(0.18)	(0.17)	(0.62)
(2)	Raised in	0.105$^+$	-0.039	0.188$^+$	0.159**	-0.036	0.197	-0.031	-0.027	0.368
	Baptist family	(0.05)	(0.09)	(0.10)	(0.04)	(0.10)	(0.14)	(0.13)	(0.19)	(0.24)
(3)	Raised in other	-0.007	-0.136	0.069	-0.028	-0.155	-0.063	0.027	-0.104	0.298$^+$
	Religion	(0.04)	(0.10)	(0.11)	(0.04)	(0.11)	(0.17)	(0.07)	(0.22)	(0.18)
(4)	Raised as	0.038	0.108		-0.022	0.124		0.108	0.149	
	Atheist	(0.07)	(0.14)		(0.14)	(0.16)		(0.11)	(0.36)	
(5)	AFQT score	0.173*	0.257*	0.231**	0.251**	0.354**	0.395**	-0.098	-0.193	-0.191*
	below mean	(0.04)	(0.08)	(0.04)	(0.05)	(0.10)	(0.05)	(0.08)	(0.16)	(0.08)
(6)	Mother's	-0.045**	-0.011	0.005	-0.062**	-0.004	-0.009$^+$	0.001	-0.013	0.058**
	education	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.02)	(0.03)	(0.01)
(7)	Both parents are	-0.177*	-0.169*	-0.192**	-0.172**	-0.193**	-0.136**	-0.23**	-0.029	-0.246
	in the household	(0.03)	(0.05)	(0.06)	(0.04)	(0.05)	(0.04)	(0.07)	(0.11)	(0.18)
(8)	Constant	-5.358$^+$	-7.469$^+$	-5.864$^+$	-2.066**	-2.766**	-2.704**	-2.758**	-7.513**	-3.671**
		(2.52)	(3.64)	(3.41)	(0.23)	(0.29)	(0.27)	(0.40)	(0.53)	(0.50)
(9)	Age polynomial	yes	yes	yes	yes	yes	yes	yes	yes	yes
	State, calendar time fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
	# of observations	59695	25614	18347	58935	25575	17990	53040	11128	15247

** significant at 1%; * significant at 5%; + significant at 10%. Standard errors clustered by state. Person-month observations. Excluded category for religion is women raised in Catholic families. [a] The large estimates are driven by small sample size and rare event occurrence. [b] The standard error cannot be calculated for all covariates given the sample size and existing excessive collinearity among the predictors.

Table 1.9

Probit coefficient estimates for pregnancy, birth, and abortion models, 18-20 year-old women (Specification 3)

Dependent variable in **pregnancy model**: pregnancy status that equals 1 if pregnant, 0 otherwise
Dependent variable in **birth model**: equals 1 if 1st time pregnant and that pregnancy ended in birth, 0 otherwise
Dependent variable in **abortion model**: equals 1 if 1st time pregnant and that pregnancy ended in abortion, 0 otherwise

		Panel A: Pregnancy model			***Panel B: Birth model***			***Panel C: Abortion model***		
		Whites	*Blacks*	*Hispanics*	*Whites*	*Blacks*	*Hispanics*	*Whites*	*Blacks*	*Hispanics*
(1)	***Legally eligible***	***-0.067***	***-0.103$^+$***	***-0.149***	***0.132$^+$***	***-0.11***	***-0.225***	***-0.293****	***0.087***	***-0.203***
	to drink	(0.04)	(0.05)	(0.12)	(0.07)	(0.07)	(0.15)	(0.12)	(0.22)	(0.28)
(2)	Raised in	0.106$^+$	-0.037	0.196*	0.157**	-0.034	0.205	-0.031	-0.026	0.365
	Baptist family	(0.05)	(0.09)	(0.10)	(0.04)	(0.10)	(0.14)	(0.13)	(0.18)	(0.24)
(3)	Raised in other	-0.006	-0.134	0.079	-0.029	-0.154	-0.05	0.025	-0.106	0.318$^+$
	Religion	(0.04)	(0.10)	(0.10)	(0.04)	(0.11)	(0.16)	(0.06)	(0.22)	(0.17)
(4)	Raised as	0.038	0.111		-0.02	0.126		0.101	0.117	
	Atheist	(0.07)	(0.14)		(0.14)	(0.16)		(0.11)	(0.35)	
(5)	AFQT score	0.173*	0.258**	0.234**	0.251**	0.354**	0.396**	-0.098	-0.19	-0.172*
	below mean	(0.04)	(0.08)	(0.04)	(0.05)	(0.10)	(0.05)	(0.08)	(0.16)	(0.09)
(6)	Mother's	-0.044**	-0.01	0.005	-0.062**	-0.003	-0.008$^+$	0.002	-0.012	0.056**
	education	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.02)	(0.03)	(0.01)
(7)	Both parents are	-0.178*	-0.169**	-0.188**	-0.171**	-0.192**	-0.136**	-0.234**	-0.04	-0.221
	in the household	(0.03)	(0.05)	(0.06)	(0.04)	(0.05)	(0.04)	(0.07)	(0.11)	(0.18)
(8)	Constant	-5.242$^+$	-7.003$^+$	-5.586	-2.159**	-2.708**	-2.633**	-2.90**	-7.069	-3.648**
		(2.53)	(3.65)	(3.42)	(0.15)	(0.20)	(0.27)	(0.40)	(0.00)	(0.48)
(9)	Age polynomial	yes	yes	yes	yes	yes	yes	yes	yes	yes
	State, calendar time fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
	# of observations	59695	25614	18347	58935	25575	17990	53040	12170	15247

** significant at 1%; * significant at 5%; + significant at 10%. Standard errors clustered by state. Person-month observations. Excluded category for religion is women raised in Catholic families.

Table 1.10
Annual predicted probabilities of becoming pregnant for the first time, by race and age group

Annual predicted probability of 1st pregnancy among 15 -19 year old women

	Mean	Std. Dev.	# of observations
WHITES	0.0444	0.04	73608
BLACKS	0.1024	0.07	37694
HISPANICS	0.0669	0.06	25285

Annual predicted probability of 1st pregnancy among 18 -20 year old women (model with a drinking age 18 or 19 dummy)

	Mean	Std. Dev.	# of observations
WHITES	0.0817	0.06	59695
BLACKS	0.1274	0.07	25614
HISPANICS	0.1291	0.07	18347

Annual predicted probability of 1st pregnancy among 18 -20 year old women (model with an eligibility dummy)

	Mean	Std. Dev.	# of observations
WHITES	0.0817	0.06	59695
BLACKS	0.1274	0.07	25614
HISPANICS	0.1292	0.07	18347

Table 1.11

Discrete change in the predicted annual probability of **first pregnancy**, by race and age

Upper Panel: Effect of a DECREASE in the drinking age, 15-17 year-old women

	WHITES		BLACKS		HISPANICS	
	Mean	Bootstrap Std. error	Mean	Bootstrap Std. error	Mean	Bootstrap Std. error
Annual predicted probability of 1st pregnancy if drinking age is 20 or 21	0.054	0.012	0.076	0.015	0.079	0.028
Annual predicted probability of 1st pregnancy if drinking age **is 18 or 19**	0.041	0.004	0.113	0.009	0.059	0.041
discrete change ($\bar{\Delta}$)	**-0.013**	0.014	**0.037**	0.022	**-0.020**	0.060

Middle Panel: Effect of a DECREASE in the drinking age, 18-20 year-old women

	WHITES		BLACKS		HISPANICS[†]	
	Mean	Bootstrap Std. error	Mean	Bootstrap Std. error	Mean	Bootstrap Std. error
Annual predicted probability of 1st pregnancy if drinking age is 20 or 21	0.090	0.016	0.111	0.038	0.244	0.071
Annual predicted probability of 1st pregnancy if drinking age **is 18 or 19**	0.078	0.007	0.133	0.015	0.081	0.071
discrete change ($\bar{\Delta}$)	**-0.012**	0.021	**0.021**	0.050	**-0.163**	0.084

Lower Panel: Change in ELIGIBILITY, 18-20 year-old women

	WHITES		BLACKS		HISPANICS	
	Mean	Bootstrap Std. error	Mean	Bootstrap Std. error	Mean	Bootstrap Std. error
Annual predicted probability of 1st pregnancy if cannot legally drink	0.091	0.011	0.151	0.025	0.153	0.024
Annual predicted probability of 1st pregnancy if **CAN** legally drink	0.076	0.006	0.119	0.009	0.108	0.019
discrete change ($\bar{\Delta}$)	**-0.014**	0.015	**-0.032**	0.030	**-0.045**	0.040

[†] Indicates that the large underlying point estimate for a corresponding eligibility restriction is translated into a large change in the probability. The estimate is driven by a relatively small sample size and rare event occurrence.

Number of person-month observations 15-17 years old: whites 73608; blacks 37694; Hispanics 25285

Number of person-month observations 18-20 years old: whites 59695; blacks 25614; Hispanics 18347

Table 1.12
Discrete change in the predicted annual probability of a **first pregnancy that will end in birth**, by race and age

Upper Panel: Effect of a DECREASE in the drinking age, 15-17 year-old women

	WHITES		BLACKS		HISPANICS	
	Mean	Bootstrap Std. error	Mean	Bootstrap Std. error	Mean	Bootstrap Std. error
Annual predicted probability of 1st pregnancy if drinking age is 20 or 21	0.034	0.009	0.067	0.015	0.085	0.034
Annual predicted probability of 1st pregnancy if drinking age **is 18 or 19**	0.030	0.004	0.093	0.008	0.043	0.008
discrete change ($\bar{\Delta}$)	**-0.004**	0.012	**0.025**	0.021	**-0.041**	0.039

Middle Panel: Effect of a DECREASE in the drinking age, 18-20 year-old women

	WHITES		BLACKS		HISPANICS[†]	
	Mean	Bootstrap Std. error	Mean	Bootstrap Std. error	Mean	Bootstrap Std. error
Annual predicted probability of 1st pregnancy if drinking age is 20 or 21	0.040	0.010	0.092	0.040	0.169	0.080
Annual predicted probability of 1st pregnancy if drinking age **is 18 or 19**	0.063	0.009	0.109	0.014	0.063	0.025
discrete change ($\bar{\Delta}$)	**0.022**	0.018	**0.016**	0.052	**-0.107**	0.097

Lower Panel: Change in ELIGIBILITY, 18-20 year-old women

	WHITES		BLACKS		HISPANICS	
	Mean	Bootstrap Std. error	Mean	Bootstrap Std. error	Mean	Bootstrap Std. error
Annual predicted probability of 1st pregnancy if cannot legally drink	0.043	0.007	0.126	0.023	0.126	0.025
Annual predicted probability of 1st pregnancy if **CAN** legally drink	0.062	0.007	0.097	0.009	0.072	0.016
discrete change ($\bar{\Delta}$)	**0.018**	0.012	**-0.029**	0.028	**-0.053**	0.037

[†] Indicates that the large underlying point estimate for a corresponding eligibility restriction is translated into a large change in the probability. The estimate is driven by a relatively small sample size and rare event occurrence.

Number of person-month observations for 15-17 years old: whites 71143; blacks 37313; Hispanics 24476
Number of person-month observations for 18-20 years old: whites 58935; blacks 25575; Hispanics 17990

Table 1.13

Discrete change in the predicted annual probability of a **first pregnancy that will end in abortion**, by race and age

Upper Panel: Effect of a DECREASE in the drinking age, 15-17 year-old women

	WHITES		BLACKS		HISPANICS	
	Mean	Bootstrap Std. error	Mean	Bootstrap Std. error	Mean	Bootstrap Std. error
Annual predicted probability of 1st abortion if drinking age is 20 or 21	0.029	0.016	0.010	0.157	0.029	0.019
Annual predicted probability of 1st abortion if drinking age **is 18 or 19**	0.011	0.011	0.028	0.058	0.012	0.179
discrete change ($\overline{\Delta}$)	**-0.018**	0.021	**0.018**	0.179	**0.017**	0.189

Middle Panel: Effect of a DECREASE in the drinking age, 18-20 year-old women

	WHITES		BLACKS†		HISPANICS†	
	Mean	Bootstrap Std. error	Mean	Bootstrap Std. error	Mean	Bootstrap Std. error
Annual predicted probability of 1st abortion if drinking age is 20 or 21	0.038	0.015	0.004	0.063	0.184	0.215
Annual predicted probability of 1st abortion if drinking age **is 18 or 19**	0.015	0.003	0.135	0.050	0.014	0.082
discrete change ($\overline{\Delta}$)	**-0.023**	0.017	**0.131**	0.096	**-0.169**	0.252

Lower Panel: Change in ELIGIBILITY, 18-20 year-old women

	WHITES		BLACKS		HISPANICS	
	Mean	Bootstrap Std. error	Mean	Bootstrap Std. error	Mean	Bootstrap Std. error
Annual predicted probability of 1st abortion if cannot legally drink	0.035	0.009	0.021	0.028	0.035	0.030
Annual predicted probability of 1st abortion if **CAN** legally drink	0.015	0.003	0.027	0.032	0.020	0.144
discrete change ($\overline{\Delta}$)	**-0.021**	0.010	**0.006**	0.052	**-0.015**	0.161

† Indicates that the large underlying point estimate for a corresponding eligibility restriction is translated into a large change in the probability. The estimate is driven by a relatively small sample size and rare event occurrence.

Number of person-month observations for 15-17 years old: whites 64867; blacks 20277; Hispanics 13054

Number of person-month observations for 18-20 years old: whites 53040; blacks 11128; Hispanics 15247

Table 2.1
Summary statistics, 1982 – 1985

		Mean	Std. Dev.	Min	Max	Observations
DEPENDENT VARIABLES						
Had pregnancy in a given year	overall	0.130	0.336	0	1	N = 12035
	between		0.189	0	1	n = 3033
	within		0.279	-0.620	0.880	T-bar = 3.96802
Consumed alcohol in a given year	overall	0.639	0.480	0	1	N = 11680
	between		0.382	0	1	n = 3014
	within		0.294	-0.111	1.389	T-bar = 3.87525
INSTRUMENTS						
Legal drinking age is 21	overall	0.402	0.490	0	1	N = 12006
	between		0.441	0	1	n = 3033
	within		0.215	-0.348	1.152	T-bar = 3.95846
Cigarette tax per pack, in 2000 $	overall	0.271	0.101	0.032	0.448	N = 12006
	between		0.097	0.034	0.427	n = 3033
	within		0.029	-0.008	0.527	T-bar = 3.95846
Police expenditure per capita, in 2000 $	overall	23.433	27.363	2.609	458.886	N = 12006
	between		26.044	3.361	419.702	n = 3033
	within		8.265	-292.072	337.860	T-bar = 3.95846
Per capita distilled spirit consumption, gallons	overall	1.807	0.495	0.810	5.710	N = 12006
	between		0.472	0.863	5.405	n = 3033
	within		0.147	-0.670	4.827	T-bar = 3.95846
Legally eligible to drink	overall	0.903	0.296	0	1	N = 12035
	between		0.209	0	1	n = 3033
	within		0.211	0.153	1.653	T-bar = 3.96802
Per gallon beer tax, in $2000	overall	0.281	0.282	0.032	1.374	N = 12001
	between		0.275	0.033	1.313	n = 3032
	within		0.061	-0.620	1.212	T-bar = 3.95811
TIME VARIANT VARIABLES						
In poverty last year	overall	0.179	0.384	0	1	N = 10951
	between		0.306	0	1	n = 2990
	within		0.241	-0.571	0.929	T-bar = 3.66254
Woman was married last year	overall	0.340	0.474	0	1	N = 12035
	between		0.415	0	1	n = 3033
	within		0.230	-0.410	1.090	T-bar = 3.96802
In college	overall	0.193	0.395	0	1	N = 11660
	between		0.308	0	1	n = 3014
	within		0.245	-0.557	0.943	T-bar = 3.86861
Northeast	overall	0.184	0.388	0	1	N = 11628
	between		0.380	0	1	n = 3013
	within		0.085	-0.566	0.934	T-bar = 3.85928

Table 2.1 (Continued)

		Mean	Std. Dev.	Min	Max	Observations
North Central	overall	0.293	0.455	0	1	N = 11628
	between		0.444	0	1	n = 3013
	within		0.098	-0.457	1.043	T-bar = 3.85928
South	overall	0.357	0.479	0	1	N = 11628
	between		0.467	0	1	n = 3013
	within		0.108	-0.393	1.107	T-bar = 3.85928
West	overall	0.166	0.372	0	1	N = 11628
	between		0.363	0	1	n = 3013
	within		0.087	-0.584	0.916	T-bar = 3.85928
TIME INVARIANT VARIABLES						
Black	overall	0.130	0.336	0	1	N = 12035
	between		0.337	0	1	n = 3033
	within		0.000	0.130	0.130	T-bar = 3.96802
White	overall	0.798	0.402	0	1	N = 12035
	between		0.402	0	1	n = 3033
	within		0.000	0.798	0.798	T-bar = 3.96802
Hispanic	overall	0.072	0.259	0	1	N = 12035
	between		0.259	0	1	n = 3033
	within		0.000	0.072	0.072	T-bar = 3.96802
Raised as Atheist	overall	0.037	0.189	0	1	N = 12003
	between		0.189	0	1	n = 3025
	within		0.000	0.037	0.037	T-bar = 3.96793
Raised in a Baptist family	overall	0.241	0.428	0	1	N = 12003
	between		0.428	0	1	n = 3025
	within		0.000	0.241	0.241	T-bar = 3.96793
Raised in other religion	overall	0.391	0.488	0	1	N = 12003
	between		0.488	0	1	n = 3025
	within		0.000	0.391	0.391	T-bar = 3.96793
Raised in a Catholic family	overall	0.331	0.471	0	1	N = 12003
	between		0.471	0	1	n = 3025
	within		0.000	0.331	0.331	T-bar = 3.96793
AFQT score/ 10 000	overall	4.895	2.848	0	10	N = 11496
	between		2.849	0	10	n = 2897
	within		0.000	4.895	4.895	T-bar = 3.96824
Mother's education	overall	11.469	2.811	0	20	N = 11454
	between		2.817	0	20	n = 2887
	within		0.000	11.469	11.469	T-bar = 3.96744
Father's education	overall	11.710	3.591	0	20	N = 10791
	between		3.595	0	20	n = 2719
	within		0.000	11.710	11.710	T-bar = 3.96874
Two-parent household at age 14	overall	0.746	0.435	0	1	N = 12011
	between		0.436	0	1	n = 3027
	within		0.000	0.746	0.746	T-bar = 3.96796

Table 2.2
Differences in pregnancy rates among drinkers and non-drinkers

		Overall	By year			
			1982	1983	1984	1985
Pregnancy rate among drinkers	Mean	0.119	0.130	0.108	0.118	0.118
	(Std. error)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)
Pregnancy rate among non-drinkers	Mean	0.149	0.132	0.145	0.180	0.138
	(Std. error)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Difference	**Mean**	**0.030****	**0.002**	**0.037***	**0.062****	**0.019**
	(Std. error)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)

** significant at 1%; * significant at 5%; $^{+}$ significant at 10%

Table 2.3
The marginal effect of alcohol consumption on the probability of pregnancy among youth

Model	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
LPM	9152	-0.0070	0.0000	-0.0070	-0.0070
2SLS	9152	0.0515	0.0000	0.0515	0.0515
Probit	9152	-0.0064	0.0024	-0.0129	-0.0015
Biprobit	9152	0.0514	0.0213	0.0111	0.1080
2-points	9152	-0.0302	0.0110	-0.0601	-0.0072
3-points	9152	0.0253	0.0168	0.0023	0.1623
4-points	9152	0.0473	0.0296	0.0059	0.2918

Table 2.4
Likelihood ratio ‘Chi-square’ tests for various models

Panel A: Fit of the bivariate probit model

	Comparison	**LR test statistics**	**Critical value**	**Ho**
(1)	Biprobit vs. Probit	1.13	Chi-square (1, 95%) = 3.84	Fail to Reject
(2)	Biprobit vs. 2-points	16.44	Chi-square (2, 95%) = 5.99	Reject
(3)	Biprobit vs. 3-points	42.23	Chi-square (4, 95%) = 9.49	Reject
(4)	Biprobit vs. 4-points	61.99	Chi-square (6, 95%) = 12.59	Reject

Ho: restricted model is a true model

Panel B: Fit of the discrete distribution model

	Comparison	**LR test statistics**	**Critical value**	**Ho**
(1)	1-point vs. 2-points	31.13	Chi-square (3, 95%) = 7.81	Reject
(2)	2-points vs. 3-points	25.78	Chi-square (2, 95%) = 5.99	Reject
(3)	3-points vs. 4-points	19.77	Chi-square (2, 95%) = 5.99	Reject

Ho: model with the smaller number of points of support is a true model

Panel C: Log likelihood values

	Log likelihood
1-point (Probit)	-8456.702
Biprobit	-8456.049
2-points	-8447.827
3-points	-8434.936
4-points	-8425.053

Table 2.5
Effects of variables included in the 4-point discrete factor model

	Average Effect	Std. Dev.	Min	Max	Type of variable, mean	
Pregnancy equation						
Alcohol consumption	0.0473	0.0296	0.0059	0.2918	Endogenous	0.639
Black	-0.0310	0.0207	-0.1747	-0.0022	Binary	0.130
Hispanic	-0.0094	0.0064	-0.0574	-0.0002	Binary	0.072
Raised as Atheist	0.0125	0.0081	0.0003	0.0791	Binary	0.037
Raised in a Baptist family	-0.0037	0.0025	-0.0228	-0.0001	Binary	0.241
Raised in other religion	-0.0151	0.0101	-0.0924	-0.0007	Binary	0.391
Mother's education	0.0016	0.0011	0.0001	0.0092	Binary	11.469
Father's education	0.0012	0.0008	0.0001	0.0071	Binary	11.710
2 parent household at age 14	0.0217	0.0140	0.0012	0.1287	Binary	0.746
Poverty status last year	-0.0451	0.0262	-0.2440	-0.0041	Binary	0.193
Woman was married	-0.1127	0.0394	-0.4790	-0.0624	Binary	0.250
In college	0.0327	0.0192	0.0012	0.2017	Binary	0.250
Year 1983	0.0023	0.0015	0.0001	0.0143	Binary	0.250
Year 1984	-0.0003	0.0002	-0.0019	0.0000	Binary	0.293
Year 1985	0.0164	0.0107	0.0003	0.1032	Binary	0.357
North Central	-0.0236	0.0160	-0.1409	-0.0010	Binary	0.166
South	-0.0142	0.0095	-0.0865	-0.0003	Binary	0.130
West	-0.0312	0.0214	-0.1795	-0.0008	Binary	0.072
Drinking equation						
Black	0.1220	0.0253	0.0093	0.1459	Binary	0.130
Hispanic	0.1249	0.0273	0.0099	0.1511	Binary	0.072
Raised as Atheist	0.1225	0.0279	0.0097	0.1495	Binary	0.037
Raised in a Baptist family	0.0901	0.0184	0.0057	0.1076	Binary	0.241
Raised in other religion	0.0786	0.0185	0.0050	0.0977	Binary	0.391
Mother's education	-0.0095	0.0023	-0.0116	-0.0013	Binary	11.469
Father's education	-0.0064	0.0014	-0.0077	-0.0007	Binary	11.710
2-parent household at age 14	-0.0037	0.0008	-0.0045	-0.0002	Binary	0.746
Poverty status last year	0.0063	0.0015	0.0003	0.0078	Binary	0.193
Woman was married	0.1483	0.0286	0.0128	0.1751	Binary	0.250
In college	-0.0058	0.0013	-0.0071	-0.0002	Binary	0.250
Year 1983	0.0273	0.0063	0.0013	0.0337	Binary	0.250
Year 1984	0.0030	0.0007	0.0001	0.0037	Binary	0.293
Year 1985	0.0158	0.0037	0.0007	0.0196	Binary	0.357
North Central	-0.0197	0.0046	-0.0244	-0.0007	Binary	0.166
South	0.0823	0.0160	0.0021	0.0979	Binary	0.130
West	0.0151	0.0035	0.0007	0.0187	Binary	0.072

Table 2.5 (Continued)

	Average Effect	Std. Dev.	Min	Max	Type of variable, mean	
Legal drinking age is 21	0.0176	0.0041	0.0008	0.0218	Binary	0.402
Legally eligible to drink	-0.0281	0.0064	-0.0346	-0.0013	Binary	0.903
Beer tax	-0.0594	0.0138	-0.0736	-0.0024	Continuous	0.281
Cigarette tax	0.1649	0.0383	0.0067	0.2042	Continuous	0.271
Per capita police expenditure	0.0004	0.0001	0.0000	0.0005	Continuous	23.433
Per capita distilled spirit cons.	0.0742	0.0172	0.0030	0.0919	Continuous	1.807

For a binary variable Z in the drinking equation, the marginal effect =
Prob.[Drink=1|Z=1, X_1 X_2] – Prob. [Drink=1|Z=0, X_1 X_2]
For a continuous variable Z in the drinking equation, the marginal effect =
{(Prob.[Drink=1|Z=(z+0.5*std.deviation), X_1 X_2] – Prob. [Drink=1|Z=(z -0.5*std.deviation), X_1 X_2])/std.deviation} where z is a value of variable Z for a person *i*

Figure 1.1
Share of states by the minimum legal drinking age (DA) for beer, 1970-1990

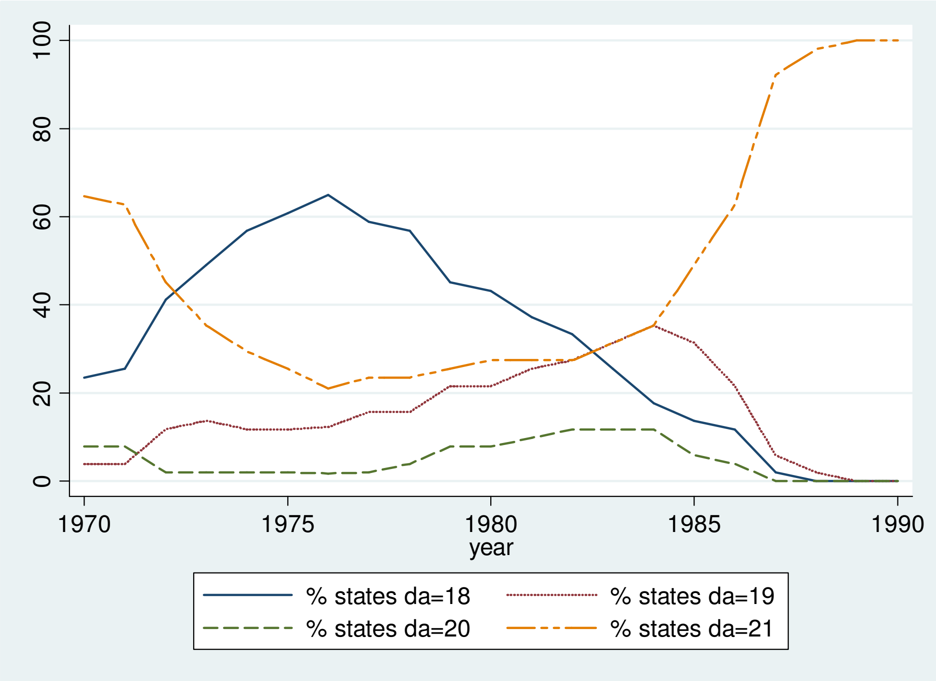
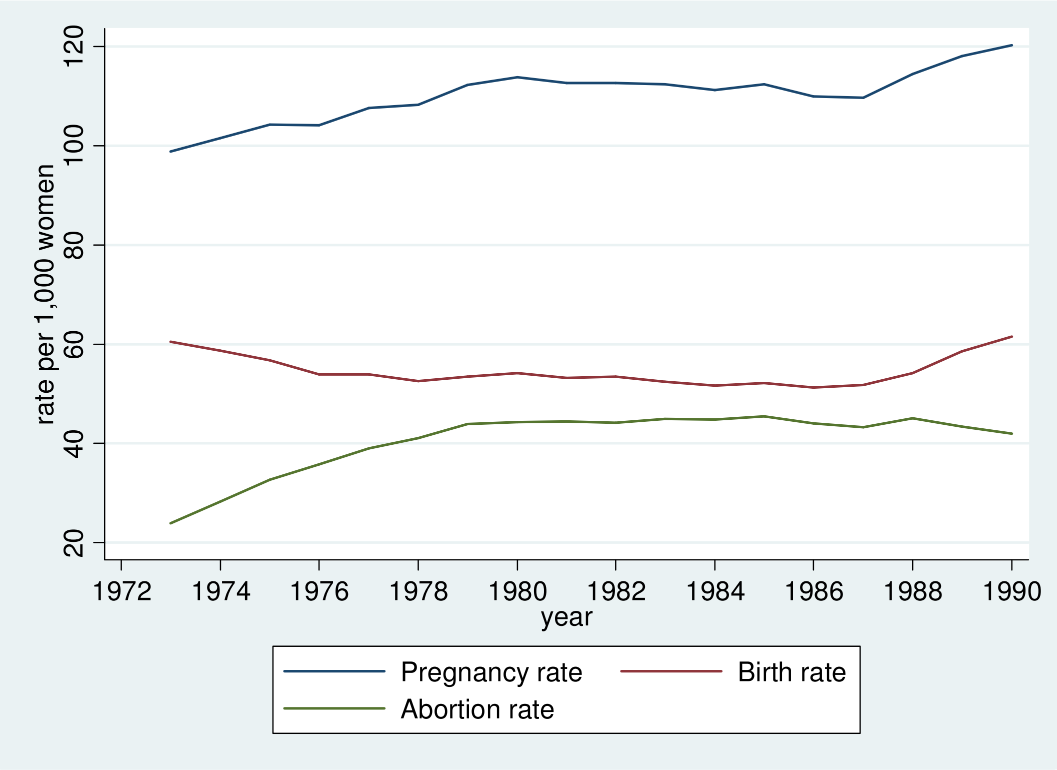


Figure 1.2
Fertility rates for women less than 20 years old, 1973-1988



APPENDICES

Appendix A

Difference-in-Difference estimates, control group women 20-24 years old (1974-1988)

Panel A

	Dependent variable:	**logarithm of PREGNANCY rate**			
		(1)	(2)	(3)	(4)
(1)	Teens (treatment group)	-0.620**	-0.620**	-0.607**	-2.275
		(0.03)	(0.03)	(0.04)	(2.11)
(2)	Drinking age 18 or 19	0.018	-0.043	-0.003	-0.009
		(0.04)	(0.03)	(0.02)	(0.03)
(3)	***Teens ×*** *(drinking age 18 or 19)*	***-0.003***	***-0.003***	***-0.012***	***-0.005***
		(0.04)	(0.04)	(0.04)	(0.05)
(4)	Medicaid funding restrictions			0.012	0.012
				(0.02)	(0.02)
(5)	Enforced parental consent and notification			-0.095	-0.09
				(0.08)	(0.07)
(6)	Log real personal income, 2000$			0.529**	0.454*
				(0.16)	(0.17)
(7)	Log real max AFDC, in 2000 $			0.109*	0.107*
				(0.04)	(0.04)
(8)	Unemployment rate			-0.014*	-0.022**
				(0.01)	(0.01)
(9)	Percent of black population			0.010^{+}	0.011^{+}
				(0.01)	(0.01)
(10)	Log predicted abortion providers			0.082	0.073
				(0.12)	(0.12)
(11)	Log state beer tax, In 2000 dollars			0.002	0.002
				(0.05)	(0.05)
(12)	# of unrestricted border states for parental consent			-0.001	0.006
				(0.01)	(0.02)
(13)	# of unrestricted border states for alcohol			-0.002	-0.004
				(0.01)	(0.01)
(14)	Teens × (Unemployment rate)				0.016^{+}
					(0.01)
(15)	Teens × (Income)				0.156
					(0.21)
(16)	Constant	5.014**	4.700**	-1.045	-0.23
		(0.03)	(0.03)	(1.67)	(1.64)
(17)	State, year fixed effects	no	yes	yes	yes
(18)	R square	0.67	0.92	0.93	0.94
(19)	Number of observations	1144	1144	1120	1120

Standard errors clustered by state are in parentheses. I use the F-test to test model (4) v. (1) and reject the null. ** significant at 1%; * significant at 5%; + significant at 10%

Appendix A (Continued)

Panel B

	Dependent variable:	**logarithm of BIRTH rate**[53]			
		(5)	(6)	(7)	(8)
(1)	Teens (treatment group)	-0.819**	-0.819**	-0.825**	-1.056**
		(0.03)	(0.03)	(0.05)	(0.12)
(2)	Drinking age 18 or 19	0.025	-0.014	0.005	0.004
		(0.04)	(0.03)	(0.02)	(0.02)
(3)	***Teens ×***	***0.012***	***0.012***	***-0.016***	***-0.015***
	(drinking age 18 or 19)	(0.04)	(0.04)	(0.05)	(0.04)
(4)	Medicaid funding restrictions			-0.004	-0.004
				(0.01)	(0.01)
(5)	Enforced parental consent and notification			-0.093	-0.082
				(0.06)	(0.06)
(6)	Log real personal income, 2000$			0.278*	0.281*
				(0.12)	(0.12)
(7)	Log real max AFDC, in 2000 $			0.105*	0.105*
				(0.05)	(0.05)
(8)	Unemployment rate			-0.013**	-0.024**
				(0.00)	(0.01)
(9)	Percent of black population			-0.007	-0.007
				(0.01)	(0.01)
(10)	Log predicted abortion providers			-0.001	-0.021
				(0.05)	(0.05)
(11)	Log state beer tax, In 2000 dollars			-0.022	-0.021
				(0.05)	(0.05)
(12)	# of unrestricted border states for parental consent			0.017	0.000
				(0.02)	(0.00)
(13)	# of unrestricted border states for alcohol			-0.012	0.006
				(0.01)	(0.03)
(14)	Teens ×				0.020*
	(Unemployment rate)				(0.01)
(15)	Teens ×				0.024
	(Providers)				(0.02)
(16)	Teens ×				-0.019
	(Unrestricted for alcohol)				(0.03)
(17)	Teens ×				0.021
	(Unrestricted for consent)				(0.02)
(18)	Constant	4.730**	4.985**	1.875	1.984^{+}
		(0.03)	(0.02)	(1.17)	(1.14)
(19)	State, year fixed effects	no	yes	yes	yes
(20)	R square	0.74	0.94	0.94	0.95
(21)	Number of observations	1530	1530	1506	1506

Standard errors clustered by state are in parentheses. I use the F-test to test model (8) v. (5) and reject the null. ** significant at 1%; * significant at 5%; + significant at 10%

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[53] For each age group g, birth rate in a given year t and state s reflects the number of births conceived in that year and is calculated as: (1/4 Births$_{gst}$ + Births$_{gst+1}$)/(female population$_{gst}$). For discussion see Section "Analysis of aggregate data: Difference-in-Difference model".

Appendix A (Continued)

Panel C

	Dependent variable	logarithm of ABORTION rate			
		(9)	(10)	(11)	(12)
(1)	Teens (treatment group)	-0.145** (0.02)	-0.145** (0.02)	-0.125** (0.03)	-0.126** (0.03)
(2)	Drinking age 18 or 19	-0.097 (0.14)	-0.049 (0.05)	0.011 (0.04)	0.011 (0.04)
(3)	***Teens ×*** *(drinking age 18 or 19)*	***0.01*** (0.03)	***0.01*** (0.03)	***0.035*** (0.02)	***0.034*** (0.02)
(4)	Medicaid funding restrictions			0.121^{+} (0.07)	0.121^{+} (0.07)
(5)	Enforced parental consent and notification			-0.016 (0.05)	-0.016 (0.05)
(6)	Log real personal income, 2000$			1.169* (0.53)	1.168* (0.53)
(7)	Log real max AFDC, in 2000 $			0.663^{+} (0.36)	0.663^{+} (0.36)
(8)	Unemployment rate			0.03 (0.03)	0.03 (0.03)
(9)	Percent of black population			-0.053 (0.06)	-0.054 (0.06)
(10)	Log predicted abortion providers			1.023** (0.35)	1.023** (0.35)
(11)	Log state beer tax, In 2000 dollars			0.053 (0.10)	0.053 (0.10)
(12)	# of unrestricted border states for parental consent			-0.02 (0.02)	-0.02 (0.02)
(13)	# of unrestricted border states for alcohol			0.01 (0.01)	0.01 (0.01)
(14)	Teens × (Black)				0.000 (0.00)
(15)	Constant	3.462** (0.09)	1.087** (0.07)	-10.246 (7.86)	-10.241 (7.86)
(16)	State, year fixed effects	no	yes	yes	yes
(17)	R square	0.02	0.86	0.88	0.88
(18)	Number of observations	1144	1144	1120	1120

Standard errors clustered by state are in parentheses. I use the F-test to test model (12) v. (9) and reject the null.

** significant at 1%; * significant at 5%; + significant at 10%

Appendix B

Difference-in-Difference estimates, control group women 25-29 years old (1974-1988)

Dependent variable: **logarithm of PREGNANCY rate**[54]

		(1)	(2)	(3)	(4)
(1)	Teens (treatment group)	-0.528** (0.04)	-0.528** (0.04)	-0.502** (0.06)	-0.605 (2.83)
(2)	Drinking age 18 or 19	0.004 (0.03)	-0.047 (0.04)	0.002 (0.03)	-0.002 (0.03)
(3)	***Teens × da_18or19***	***0.008*** (0.06)	***0.008*** (0.06)	***-0.017*** (0.06)	***-0.038*** (0.06)
(4)	Medicaid funding restrictions			0.01 (0.02)	0.01 (0.02)
(5)	Enforced parental consent and notification			-0.166^{+} (0.09)	-0.160* (0.08)
(6)	Log real personal income, 2000$			0.524** (0.17)	0.517* (0.21)
(7)	Log real max AFDC, in 2000 $			0.100* (0.04)	0.097* (0.04)
(8)	Unemployment rate			-0.014* (0.01)	-0.028** (0.01)
(9)	Percent of black population			0.013* (0.01)	0.013* (0.01)
(10)	Log predicted abortion providers			0.068 (0.14)	0.046 (0.14)
(11)	Log state beer tax, In 2000 dollars			-0.024 (0.05)	-0.024 (0.05)
(12)	# of unrestricted border states for parental consent			0.006 (0.02)	0.032 (0.03)
(13)	# of unrestricted border states for alcohol			-0.003 (0.02)	-0.018 (0.01)
(14)	Teens × (Unemployment rate)				0.026* (0.01)
(15)	Teens × (Unrestricted for consent)				-0.022 (0.02)
(16)	Teens × Income				-0.001 (0.28)
(17)	Constant	4.921** (0.02)	4.774** (0.04)	-1.392 (1.60)	-1.167 (1.91)
(18)	State, year fixed effects	no	yes	yes	yes
(19)	R square	0.62	0.83	0.85	0.86
(20)	Number of observations	1144	1144	1120	1120

Standard errors clustered by state are in parentheses. I use the F-test to test model (4) v. (1) and reject the null. ** significant at 1%; * significant at 5%; + significant at 10%

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[54] Number of pregnancies is calculated using the following formula:
$\text{Pregnancies}_{gst} = \text{Births}_{gst+1} + \text{Fetal deaths}_{gst} + \text{Abortions}_{gst}$

Appendix C

Data sources and description of variables used in the Difference-in-Difference estimation

Variable	Data source:
Dependent variables	
Number of abortions by age group	Centers for Disease Control and Prevention
Number of births by age group	National Center for Health Statistics
Number of fetal deaths by age group	National Center for Health Statistics
State socio-economic characteristics	
Percent of black population	U.S. Census Bureau
State per capita personal income	Bureau of Economic Analysis
State unemployment rate	Bureau of Labor Statistics
Policy variables	
Minimum legal drinking age	Wagenaar (1981), O'Malley and Wagenaar (1990), and the National Highway Traffic Safety Administration website
Beer tax rate per gallon	Brewers Almanac, 1996, Beer Institute, Washington, DC
Maximum AFDC benefit level for a family of four	Welfare Benefit Data Base; Retrieved from Robert A. Moffitt's webpage on 08/04/2009: http://www.econ.jhu.edu/people/moffitt/datasets.html
Enforced parental consent and notification laws for minor seeking abortion	Merz (1995), Haas-Wilson (1996), Greenberger and Connor (1992), New (2004), and NARAL website For 15-19 year-old women: Variables range from 0 to 1, where 0 indicates no restrictions and 1 indicates a presence of the restrictive law. Values between 0 and 1 reflect changes that occurred during the calendar year (e.g., 0.25 tells us that a change from non-restrictive to restrictive policy happened in the forth quarter of the year implying non restrictive policy for the most of the year). For 25-29 and 20-24 year-old women: Values are set to zero.

Appendix C (Continued)

Variable	**Data source:**
Number of unrestricted border states for consent	Author's calculation For 15-19 year-old women: For each state *s*, this variable equals the number of border states that do not enforce a parental notification and consent law. For 25-29 and 20-24 year-old women: For each state *s*, this variable equals the number of border states as this restriction does not affect women who are 18 and older.
Medicaid funding restrictions for abortion	Blank et al. (1996), New (2004), and NARAL website Variables range from 0 to 1, where 0 indicates no restrictions and 1 indicates a presence of the restrictive law. Values between 0 and 1 reflect changes that occurred during the calendar year (e.g., 0.25 tells us that a change from non-restrictive to restrictive policy happened in the forth quarter of the year implying non restrictive policy for the most of the year).
Number of unrestricted border states for beer	Author's calculation For 15-19 year-old women: For each state *s*, this variable equals the number of border states that have a lower legal drinking age than state *s*. For 25-29 and 20-24 year-old women: For each state *s*, this variable equals the number of border states.
Number of abortion providers	The Alan Guttmacher Institute
Number of non-Ob/Gyn physicians	Blank et al. (1996) Calculated as a difference between the total number of physicians and Ob/Gyn physicians in a given state.
Other variables	
Consumer price index, base year 2000	Bureau of Labor Statistics
Female population by state and age groups	US Census Bureau

Appendix D

Difference-in-Difference estimates from the model that includes an alternative measure of border effects

Panel A

	Dependent variable:	**logarithm of PREGNANCY rate**			
		(1)	(2)	(3)	(4)
(1)	Teens (treatment group)	-0.523**	-0.523**	-0.487**	-0.927
		(0.04)	(0.04)	(0.03)	(2.95)
(2)	Drinking age 18 or 19	0.004	-0.047	-0.003	-0.004
		(0.03)	(0.04)	(0.03)	(0.03)
(3)	***Teens ×***	***0.011***	***0.011***	***-0.012***	***-0.013***
	(drinking age 18 or 19)	(0.06)	(0.06)	(0.05)	(0.06)
(4)	Constant	4.918**	4.773**	-0.842	-0.283
		(0.02)	(0.03)	(1.31)	(1.91)
(5)	State characteristics	no	no	yes	yes
(6)	Interaction terms	no	no	no	yes
(7)	State, year fixed effects	no	no	yes	yes
(8)	Number of observations	1144	1144	1120	1120
(9)	R square	0.61	0.83	0.85	0.86

Interaction terms included in (4) are (Teen × Income), (Teens × Unemployment rate), and (Teens × Border effect of parental involvement law).

Appendix D (Continued)

Panel B

	Dependent variable:	**logarithm of BIRTH rate**			
		(5)	(6)	(7)	(8)
(1)	Teens (treatment group)	-0.833**	-0.833**	-0.809**	-1.001**
		(0.05)	(0.05)	(0.05)	(0.14)
(2)	Drinking age 18 or 19	-0.013	-0.041	-0.015	0.003
		(0.03)	(0.04)	(0.04)	(0.03)
(3)	***Teens ×***	***0.05***	***0.05***	***0.035***	***-0.001***
	(drinking age 18 or 19)	(0.06)	(0.06)	(0.06)	(0.05)
(4)	Constant	4.745**	4.913**	2.381^{+}	2.467^{+}
		(0.02)	(0.03)	(1.35)	(1.36)
(5)	State characteristics	no	no	yes	yes
(6)	Interaction terms	no	no	no	yes
(7)	State, year fixed effects	no	no	yes	yes
(8)	Number of observations	1530	1530	1506	1506
(9)	R square	0.77	0.87	0.87	0.88

Interaction terms included in (8) are (Teen × Providers), (Teens × Unemployment rate), and (Teens × Border effect of legal drinking age).

Panel C

	Dependent variable:	**logarithm of ABORTION rate**			
		(9)	(10)	(11)	(12)
(1)	Teens (treatment group)	0.405**	0.405**	0.422**	0.612**
		(0.03)	(0.03)	(0.03)	(0.06)
(2)	Drinking age 18 or 19	-0.109	-0.051	-0.001	-0.006
		(0.14)	(0.05)	(0.06)	(0.05)
(3)	***Teens ×***	***0.022***	***0.022***	***0.023***	***0.033***
	(drinking age 18 or 19)	(0.04)	(0.04)	(0.04)	(0.03)
(4)	Constant	2.912**	0.506**	-9.31	-9.472
		(0.09)	(0.07)	(7.96)	(7.95)
(5)	State characteristics	no	no	yes	yes
(6)	Interaction terms	no	no	no	yes
(7)	State, year fixed effects	no	no	yes	yes
(8)	Number of observations	1144	1144	1120	1120
(9)	R square	0.1	0.86	0.89	0.89

Interaction terms included in (12) are (Teen × Percent of Black population) and (Teens × Unemployment rate).

Appendix E

First stage regression

Dependent variable: natural logarithm of abortion providers		
	Coefficient	Std. error
Log non-Ob/Gyn physicians (instrument)	0.390	(0.07) **
Medicaid funding restrictions for abortions	-0.019	(0.02)
Enforced parental consent and notification laws	-0.019	(0.02)
Border effect of enforced parental involvement laws	0.001	(0.00) **
Governor/senate/house are Republicans	0.075	(0.02) **
Marriage rate per 1,000 females	0.000	(0.00)
Percent of teen female in fertile population	0.025	(0.01) **
Percent of black population	-0.018	(0.01) **
Female labor force participation rate	0.016	(0.00) **
Log real personal disposable income, 2000$	0.103	(0.11)
Unemployment rate in a state	-0.022	(0.00) **
Population density	0.001	(0.00) **
State and year fixed effects	yes	
Number of observations	2295	
R square	0.9794	

** significant at 1%; * significant at 5%; $^{+}$ significant at 10%
Number of non-Ob/Gyn physicians is an instrument for abortion providers.

Appendix F

Constructing dataset: arranging and reshaping NLSY data into a panel with a unit of observation being person-month

The NLSY79 is a nationally representative sample of 12,686 young men and women who were 14-22 years old when they were first surveyed in 1979. I limited my sample to women only: 6283 observations.

The NLSY provides detailed retrospective fertility histories (i.e., dates (month/year) and outcomes of each pregnancy) and mobility histories (dates (month/year) of moves and location (state, county) of residence).

1) Identifying first pregnancy

Month, year when the first pregnancy began and the outcome of the first pregnancy are reported in the NLSY public use dataset.

2) Identifying locations at different points in time

- Location of the individual is reported in the NLSY GEOCODE data.
- Month and year of each move are reported in the public use dataset.
- Month and year of birth as well as interview dates are reported in the public use dataset.

Available information allows one to identify only locations in a certain points in time: location of the birth place, location at age 14, location on the date of the interview, location of the most recent residence prior to the current residence, etc. All dates were assigned corresponding locations. Once the sequence of dates with corresponding locations was established, it was assumed that this woman stayed in this location until the new information is available.

3) Merging fertility and mobility histories

For each of 6283 observations additional entries were created such that the first entry for each observation would correspond to the date of birth (month/year); the second entry – the date of birth plus 1; the third entry – the date of birth plus two, etc. This expansion converted dataset into a person-month panel.

Each month/year combination was assigned a unique value. This unique value and the unique individual identification number were used to merge fertility, mobility, and policy variables in one dataset.

Additionally, the following restrictions were applied to the dataset (in the sequential order):

- Women for whom I could not identify mobility history were excluded (15 observations);

- Women with incomplete fertility history were excluded (119 observations excluded);
- Women who participated in 1979 interview but have missing values for all interviews between 1980 and1988 were excluded (3 observations);
- Women serving in the military were excluded (443 observations);
- Women in the poor white oversample were excluded (879 observations);
- Women who had the first pregnancy before their 15th birthday were excluded (134 observations).

The final sample includes 337,680 person-month observations on 4,690 women.

Appendix G

Comparison of probit coefficient estimates for pregnancy, birth, and abortion models

Panel A: Probit coefficient estimates for pregnancy, birth, and abortion models; 15-17 year-old women (Specification 1)

Dependent variable in **pregnancy model**: pregnancy status that equals 1 if pregnant, 0 otherwise
Dependent variable in **birth model**: equals 1 if 1st time pregnant and that pregnancy ended in birth, 0 otherwise
Dependent variable in **abortion model**: equals 1 if 1st time pregnant and that pregnancy ended in abortion, 0 otherwise

		Pregnancy model		***Birth model***		***Abortion model***	
		Whites	*Whites and poor whites oversample*	*Whites*	*Whites and poor whites oversample*	*Whites*	*Whites and poor whites oversample*
(1)	***Drinking age***	***-0.101***	***-0.177***	***-0.046***	***-0.218***	-0.311**	***-0.330****
	18 or 19	(0.11)	(0.11)	***(0.12)***	(0.14)	(0.09)	*(0.09)*
(2)	Raised in	0.252*	0.182**	0.248**	0.178*	0.189	0.132
	Baptist family	(0.08)	(0.07)	(0.08)	(0.07)	(0.12)	(0.11)
(3)	Raised in other	0.086	0.067	0.034	0.037	0.152*	0.102^{+}
	Religion	(0.06)	(0.04)	(0.07)	(0.05)	(0.07)	(0.06)
(4)	Raised as	0.217*	0.229**	0.187^{+}	0.135*	0.213	0.126
	Atheist	(0.08)	(0.06)	(0.11)	(0.06)	(0.14)	(0.12)
(5)	AFQT score	0.211*	0.254**	0.296**	0.262**	0.025	0.037
	below mean	(0.05)	(0.04)	(0.07)	(0.07)	(0.07)	(0.06)
(6)	Mother's	-0.047**	-0.037**	-0.05**	-0.044**	-0.028*	-0.013
	education	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
(7)	Both parents are in the	-0.135*	-0.142**	-0.174**	-0.170**	-0.019	-0.027
	Household at age 14	(0.05)	(0.04)	(0.06)	(0.05)	(0.07)	(0.05)
(8)	Constant	-2.431*	-2.551**	-2.327**	-2.461**	-2.699**	-6.607
		(0.20)	(0.21)	(0.34)	(0.25)	(0.32)	(0.00)
	# of observations	73608	98354	71143	95817	64867	91444

** significant at 1%; * significant at 5%; + significant at 10%. Standard errors clustered by state. Person-month observations. All models include state and calendar time effects as well as age cubic polynomial. Excluded category for religion is women raised in Catholic families. Cells highlighted in orange are from Table 1.7

Appendix G (Continued)

Panel B: Probit coefficient estimates for pregnancy, birth, and abortion models, 18-20 year-old women (Specification 2)

Dependent variable in **pregnancy model**: pregnancy status that equals 1 if pregnant, 0 otherwise
Dependent variable in **birth model**: equals 1 if 1st time pregnant and that pregnancy ended in birth, 0 otherwise
Dependent variable in **abortion model**: equals 1 if 1st time pregnant and that pregnancy ended in abortion, 0 otherwise

	Pregnancy model		***Birth model***		***Abortion model***	
	Whites	*Whites and poor whites oversample*	*Whites*	*Whites and poor whites oversample*	*Whites*	*Whites and poor whites oversample*
(1) Drinking age	***-0.056***	***0.051***	***0.167$^+$***	***0.216*****	***-0.303$^+$***	***-0.173***
18 or 19	(0.08)	(0.06)	*(0.10)*	(0.08)	(0.18)	(0.15)
(2) Raised in	0.105$^+$	0.113*	0.159**	0.179**	-0.031	0.027
Baptist family	(0.05)	(0.05)	(0.04)	(0.05)	(0.13)	(0.11)
(3) Raised in other	-0.007	0.005	-0.028	0.013	0.027	0.025
Religion	(0.04)	(0.04)	(0.04)	(0.04)	(0.07)	(0.06)
(4) Raised as	0.038	0.169**	-0.022	0.189$^+$	0.108	0.195$^+$
Atheist	(0.07)	(0.06)	(0.14)	(0.11)	(0.11)	(0.10)
(5) AFQT score	0.173*	0.195**	0.251**	0.281**	-0.098	-0.175**
below mean	(0.04)	(0.04)	(0.05)	(0.04)	(0.08)	(0.06)
(6) Mother's	-0.045**	-0.036**	-0.062**	-0.047**	0.001	0.002
education	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)
(7) Both parents are in the	-0.177*	-0.181**	-0.172**	-0.203**	-0.23**	-0.169**
household at age 14	(0.03)	(0.03)	(0.04)	(0.03)	(0.07)	(0.06)
(8) Constant	-5.358$^+$	-5.936**	-2.066**	-4.393$^+$	-2.758**	-12.096*
	(2.52)	(2.19)	(0.23)	(2.55)	(0.40)	(5.86)
# of observations	59695	78396	59695	78285	53040	71769

** significant at 1%; * significant at 5%; + significant at 10%. Standard errors clustered by state. Person-month observations. All models include state and calendar time effects as well as age cubic polynomial. Excluded category for religion is women raised in Catholic families. Cells highlighted in orange are from Table 1.8.

Appendix G (Continued)

Panel C: Probit coefficient estimates for pregnancy, birth, and abortion models, 18-20 year-old women (Specification 3)

Dependent variable in **pregnancy model**: pregnancy status that equals 1 if pregnant, 0 otherwise
Dependent variable in **birth model**: equals 1 if 1st time pregnant and that pregnancy ended in birth, 0 otherwise
Dependent variable in **abortion model**: equals 1 if 1st time pregnant and that pregnancy ended in abortion, 0 otherwise

		Pregnancy model		***Birth model***		***Abortion model***	
		Whites	*Whites and poor whites oversample*	*Whites*	*Whites and poor whites oversample*	*Whites*	*Whites and poor whites oversample*
(1)	***Legally eligible***	***-0.067***	***-0.012***	***0.132^{+}***	***0.111***	***-0.293****	***-0.195^{+}***
	to drink	(0.04)	(0.05)	(0.07)	(0.07)	(0.12)	(0.10)
(2)	Raised in	0.106^{+}	0.113*	0.157**	0.177**	-0.031	0.027
	Baptist family	(0.05)	(0.05)	(0.04)	(0.05)	(0.13)	(0.11)
(3)	Raised in other	-0.006	0.005	-0.029	0.011	0.025	0.025
	Religion	(0.04)	(0.04)	(0.04)	(0.04)	(0.06)	(0.06)
(4)	Raised as	0.038	0.169**	-0.02	0.189^{+}	0.101	0.192^{+}
	Atheist	(0.07)	(0.06)	(0.14)	(0.11)	(0.11)	(0.10)
(5)	AFQT score	0.173*	0.194**	0.251**	0.280**	-0.098	-0.175**
	below mean	(0.04)	(0.04)	(0.05)	(0.04)	(0.08)	(0.06)
(6)	Mother's	-0.044**	-0.036**	-0.062**	-0.047**	0.002	0.003
	education	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)
(7)	Both parents are in the	-0.178*	-0.18**	-0.171**	-0.200**	-0.234**	-0.172**
	Household at age 14	(0.03)	(0.03)	-0.04	(0.03)	(0.07)	(0.06)
(8)	Constant	-5.242^{+}	-5.841**	-2.159**	-4.431^{+}	-2.90**	-11.706^{+}
		(2.53)	(2.21)	(0.15)	(2.57)	(0.40)	(5.98)
	# of observations	59695	78396	58935	78285	53040	71769

** significant at 1%; * significant at 5%; + significant at 10%. Standard errors clustered by state. Person-month observations. All models include state and calendar time effects as well as age cubic polynomial. Excluded category for religion is women raised in Catholic families. Cells highlighted in orange are from Table 1.9

Appendix H

Composition of first pregnancies and pregnancy outcomes aggregated by years of age and race

Panel A

Age in years	Females at risk	Had 1st pregnancy	1st pregnancies by race		
			Whites	Blacks	Hispanics
15	4690	222	71	109	42
16	4468	328	109	143	76
17	4140	353	139	140	74
18	3787	406	189	121	96
19	3381	389	162	132	95
20	2992	274	123	92	59

Panel B

Age in years	Females at risk	Had 1st pregnancy ending in births	1st pregnancies ending in births by race		
			White	Blacks	Hispanics
15	4690	175	46	94	35
16	4468	260	76	124	60
17	4140	265	92	109	64
18	3787	296	118	102	76
19	3381	293	109	111	73
20	2992	187	79	69	39

Panel C

Age in years	Females at risk	Had 1st pregnancy ending in an abortion	1st pregnancies ending in abortions by race		
			White	Blacks	Hispanics
15	4690	36	22	10	4
16	4468	48	25	11	12
17	4140	63	37	20	6
18	3787	64	48	8	8
19	3381	61	34	11	16
20	2992	43	21	10	12

Appendix I

Likelihood ratio tests for additionally considered variables, 15-17 and 18-20 year-old women

Panel A: Likelihood ratio tests for additional variables considered for **pregnancy model**
Dependent variable in **pregnancy model**: pregnancy status that equals 1 if pregnant, 0 otherwise

Additional	*15-17*			*18-20*			*18-20*		
variables considered	*Specification 1*			*Specification 2*			*Specification 3*		
	Whites	*Blacks*	*Hispanics*	*Whites*	*Blacks*	*Hispanics*	*Whites*	*Blacks*	*Hispanics*
Presence of older siblings	Fail to reject Ho	Fail to reject Ho	Fail to reject Ho	Fail to reject Ho	Fail to reject Ho	Fail to reject Ho	Fail to reject Ho	Fail to reject Ho	Fail to reject Ho
Enforced parental notification/consent law	Reject Ho	-	-	Fail to reject Ho	Fail to reject Ho	Fail to reject Ho	Fail to reject Ho	Fail to reject Ho	Fail to reject Ho
Marital status	Reject Ho	Reject Ho	-	Reject Ho	-	Reject Ho	Reject Ho	-	Reject Ho
Father's education	Fail to reject Ho	Fail to reject Ho	Reject Ho	Reject Ho	Fail to reject Ho	Fail to reject Ho	Reject Ho	Fail to reject Ho	Fail to reject Ho
Contraception use before 1st pregnancy	Reject Ho	Reject Ho	Reject Ho	Fail to reject Ho	Fail to reject Ho	Fail to reject Ho	Fail to reject Ho	Fail to reject Ho	Fail to reject Ho
AFQT below mean × (Drinking age 18 or 19)	Fail to reject Ho	Reject Ho	Fail to reject Ho	Reject Ho	Fail to reject Ho	Fail to reject Ho	Reject Ho	Fail to reject Ho	Fail to reject Ho

The null hypothesis: restricted model is nested in the full model. Empty cells indicate that the variable of interest was dropped from the analysis due to collinearity. Marital status is defined as currently married, previously married, or never married (omitted category).
All specifications include state, year and month fixed effects, cubic polynomial for age, religion in which one was raised, AFQT score below mean, two-parent household at age 14, and mother's education. Excluded category for religion is women raised in Catholic families. Additionally, Specifications 1 and 2 include a dummy indicating whether the legal drinking age in the state is set to 18 or 19; Specification 3 – a dummy indicating whether a woman is legally eligible to drink.

Appendix I (Continued)

Panel B: Likelihood ratio tests for additional variables considered for **birth model**
Dependent variable in **birth model**: equals 1 if 1st time pregnant and that pregnancy ended in birth, 0 otherwise

Additional variables considered	***15-17***			***18-20***			***18-20***		
	Specification 1			***Specification 2***			***Specification 3***		
	Whites	*Blacks*	*Hispanics*	*Whites*	*Blacks*	*Hispanics*	*Whites*	*Blacks*	*Hispanics*
Presence of older siblings	Fail to reject Ho	Fail to reject Ho	Fail to reject Ho	Fail to reject Ho	Fail to reject Ho	Fail to reject Ho	Fail to reject Ho	Fail to reject Ho	Fail to reject Ho
Enforced parental notification/consent law	Fail to reject Ho	-	-	Fail to reject Ho	-	Fail to reject Ho	Fail to reject Ho	-	Fail to reject Ho
Marital status	Reject Ho	Reject Ho	-	Reject Ho	-	Reject Ho	Reject Ho	-	Reject Ho
Father's education	Reject Ho	Reject Ho	Fail to reject Ho	Reject Ho	Fail to reject Ho	Fail to reject Ho	Reject Ho	Fail to reject Ho	Fail to reject Ho
Contraception use before 1st pregnancy	Reject Ho	Reject Ho	Reject Ho	Fail to reject Ho	Fail to reject Ho	Reject Ho	Fail to reject Ho	Fail to reject Ho	Reject Ho
AFQT below mean × (Drinking age 18 or 19)	Fail to reject Ho	Fail to reject Ho	Fail to reject Ho	Fail to reject Ho	Fail to reject Ho	Fail to reject Ho	Fail to reject Ho	Fail to reject Ho	Fail to reject Ho

The null hypothesis: restricted model is nested in the full model. Empty cells indicate that the variable of interest was dropped from the analysis due to collinearity. Marital status is defined as currently married, previously married, or never married (omitted category).
All specifications include state, year and month fixed effects, cubic polynomial for age, religion in which one was raised, AFQT score below mean, two-parent household at age 14, and mother's education. Excluded category for religion is women raised in Catholic families. Additionally, Specifications 1 and 2 include a dummy indicating whether the legal drinking age in the state is set to 18 or 19; Specification 3 – a dummy indicating whether a woman is legally eligible to drink.

Appendix I (Continued)

Panel C: Likelihood ratio tests for additional variables considered for **abortion model**
Dependent variable in **abortion model**: equals 1 if 1^{st} time pregnant and that pregnancy ended in abortion, 0 otherwise

Additional variables considered	***15-17***			***18-20***			***18-20***		
	Specification 1			***Specification 2***			***Specification 3***		
	Whites	*Blacks*	*Hispanics*	*Whites*	*Blacks*	*Hispanics*	*Whites*	*Blacks*	*Hispanics*
Presence of older siblings	Fail to reject Ho	Fail to reject Ho	Reject Ho	Fail to reject Ho	Fail to reject Ho	Fail to reject Ho	Fail to reject Ho	Fail to reject Ho	Fail to reject Ho
Enforced parental notification/consent law	Fail to reject Ho	-	-	Fail to reject Ho	-	Fail to reject Ho	Fail to reject Ho	-	Fail to reject Ho
Marital status	-	-	-	-	-	Fail to reject Ho	-	-	Fail to reject Ho
Father's education (years)	Fail to reject Ho	Fail to reject Ho	Fail to reject Ho	Fail to reject Ho	Fail to reject Ho	Fail to reject Ho	Fail to reject Ho	Fail to reject Ho	Fail to reject Ho
Contraception use before 1^{st} pregnancy	Reject Ho	Fail to reject Ho	Fail to reject Ho	Fail to reject Ho	Reject Ho	Reject Ho	Fail to reject Ho	Reject Ho	Reject Ho
AFQT below mean × (Drinking age 18 or 19)	Fail to reject Ho	Fail to reject Ho	Fail to reject Ho	Fail to reject Ho	-	Fail to reject Ho	Fail to reject Ho	-	Fail to reject Ho

The null hypothesis: restricted model is nested in the full model. Empty cells indicate that the variable of interest was dropped from the analysis due to collinearity. Marital status is defined as currently married, previously married, or never married (omitted category).
All specifications include state, year and month fixed effects, cubic polynomial for age, religion in which one was raised, AFQT score below mean, two-parent household at age 14, and mother's education. Excluded category for religion is women raised in Catholic families. Additionally, Specifications 1 and 2 include a dummy indicating whether the legal drinking age in the state is set to 18 or 19; Specification 3 – a dummy indicating whether a woman is legally eligible to drink.

Appendix J

Probit coefficient estimates for **birth outcome conditional on pregnancy**, 15-17 and 18-20 year-old women

Dependent variable equals 1 if 1st pregnancy ended in birth, 0 otherwise
Sample is limited to women who are pregnant

		15-17 [a]			***18-20***			***18-20***		
		Whites	*Blacks*	*Hispanics*	*Whites*	*Blacks*	*Hispanics*	*Whites*	*Blacks*	*Hispanics*
(1)	***Drinking age 18 or 19***	***0.338*** (0.32)	***-0.904*** (0.91)	***-0.883*** (0.99)	***0.850**** (0.38)	***-0.624*** (0.76)	***-0.034*** (0.68)			
(2)	***Legally eligible To drink***							***1.013***** (0.34)	***-0.145*** (0.34)	***-0.858*** (0.64)
(3)	Raised in Baptist family				0.346 (0.23)	0.116 (0.40)	0.133 (0.53)	0.323 (0.22)	0.109 (0.40)	0.123 (0.52)
(4)	Raised in other Religion				-0.147 (0.16)	-0.17 (0.38)	-0.507 (0.44)	-0.235 (0.17)	-0.167 (0.38)	-0.49 (0.44)
(5)	Raised as Atheist				0.061 (0.48)	0.288 (0.71)		0.133 (0.52)	0.252 (0.71)	
(6)	AFQT score below mean	0.705** (0.24)	0.631** (0.24)	0.891^{+} (0.52)	0.447** (0.15)	0.803** (0.25)	0.929** (0.14)	0.448** (0.15)	0.767** (0.25)	0.949** (0.15)
(7)	Mother's education	-0.062 (0.04)	-0.151* (0.06)	-0.247** (0.04)	-0.143** (0.05)	0.082* (0.03)	-0.092** (0.02)	-0.152** (0.05)	0.078* (0.04)	-0.092** (0.02)
(8)	Age of the respondent	0.069 (0.13)	-0.09 (0.10)	0.311 (0.20)	0.163 (0.10)	-0.276* (0.11)	-0.262 (0.19)	0.067 (0.10)	-0.239^{+} (0.14)	-0.184 (0.16)
(9)	Constant	0.945 (2.00)	4.974* (2.14)	-1.101 (3.53)	-1.467 (2.20)	6.107** (2.15)	5.29 (3.43)	0.804 (1.83)	5.050* (2.51)	3.874 (3.00)
State, year fixed effects		yes	yes	yes	yes	yes	yes	yes	yes	yes
# of pregnancies		260	305	116	414	258	198	414	258	198

** significant at 1%; * significant at 5%; + significant at 10%. Standard errors clustered by state. Excluded category for religion is women raised in Catholic families. [a] Due to a small sample size religion dummies were excluded from the model.

Appendix K

Probit coefficient estimates for **abortion outcome conditional on pregnancy**, 15-17 and 18-20 year-old women

Dependent variable equals 1 if 1st pregnancy ended in abortion, 0 otherwise
Sample is limited to women who are pregnant

	15-17 ^{a}			***18-20***			***18-20***		
	Whites	*Blacks*	*Hispanics*	*Whites*	*Blacks*	*Hispanics*	*Whites*	*Blacks*	*Hispanics*
(1) Drinking age 18 or 19	***-0.496*** (0.39)	***0.382*** (0.32)	***1.735*** (1.16)	***-0.565*** (0.48)	***0.874*** (0.62)	***-0.867$^+$*** (0.51)			
(2) Legally eligible to drink							***-0.602*** (0.39)	***0.153*** (0.36)	***1.204$^+$*** (0.70)
(3) Raised in Baptist family				-0.225 (0.25)	-0.660$^+$ (0.39)	0.473 (0.87)	-0.217 (0.24)	-0.651$^+$ (0.38)	0.565 (0.84)
(4) Raised in other Religion				0.173 (0.12)	-0.19 (0.43)	0.531 (0.35)	0.242* (0.11)	-0.198 (0.41)	0.512 (0.34)
(5) Raised as Atheist				0.093 (0.49)	-1.359* (0.62)		0.073 (0.52)	-1.279* (0.64)	
(6) AFQT score below mean	-0.736** (0.23)	-0.972** (0.29)	-1.176* (0.59)	-0.448** (0.17)	-1.122* (0.44)	-1.468** (0.20)	-0.445** (0.17)	-1.057* (0.42)	-1.506** (0.21)
(7) Mother's education	0.100* (0.05)	0.351** (0.13)	0.322** (0.11)	0.164** (0.05)		0.157** (0.06)	0.167** (0.05)		0.160** (0.05)
(8) Age of the respondent	-0.166 (0.15)	-0.087 (0.19)	0.02 (0.25)	-0.249* (0.11)	0.189 (0.16)	0.569** (0.10)	-0.187$^+$ (0.10)	0.166 (0.18)	0.455** (0.10)
(9) Constant	0.371 (2.14)	-3.265 (3.66)	-5.007 (4.85)	1.702 (2.50)	-4.467 (3.28)	-10.892** (1.92)	0.151 (2.13)	-3.941 (3.67)	-8.830** (2.15)
State, year fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
# of pregnancies	254	210	109	394	187	174	394	187	174

** significant at 1%; * significant at 5%; + significant at 10%. Standard errors clustered by state. Excluded category for religion is women raised in Catholic families. ^{a} Due to a small sample size religion dummies were excluded from the model.

Appendix L

Test of equality of estimated coefficients on eligibility restrictions in conditional and unconditional models

Panel A: Birth outcome

	$\beta^{Conditional}_{da1819} = \beta^{Unconditional}_{da1819}$			$\beta^{Conditional}_{da1819} = \beta^{Unconditional}_{da1819}$			$\beta^{Conditional}_{eligible} = \beta^{Unconditional}_{eligible}$		
	15-17			**18-20**			**18-20**		
Variable of interest	Whites	Blacks	Hispanics	Whites	Blacks	Hispanics	Whites	Blacks	Hispanics
Drinking age 18 or 19	Fail to reject Ho	Fail to reject Ho	Fail to reject Ho	Reject Ho	Reject Ho	Fail to reject Ho			
Legally eligible to drink							Reject Ho	Fail to reject Ho	Fail to reject Ho

"da1819" is an indicator of whether drinking age in the state of residence is 18 or 19; "eligible" is an indicator of whether a woman can legally drink. **Conditional model**: Probability of birth outcome conditional on being pregnant for the first time. Corresponding estimate is reported in Appendix J, Rows 1 and 2. **Unconditional model**: Probability of first pregnancy that will end in birth. Corresponding estimate are reported in Table 1.7, Panel B, Row (1) for 15-17 year-old; Table 1.8, Panel B, Row (1) for 18-20 year-old; Table 1.9, Panel B, Row (1) for 18-20 year-old.

Panel B: Abortion outcome

	$\beta^{Conditional}_{da1819} = \beta^{Unconditional}_{da1819}$			$\beta^{Conditional}_{da1819} = \beta^{Unconditional}_{da1819}$			$\beta^{Conditional}_{eligible} = \beta^{Unconditional}_{eligible}$		
	15-17			**18-20**			**18-20**		
Variable of interest	Whites	Blacks	Hispanics	Whites	Blacks	Hispanics	Whites	Blacks	Hispanics
Drinking age 18 or 19	Fail to reject Ho	Fail to reject Ho	Fail to reject Ho	Fail to reject Ho	Reject Ho	Fail to reject Ho			
Legally eligible to drink							Fail to reject Ho	Fail to reject Ho	Reject Ho

"da1819" is an indicator of whether drinking age in the state of residence is 18 or 19; "eligible" is an indicator of whether a woman can legally drink. **Conditional model**: Probability of abortion outcome conditional on being pregnant for the first time. Corresponding estimate is reported in Appendix K, Rows 1 and 2. **Unconditional model**: Probability of first pregnancy that will end in abortion. Corresponding estimate are reported in Table 1.7, Panel C, Row (1) for 15-17 year-old; Table 1.8, Panel C, Row (1) for 18-20 year-old; Table 1.9, Panel C, Row (1) for 18-20 year-old.

Appendix M

Discrete changes in the predicted average annual probability of a first pregnancy with birth or abortion outcomes by race and age

Panel A: ***First pregnancy with BIRTH outcome***

Effect of a DECREASE in the drinking age, 15-17 year-old women	WHITE	BLACK	HISPANIC
	Mean	Mean	Mean
Pr(pregnant ∩ birth, drinking age=20or21)	0.056	0.078	0.080
Pr(pregnant ∩ birth, drinking age=18or19)	0.043	0.114	0.058
Discrete change	**-0.013**	**0.036**	**-0.022**

Effect of a DECREASE in the drinking age, 18-20 year-old women	WHITE	BLACK	HISPANIC[†]
	Mean	Mean	Mean
Pr(pregnant ∩ birth, drinking age=20or21)	0.094	0.114	0.247
Pr(pregnant ∩ birth, drinking age=18or19)	0.086	0.135	0.082
Discrete change	**-0.008**	**0.021**	**-0.165**

Change in ELIGIBILITY, 18-20 year-old women	WHITE	BLACK	HISPANIC
	Mean	Mean	Mean
Pr(pregnant ∩ birth, eligible=no)	0.093	0.154	0.156
Pr(pregnant ∩ birth, eligible=yes)	0.084	0.121	0.107
Discrete change	**-0.009**	**-0.033**	**-0.049**

Average Prob.(pregnancy ∩ birth) = Average Prob.(pregnancy) × Average Prob.(birth | pregnancy).

[†] Indicates that the large underlying point estimate for corresponding eligibility restriction is translated into a large change in the probability. The estimate is driven by a relatively small sample size and rare event occurrence.

Appendix M (Continued)

Panel B: ***First pregnancy with ABORTION outcome***

Effect of a DECREASE in the drinking age, 15-17 year-old women	WHITE	BLACK	HISPANIC
	Mean	Mean	Mean
Pr(pregnant ∩ abortion, drinking age=20or21)	0.052	0.034	0.026
Pr(pregnant ∩ abortion, drinking age=18or19)	0.035	0.063	0.038
Discrete change	**-0.018**	**0.029**	**0.012**

Effect of a DECREASE in the drinking age, 18-20 year-old women	WHITE	BLACK	HISPANIC
	Mean	Mean	Mean
Pr(pregnant ∩ abortion, drinking age=20or21)	0.087	0.036	0.161
Pr(pregnant ∩ abortion, drinking age=18or19)	0.062	0.087	0.033
Discrete change	**-0.025**	**0.050**	**-0.129**

Change in ELIGIBILITY, 18-20 year-old women	WHITE	BLACK	HISPANIC
	Mean	Mean	Mean
Pr(pregnant ∩ abortion, eligible=no)	0.088	0.083	0.058
Pr(pregnant ∩ abortion, eligible=yes)	0.059	0.073	0.079
Discrete change	**-0.029**	**-0.011**	**0.020**

Average Prob.(pregnancy ∩ abortion) = Average Prob.(pregnancy) × Average Prob.(abortion | pregnancy).

Appendix N

Probit estimates for pregnancy, birth, and abortion models, 15-17 and 18-20 year-old women

Panel A: Specification 1

	15-17 (all races pooled together)		
	Pregnancy model	**Birth model**	**Abortion model**
Drinking age 18 or 19	-0.018 (0.09)	-0.011 (0.10)	-0.128 (0.09)
Black	0.104* (0.05)	0.114^{+} (0.06)	-0.117 (0.10)
Hispanic	0.066 (0.09)	0.132 (0.12)	-0.074 (0.11)
(Drinking age 18 or 19) × Black	***0.033*** (0.06)	***0.045*** (0.07)	***0.118*** (0.12)
(Drinking age) × Hispanic	***0.017*** (0.10)	***-0.042*** (0.12)	***0.179*** (0.15)
Raised in Baptist family	0.189** (0.05)	0.161** (0.06)	0.271** (0.09)
Raised in other religion	0.128** (0.04)	0.091^{+} (0.05)	0.200** (0.06)
Raised as Atheist	0.283** (0.05)	0.243** (0.06)	0.195 (0.13)
AFQT score below mean	0.217** (0.03)	0.289** (0.04)	-0.005 (0.05)
Mother's education	-0.028** (0.01)	-0.037** (0.01)	0.014^{+} (0.01)
Both parents are in the household at age 14	-0.167** (0.02)	-0.18** (0.03)	-0.089* (0.04)
Constant	-2.71** (0.15)	-2.662** (0.18)	-7.059 (0.00)
Age polynomial	yes	yes	yes
State, calendar time fixed effects	yes	yes	yes
Number of person-month observations	137788	137779	131647
Likelihood ratio test for interaction terms	Fail to reject Ho	Fail to reject Ho	Fail to reject Ho

** significant at 1%; * significant at 5%; + significant at 10%. Standard errors clustered by state. Excluded category for religion is women raised in Catholic families; for race – White.

Dependent variable in **pregnancy model**: pregnancy status that equals 1 if pregnant, 0 otherwise

Dependent variable in **birth model**: equals 1 if 1st time pregnant and that pregnancy ended in birth, 0 otherwise

Dependent variable in **abortion model**: equals 1 if 1st time pregnant and that pregnancy ended in abortion, 0 otherwise

Appendix N (Continued)

Panel B: Specification 2

	18-20 (all races pooled together)		
	Pregnancy model	**Birth model**	**Abortion model**
Drinking age 18 or 19	-0.081	0.071	-0.368*
	(0.09)	(0.10)	(0.17)
Black	-0.091	-0.042	-0.373
	(0.08)	(0.07)	(0.25)
Hispanic	-0.005	0.012	-0.037
	(0.05)	(0.06)	(0.09)
(Drinking age 18 or 19) × Black	***0.081***	***0.045***	***0.338***
	(0.08)	(0.08)	(0.24)
(Drinking age) × Hispanic	***-0.018***	***-0.079***	***0.271****
	(0.08)	(0.09)	(0.11)
Raised in Baptist family	0.082*	0.096*	0.075
	(0.04)	(0.04)	(0.11)
Raised in other religion	-0.015	-0.037	0.036
	(0.04)	(0.04)	(0.07)
Raised as Atheist	0.046	0.022	0.103
	(0.08)	(0.11)	(0.10)
AFQT score below mean	0.224**	0.323**	-0.120^{+}
	(0.03)	(0.03)	(0.06)
Mother's education	-0.015*	-0.023**	0.022*
	(0.01)	(0.01)	(0.01)
Both parents are in the household	-0.178**	-0.171**	-0.166**
at age 14	(0.02)	(0.03)	(0.05)
Constant	-6.049**	-5.847*	-7.566^{+}
	(1.71)	(2.45)	(4.29)
Age polynomial	yes	yes	yes
State, calendar time fixed effects	yes	yes	yes
Number of person-month observations	104814	104814	96897
Likelihood ratio test for interaction terms	Fail to reject Ho	Fail to reject Ho	Reject Ho

** significant at 1%; * significant at 5%; + significant at 10%. Standard errors clustered by state. Excluded category for religion is women raised in Catholic families; for race – White.

Dependent variable in **pregnancy model**: pregnancy status that equals 1 if pregnant, 0 otherwise

Dependent variable in **birth model**: equals 1 if 1st time pregnant and that pregnancy ended in birth, 0 otherwise

Dependent variable in **abortion model**: equals 1 if 1st time pregnant and that pregnancy ended in abortion, 0 otherwise

Appendix N (Continued)

Panel C: Specification 3

	18-20 (all races pooled together)		
	Pregnancy model	**Birth model**	**Abortion model**
Legally eligible to drink	-0.098**	0.019	-0.324**
	(0.04)	(0.06)	(0.10)
Black	-0.075	-0.006	-0.378^{+}
	(0.07)	(0.06)	(0.21)
Hispanic	-0.01	0.05	-0.11
	(0.05)	(0.07)	(0.08)
(Legally eligible) × Black	***0.064***	***-0.006***	***0.378***$^{+}$
	(0.07)	(0.07)	(0.20)
(Legally eligible) × Hispanic	***-0.009***	***-0.154***$^{+}$	***0.409****
	(0.06)	(0.09)	(0.08)
Raised in Baptist family	0.082*	0.095*	0.071
	(0.04)	(0.04)	(0.11)
Raised in other religion	-0.015	-0.036	0.029
	(0.04)	(0.03)	(0.07)
Raised as Atheist	0.045	0.026	0.086
	(0.08)	(0.11)	(0.11)
AFQT score below mean	0.223**	0.323**	-0.119^{+}
	(0.03)	(0.03)	(0.06)
Mother's education	-0.015*	-0.023**	0.021*
	(0.01)	(0.01)	(0.01)
Both parents are in the household	-0.178**	-0.171**	-0.166**
at age 14	(0.02)	(0.02)	(0.05)
Constant	-5.891**	-5.724*	-7.232^{+}
	(1.73)	(2.46)	(4.39)
Age polynomial	yes	yes	yes
State, calendar time fixed effects	yes	yes	yes
Number of person-month observations	104814	104814	96897
Likelihood ratio test for interaction terms	Fail to reject Ho	Fail to reject Ho	Reject Ho

** significant at 1%; * significant at 5%; + significant at 10%. Standard errors clustered by state. Excluded category for religion is women raised in Catholic families; for race – White.
Dependent variable in **pregnancy model**: pregnancy status that equals 1 if pregnant, 0 otherwise
Dependent variable in **birth model**: equals 1 if 1st time pregnant and that pregnancy ended in birth, 0 otherwise
Dependent variable in **abortion model**: equals 1 if 1st time pregnant and that pregnancy ended in abortion, 0 otherwise

Appendix O

Probit coefficient estimates for pregnancy, birth, and abortion models with **drinking age 18 or 19 dummy**, 15-20 year-old white, Black, and Hispanic women pooled together

	Pregnancy model		**Birth model**		**Abortion model**	
Drinking age 18 or 19	***-0.014*** (0.06)	***-0.036*** (0.06)	***0.054*** (0.07)	***0.046*** (0.08)	***-0.189**** (0.10)	***-0.256***** (0.10)
Black	0.047* (0.02)	0.000 (0.06)	0.074** (0.03)	0.046 (0.05)	-0.081 (0.06)	-0.251** (0.10)
Hispanic	0.021 (0.04)	0.024 (0.06)	0.027 (0.04)	0.068 (0.08)	0.074 (0.07)	-0.061 (0.06)
(Drinking age 18 or 19) × (Black)		***0.064*** (0.06)		***0.037*** (0.06)		***0.238**** (0.11)
(Drinking age 18 or 19) × (Hispanic)		***-0.005*** (0.08)		***-0.065*** (0.09)		***0.226***** (0.07)
Raised in Baptist family	0.125** (0.03)	0.126** (0.03)	0.119** (0.03)	0.120** (0.03)	0.171** (0.05)	0.173** (0.05)
Raised in other Religion	0.046^{+} (0.03)	0.046^{+} (0.03)	0.017 (0.03)	0.019 (0.03)	0.114* (0.05)	0.111* (0.05)
Raised as Atheist	0.164** (0.04)	0.164** (0.04)	0.135* (0.06)	0.139* (0.07)	0.153^{+} (0.09)	0.136 (0.09)
AFQT score below mean	0.217** (0.02)	0.218** (0.02)	0.301** (0.03)	0.302** (0.03)	-0.055 (0.04)	-0.056 (0.04)
Mother's education	-0.021** (0.00)	-0.021** (0.00)	-0.030** (0.00)	-0.030** (0.00)	0.018* (0.01)	0.017* (0.01)
Both parents are in the household at age 14	-0.173** (0.02)	-0.173** (0.02)	-0.174** (0.02)	-0.176** (0.02)	-0.130** (0.03)	-0.126** (0.03)

Appendix O (Continued)

	Pregnancy model		Birth model		Abortion model	
Constant	-2.623** (0.12)	-2.608** (0.12)	-2.614** (0.14)	-2.612** (0.14)	-6.681** (0.41)	-6.803** (0.41)
Age polynomial	yes	yes	yes	yes	yes	yes
State, calendar time fixed effects	yes	yes	yes	yes	yes	yes
# of observations	243442	243442	243399	243399	237846	237846
Likelihood ratio test for interaction terms		Fail to reject Ho		Fail to reject Ho		Reject Ho

** significant at 1%; * significant at 5%; + significant at 10%. Standard errors clustered by state. Excluded category for religion is women raised in Catholic families; for race – White.

Dependent variable in **pregnancy model**: pregnancy status that equals 1 if pregnant, 0 otherwise

Dependent variable in **birth model**: equals 1 if 1st time pregnant and that pregnancy ended in birth, 0 otherwise

Dependent variable in **abortion model**: equals 1 if 1st time pregnant and that pregnancy ended in abortion, 0 otherwise

Appendix P

Probit coefficient estimates for pregnancy, birth, and abortion models with **legally eligible dummy**, 15-20 year-old white, Black, and Hispanic women pooled together

	Pregnancy model		**Birth model**		**Abortion model**	
Legally eligible to drink	-0.065* (0.03)	-0.029 (0.04)	-0.04 (0.05)	0.031 (0.06)	-0.113* (0.05)	-0.176** (0.06)
Black	0.047* (0.02)	0.075* (0.03)	0.074** (0.03)	0.113** (0.04)	-0.082 (0.06)	-0.097 (0.07)
Hispanic	0.022 (0.04)	0.031 (0.04)	0.028 (0.04)	0.07 (0.05)	0.074 (0.07)	-0.027 (0.07)
(Legally eligible) × Black		***-0.088**** (0.04)		***-0.120***** (0.04)		***0.056*** (0.09)
(Legally eligible) × Hispanic		***-0.027*** (0.05)		***-0.142**** (0.07)		***0.323***** (0.09)
Raised in Baptist family	0.125** (0.03)	0.124** (0.03)	0.120** (0.03)	0.118** (0.03)	0.170** (0.05)	0.169** (0.05)
Raised in other Religion	0.046^{+} (0.03)	0.045^{+} (0.03)	0.017 (0.03)	0.018 (0.03)	0.113* (0.05)	0.110* (0.05)
Raised as Atheist	0.164** (0.04)	0.165** (0.04)	0.136* (0.06)	0.139* (0.06)	0.154^{+} (0.09)	0.143 (0.09)
AFQT score below mean	0.218** (0.02)	0.218** (0.02)	0.301** (0.03)	0.303** (0.03)	-0.054 (0.04)	-0.056 (0.04)
Mother's education	-0.021** (0.00)	-0.021** (0.00)	-0.030** (0.00)	-0.030** (0.00)	0.018* (0.01)	0.017* (0.01)
Both parents are in the household at age 14	-0.173** (0.02)	-0.173** (0.02)	-0.174** (0.02)	-0.174** (0.02)	-0.132** (0.03)	-0.130** (0.03)

Appendix P (Continued)

	Pregnancy model		**Birth model**		**Abortion model**	
Constant	-2.623**	-2.636**	-2.580**	-2.605**	-6.929	-6.901
	(0.11)	(0.10)	(0.12)	(0.11)	(0.00)	(0.00)
Age polynomial	yes	yes	yes	yes	yes	yes
State, calendar time fixed effects	yes	yes	yes	yes	yes	yes
# of observations	243442	243442	243399	243399	237846	237846
Likelihood ratio test for interaction terms		Fail to reject Ho		Reject Ho		Reject Ho

** significant at 1%; * significant at 5%; + significant at 10%. Standard errors clustered by state. Excluded category for religion is women raised in Catholic families; for race – White.

Dependent variable in **pregnancy model**: pregnancy status that equals 1 if pregnant, 0 otherwise

Dependent variable in **birth model**: equals 1 if 1st time pregnant and that pregnancy ended in birth, 0 otherwise

Dependent variable in **abortion model**: equals 1 if 1st time pregnant and that pregnancy ended in abortion, 0 otherwise

Appendix Q

List of instruments considered

Instruments	
Personal /family characteristics	Legally eligible to drink alcohol in a given year (adjusted for "grandfather clause")
	Alcoholics in the family
Alcohol policy	Minimum legal drinking age is 21
	Minimum legal drinking age is 20 or 21
	Beer tax per gallon, in 2000 dollars [a]
	The natural logarithm of beer tax per gallon, in 2000 dollars
Alcohol consumption	Per capita consumption of malt beverages, gallons
	Per capita distilled spirit consumption, gallons
	Per capita alcohol consumption, gallons [a]
Tobacco policy	Average cigarette price, in 2000 $
	The natural logarithm of average cigarette price, in 2000 $
	Cigarette tax per pack, in 2000 $ [a]
	The natural logarithm of cigarette tax per pack, in 2000 $
Police / crime / arrests	Total police protection expenditures per 1000 people, in 2000 $ [a b]
	The natural logarithm of police expenditure per capita, in 2000 $
	Total juvenile arrests in a state for DUI per 100,000 population aged 10-17 [a]
	Total arrests in a state for DUI
	Number of arrests per crime [b]
	Number of arrests per violent crime [b]

[a] Similar instruments used in Sen (2002); [b] similar instruments used in Rees et al. (2001)

Sources: Personal /family characteristics – NLSY79; legal drinking age - O'Malley and Wagenaar (1990); beer tax – Brewers Almanac (1996) and Hedlund et al. (2001); consumption of malt beverages, distilled spirit consumption, and alcohol consumption – Brewers Almanac (1996); average cigarette price – Orzechowski and Walker (2007); cigarette tax – Annual Report on Tobacco Statistics, 1982-1985; police expenditure – Expenditure and Employment Data for the Criminal Justice System, various years; juvenile arrests for DUI – Sourcebook of Criminal Justice, various years; total arrests – Uniform Crime Reporting Program data US 1982-1985; crime, violent crime – United States: Uniform Crime Reports – State Statistics from 1960 – 2008; population – Census Bureau; Consumer Price Index – Bureau of Labor Statistics.

Appendix R

Test of validity of instruments in pregnancy equation

Dependent variable: Pregnancy status equals1 if pregnant, 0 otherwise

	Linear probability model	Two-Stage Least Square	Univariate Probit	Bivariate probit [a]
Consumed alcohol in a given year	-0.008*	dropped	-0.036**	0.278
	(0.00)		(0.01)	(0.30)
Legal drinking age is 21	-0.005	-0.005	-0.027	-0.019
	(0.01)	(0.01)	(0.05)	(0.05)
Cigarette tax per pack	0.021	0.02	0.105	0.05
	(0.03)	(0.03)	(0.15)	(0.14)
Per capita police expenditures	0.000	0.000	0.000	0.000
	(0.00)	(0.00)	(0.00)	(0.00)
Per capita consumption of distilled spirits	0.008	0.007	0.042	0.015
	(0.01)	(0.01)	(0.07)	(0.06)
Legally eligible to drink	-0.018	-0.018	-0.111	-0.122
	(0.02)	(0.02)	(0.09)	(0.10)
Beer tax per gallon	0.003	0.004	0.008	0.024
	(0.01)	(0.01)	(0.06)	(0.06)
Black	0.041*	0.042*	0.217**	0.249**
	(0.01)	(0.01)	(0.05)	(0.06)
Hispanic	0.016	0.017	0.085	0.125
	(0.02)	(0.02)	(0.11)	(0.14)
Raised as Atheist	-0.033^{+}	-0.032^{+}	-0.174*	-0.128*
	(0.01)	(0.01)	(0.08)	(0.06)
Raised in a Baptist family	-0.007	-0.006	-0.021	0.011
	(0.01)	(0.01)	(0.04)	(0.06)
Raised in other religion	0.008	0.009	0.046	0.074
	(0.01)	(0.01)	(0.06)	(0.08)
AFQT score/10,000	0.002	0.002	0.018	0.006
	(0.00)	(0.00)	(0.02)	(0.02)
AFQT score square	0.000	0.000	-0.002	-0.001
	(0.00)	(0.00)	(0.00)	(0.00)
Age (in years)	0.005	0.004	0.016	-0.044
	(0.04)	(0.04)	(0.19)	(0.14)
Age square	0.000	0.000	0.000	0.001
	(0.00)	(0.00)	(0.00)	(0.00)
Mother's education	0.001	0.001	0.003	0.000
	(0.00)	(0.00)	(0.00)	(0.01)
Father's education	-0.001	-0.001	-0.004	-0.006
	(0.00)	(0.00)	(0.00)	(0.01)
Two-parent household at age 14	-0.028*	-0.028*	-0.136**	-0.136**
	(0.01)	(0.01)	(0.04)	(0.04)

Appendix R (Continued)

	Linear probability model	**Two-Stage Least Square**	**Univariate Probit**	**Bivariate probit [a]**
Poverty status last year	0.057*	0.057*	0.272**	0.271**
	(0.01)	(0.01)	(0.05)	(0.04)
Woman was married last year	0.105**	0.106**	0.492**	0.536**
	(0.01)	(0.01)	(0.05)	(0.06)
In college	-0.057*	-0.057*	-0.382**	-0.380**
	(0.01)	(0.01)	(0.05)	(0.05)
Year 1983	-0.002	-0.001	-0.011	-0.003
	(0.02)	(0.01)	(0.08)	(0.08)
Year 1984	0.010	0.010	0.045	0.046
	(0.02)	(0.02)	(0.10)	(0.10)
Year 1985	-0.008	-0.008	-0.045	-0.039
	(0.02)	(0.02)	(0.09)	(0.09)
North central	0.026**	0.026**	0.149**	0.138**
	(0.00)	(0.00)	(0.02)	(0.01)
South	-0.004	-0.004	-0.005	0.024
	(0.00)	(0.00)	(0.02)	(0.04)
West	0.028**	0.027**	0.160**	0.160**
	(0.00)	(0.00)	(0.01)	(0.02)
Constant	0.054	0.065	-1.479	-0.848
	(0.41)	(0.42)	(2.20)	(1.63)
Observations	9152	9153	9152	9152
F-test for instruments	***Fail to reject Ho***	***Fail to reject Ho***	-	-
Wald test for instruments	-	-	***Fail to reject Ho***	***Fail to reject Ho***
Likelihood ratio test for instruments	-	-	***Fail to reject Ho***	***Fail to reject Ho***

** significant at 1%; * significant at 5%; + significant at 10%. Standard errors clustered by region. Excluded categories are White, raised in Catholic families, 1982, and Northeast region.

[a] Drinking equation is not reported.

Appendix S

Likelihood functions for the bivariate probit model and the model that uses discrete factor approximation method

The likelihood function for the bivariate probit model is:

$$\begin{aligned}
&\prod_{i=1}^{N}\Bigg\{\left[\int_{-\beta_2' X_1-\alpha}^{\infty}\int_{-\beta_1' X_1-\gamma X_2}^{\infty}\phi_2\left(y_1 y_2\middle|\rho\right)dy_1 dy_2\right]^{I(D=1\cap P=1)}\\
&\left[\int_{-\beta_2' X_1}^{\infty}\int_{-\infty}^{-\beta_1' X_1-\gamma X_2}\phi_2\left(y_1 y_2\middle|\rho\right)dy_1 dy_2\right]^{I(D=0\cap P=1)}\\
&\left[\int_{-\infty}^{-\beta_2' X_1-\alpha}\int_{-\beta_1' X_1-\gamma X_2}^{\infty}\phi_2\left(y_1 y_2\middle|\rho\right)dy_1 dy_2\right]^{I(D=1\cap P=0)}\\
&\left[\int_{-\infty}^{-\beta_2' X_1}\int_{-\infty}^{-\beta_1' X_1-\gamma X_2}\phi_2\left(y_1 y_2\middle|\rho\right)dy_1 dy_2\right]^{I(D=0\cap P=0)}\Bigg\}
\end{aligned}$$

where $\phi_2(\cdot)$ is a bivariate normal density function and I is an indicator function. For simplicity of notation individual, location, and time subscripts as well as location and time fixed effects are omitted.

The discrete factor, quasi-likelihood function for the model is:

$$\begin{aligned}
\prod_{i=1}^{N}\sum_{k=1}^{K}\pi_k\Bigg\{&\left[\int_{-\beta_1' X_1-\gamma X_2-\rho_1\eta_k}^{\infty}\phi(u)du\right]^{D}\left[1-\left(\int_{-\beta_1' X_1-\gamma X_2-\rho_1\eta_k}^{\infty}\phi(u)du\right)\right]^{1-D}\\
&\left[\int_{-\beta_2' X_1-\alpha D-\rho_2\eta_k}^{\infty}\phi(u)du\right]^{P}\left[1-\left(\int_{-\beta_2' X_1-\alpha D-\rho_2\eta_k}^{\infty}\phi(u)du\right)\right]^{1-P}\Bigg\}
\end{aligned}$$

where N is a sample size, K represents a number of the support points $\{\eta_k\}$ chosen from the discrete factor distribution, each of which has a probability $\{\pi_k\}$; $\phi(\cdot)$ is the standard normal density function. The model parameters α, β_1', β_2', γ, ρ_1, ρ_2, $\{\eta_k\}$, and $\{\pi_k\}$ are jointly estimated subject to trivial normalizations discussed in the text.

Appendix T

Analysis of the sequence of the following events in a given year: month when pregnancy began, month of the interview, and month for which alcohol consumption was reported

Panel A: Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Pregnancy occurred before the date of the interview minus two	1593	0.06	0.24	0	1
Pregnancy occurred before the date of the interview minus two AND alcohol consumption = yes	97	0.41	0.49	0	1
Pregnancy occurred before the date of the interview minus two AND alcohol consumption = no	97	0.59	0.49	0	1
Among women who reported positive alcohol consumption, number of months between beginning of the pregnancy and month for which drinking is reported	40	1.33	0.66	1	4
Among women who reported that they did not consume alcohol, number of months between beginning of the pregnancy and month for which drinking is reported	57	1.44	0.71	1	4

Panel B: Duration of pregnancy up to the month for which drinking is reported for women who reported alcohol consumption

Duration in months:	Freq.	Percent	Cum.
1	30	75	75
2	8	20	95
3	1	2.5	97.5
4	1	2.5	100
Total	40	100	

Panel C: Duration of pregnancy up to the month for which drinking is reported for women who reported that they did not consume alcohol

Duration in months:	Freq.	Percent	Cum.
1	38	66.67	66.67
2	14	24.56	91.23
3	4	7.02	98.25
4	1	1.75	100
Total	57	100	

Appendix U

1982-1985 dataset

The NLSY79 is a nationally representative sample of 12,686 young men and women who were 14-22 years old when they were first surveyed in 1979. I limit my sample to women only: 6283 observations.

The NLSY provides detailed retrospective fertility histories (i.e., dates (month/year) and outcomes of each pregnancy) and mobility histories (dates (month/year) of moves and location (state, county) of residence).

4) Identifying pregnancies

Year and month of each pregnancy whether it ended in a live birth, loss, or was terminated can be extracted from the NLSY public use dataset. Where information regarding pregnancy beginning date was not readily available, I used a set of pregnancy related questions to calculate the beginning date. Unless precise or supplemental information regarding the duration of the pregnancy was given, I assumed that pregnancy began:

- 9 months before if the outcome was live-birth,
- 3 months before if the outcome was abortion.

5) Identifying locations at different points in time

- Location of the individual is reported in the NLSY GEOCODE data.
- Month and year of each move are reported in the public use dataset.
- Month and year of birth as well as interview dates are reported in the public use dataset.

Available information allows one to identify only locations in a certain points in time: location of the birth place, location at age 14, location on the date of the interview, location of the most recent residence prior to the current residence, etc. All dates were assigned corresponding locations. Once the sequence of dates with corresponding locations was established, it was assumed that this woman stayed in this location until the new information was available.

6) Merging fertility and mobility histories

For each of 6283 observations additional entries were created such that the first entry for each observation would correspond to the date of birth (month/year); the second entry – the date of birth plus 1; the third entry – the date of birth plus two, etc. This expansion converted dataset into a person-month panel.

Each month/year combination was assigned a unique value. This unique value and the unique individual identification number were used to merge fertility, mobility, and policy variables in one dataset.

After that the person-month dataset was collapsed into the person-year dataset. If the value of the variable changed in the course of a given year, then the assigned annual value for this variable reflects the value that prevailed during most of the year.

Additionally, the following restrictions were applied sequentially to the dataset:

- Women for whom I could not identify mobility history were excluded (15 women);
- Women with incomplete fertility history were excluded (119 women);
- Women who participated in 1979 interview but have missing values for all interviews between 1980 and1988 were excluded (3 women);
- Women who were not in the US for the entire period between 1982-1985 (41 women) and for 47 months between 1982-1985 (2 women);
- Women in Black supplemental oversample (1052 women), Hispanic supplemental oversample (728 women), disadvantaged white oversample (878 women), women in the military sample (412 women);

After all exclusions the sample includes 12,132 person-year observations on 3,033 women.

Additionally, I identified women who became pregnant at least two months before the interview date, and hence were answering alcohol consumption questions while being pregnant, (97 person-year observations). If in a given year such situation was observed for a woman then this observation <u>only</u> (and not that woman) was eliminated from the dataset.

The final sample includes 12,035 person-year observations on 3,033 women.

Appendix V

Coefficient estimates from linear probability (LMP), two-stage least square (2SLS), univariate probit (Probit), bivariate probit (Biprobit), 2-support point, 3-support point, and 4-support point models

	LPM	**1SLS**	**2SLS**	**Probit**		**Biprobit**		**2-points**		**3-points**		**4-points**	
Depend. Variable:	pregnant	drink	pregnant	drink	pregnant	drink	pregnant	drink	pregnant	drink	pregnant	drink	pregnant
Consumed alcohol in a given year	**-0.007**				**-0.033***		**0.274**		**-0.153**		**0.609***		**1.282+**
	(0.00)				(0.02)		(0.39)		(0.14)		(0.28)		(0.69)
Predicted drinking			**0.052**										
			(0.11)										
Legal drinking age is 21		-0.021+		-0.079**		-0.079**		-0.077+		-0.079*		-0.077+	
		(0.01)		(0.02)		(0.02)		(0.04)		(0.04)		(0.05)	
Cigarette tax per pack		0.174+		0.467**		0.469**		0.662**		0.496*		0.721**	
		(0.06)		(0.18)		(0.18)		(0.25)		(0.20)		(0.27)	
Per capita police expenditure		0.000		0.001		0.001		0.002		0.001		0.002	
		(0.00)		(0.00)		(0.00)		(0.00)		(0.00)		(0.00)	
Per capita distilled spirit consumption		0.079*		0.247**		0.249**		0.302**		0.260**		0.325**	
		(0.02)		(0.06)		(0.06)		(0.05)		(0.04)		(0.06)	
Legally eligible to consume alcohol		0.035		0.107+		0.099		0.141+		0.106		0.122	
		(0.02)		(0.06)		(0.06)		(0.08)		(0.07)		(0.09)	
Beer tax		-0.050*		-0.159**		-0.156**		-0.229*		-0.187*		-0.26*	
		(0.01)		(0.04)		(0.03)		(0.10)		(0.08)		(0.11)	
Black	0.042*	-0.108**	0.047+	-0.307**	0.220**	-0.308**	0.247**	-0.479**	0.207**	-0.325**	0.618**	-0.520**	0.733**
	(0.01)	(0.01)	(0.02)	(0.04)	(0.06)	(0.04)	(0.08)	(0.09)	(0.06)	(0.06)	(0.21)	(0.10)	(0.27)
Hispanic	0.017	-0.121*	0.024	-0.367**	0.090	-0.367**	0.128	-0.513**	0.074	-0.390**	0.179	-0.539**	0.236
	(0.02)	(0.03)	(0.03)	(0.10)	(0.10)	(0.10)	(0.15)	(0.10)	(0.08)	(0.07)	(0.26)	(0.11)	(0.32)
Raised as Atheist	-0.034*	-0.129+	-0.026	-0.413**	-0.184**	-0.412**	-0.134	-0.51**	-0.201+	-0.441**	-0.36	-0.533**	-0.327
	(0.01)	(0.04)	(0.02)	(0.12)	(0.07)	(0.12)	(0.09)	(0.10)	(0.10)	(0.08)	(0.29)	(0.11)	(0.34)
Raised in a Baptist family	-0.008	-0.095*	-0.001	-0.294**	-0.028	-0.295**	0.01	-0.36**	-0.043	-0.312**	0.052	-0.382**	0.094
	(0.01)	(0.02)	(0.02)	(0.06)	(0.04)	(0.06)	(0.08)	(0.06)	(0.06)	(0.05)	(0.18)	(0.07)	(0.21)

Appendix V (Continued)

	LPM	**1SLS**	**2SLS**	**Probit**		**Biprobit**		**2-points**		**3-points**		**4-points**	
Depend. Variable:	pregnant	drink	pregnant	drink	pregnant	drink	pregnant	drink	pregnant	drink	pregnant	drink	pregnant
Raised in other religion	0.006	-0.081**	0.013	-0.267**	0.039	-0.268**	0.071	-0.325**	0.027	-0.284**	0.306*	-0.346**	0.382
	(0.01)	(0.01)	(0.02)	(0.02)	(0.05)	(0.02)	(0.08)	(0.05)	(0.05)	(0.04)	(0.14)	(0.05)	(0.20)
AFQT score	0.002	0.041+	0.000	0.105*	0.019	0.105*	0.006	0.174**	0.023	0.111**	-0.005	0.191**	-0.032
	(0.00)	(0.02)	(0.00)	(0.05)	(0.02)	(0.05)	(0.01)	(0.03)	(0.03)	(0.02)	(0.09)	(0.04)	(0.10)
AFQT score square	0.000	-0.002	0.000	-0.006	-0.002	-0.006	-0.001	-0.011**	-0.002	-0.006**	-0.005	-0.012**	-0.004
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.01)
Age in years	-0.009	0.183**	-0.023	0.564**	-0.078	0.572**	-0.145+	0.682**	-0.058	0.604**	-0.028	0.768**	-0.118
	(0.02)	(0.01)	(0.02)	(0.04)	(0.13)	(0.04)	(0.08)	(0.14)	(0.12)	(0.12)	(0.35)	(0.12)	(0.58)
Age square	0.000	-0.004**	0.000	-0.012**	0.002	-0.012**	0.003+	-0.014**	0.001	-0.013**	0.001	-0.016**	0.002
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.01)
Mother's education	0.001	0.009**	0.000	0.025**	0.003	0.025**	0.001	0.037**	0.004	0.026**	-0.036	0.041**	-0.038
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.03)	(0.01)	(0.04)
Father's education	-0.001	0.007*	-0.001	0.021**	-0.004	0.021**	-0.006	0.027**	-0.004	0.021**	-0.019	0.027**	-0.029
	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.03)
At age 14 two-parent household	-0.029*	0.005	-0.029*	0.015	-0.138**	0.016	-0.139**	0.019	-0.137**	0.014	-0.495*	0.016	-0.536**
	(0.01)	(0.02)	(0.01)	(0.06)	(0.04)	(0.06)	(0.04)	(0.05)	(0.04)	(0.04)	(0.16)	(0.05)	(0.19)
Poverty status last year	0.057*	-0.007	0.057*	-0.013	0.273**	-0.013	0.271**	-0.02**	0.274**	-0.017	0.914**	-0.028	1.049**
	(0.01)	(0.02)	(0.01)	(0.06)	(0.05)	(0.06)	(0.04)	(0.06)	(0.05)	(0.04)	(0.20)	(0.06)	(0.38)
Woman was married last year	0.104**	-0.153**	0.114*	-0.450**	0.489**	-0.449**	0.533**	-0.588**	0.475**	-0.477**	3.173+	-0.627**	3.493
	(0.01)	(0.02)	(0.02)	(0.05)	(0.05)	(0.05)	(0.08)	(0.05)	(0.04)	(0.04)	(1.82)	(0.06)	(6.74)
In college	-0.058**	0.005	-0.058**	0.022	-0.386**	0.021	-0.382**	0.029	-0.387**	0.019	-0.757**	0.025	-0.852**
	(0.01)	(0.01)	(0.01)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.06)	(0.04)	(0.14)	(0.05)	(0.21)
Year 1983	-0.003	-0.026**	-0.001	-0.079**	-0.018	-0.078**	-0.008	-0.102+	-0.02	-0.079+	-0.088	-0.119*	-0.059
	(0.02)	(0.00)	(0.01)	(0.01)	(0.09)	(0.01)	(0.08)	(0.05)	(0.05)	(0.04)	(0.15)	(0.06)	(0.17)
Year 1984	0.008	-0.005	0.009	-0.011	0.035	-0.01	0.038	-0.009	0.035	-0.006	-0.002	-0.013	0.008
	(0.02)	(0.01)	(0.02)	(0.02)	(0.10)	(0.02)	(0.10)	(0.06)	(0.05)	(0.05)	(0.16)	(0.06)	(0.19)
Year 1985	-0.011	-0.016+	-0.009	-0.046**	-0.064	-0.045**	-0.053	-0.057	-0.066	-0.05	-0.409*	-0.069	-0.427*
	(0.02)	(0.01)	(0.02)	(0.01)	(0.10)	(0.02)	(0.10)	(0.06)	(0.06)	(0.05)	(0.17)	(0.06)	(0.21)

Appendix V (continued)

	LPM	1SLS	2SLS	Probit		Biprobit		2-points		3-points		4-points	
Depend. Variable:	pregnant	drink	pregnant	drink	pregnant	drink	pregnant	drink	pregnant	drink	pregnant	drink	pregnant
North Central	0.024**	0.031+	0.024**	0.065*	0.136**	0.065*	0.138**	0.078	0.134*	0.071	0.490*	0.086	0.586*
	(0.00)	(0.01)	(0.00)	(0.03)	(0.00)	(0.03)	(0.01)	(0.06)	(0.05)	(0.05)	(0.16)	(0.06)	(0.30)
South	-0.005	-0.086*	0.001	-0.264**	-0.022	-0.263**	0.023	-0.335**	-0.036	-0.266**	0.193	-0.347**	0.357**
	(0.00)	(0.02)	(0.01)	(0.05)	(0.02)	(0.05)	(0.05)	(0.07)	(0.06)	(0.06)	(0.18)	(0.08)	(0.34)
West	0.025**	0.000	0.026**	-0.041	0.150**	-0.041	0.156**	-0.055**	0.147*	-0.041	0.618**	-0.066	0.754+
	(0.00)	(0.01)	(0.00)	(0.03)	(0.01)	(0.03)	(0.00)	(0.07)	(0.06)	(0.06)	(0.19)	(0.08)	(0.39)
Constant	0.23	-1.856**	0.355	-7.201**	-0.346	-7.290**	0.287						
	(0.28)	(0.20)	(0.21)	(0.48)	(1.48)	(0.44)	(0.97)						
# of observations	9152	9152	9152	9152	9152	9152	9152	9152		9152		9152	
Rho				0.0000		-0.1878							
				(0.00)		(0.24)							
π_1								0.7605		0.8040		0.6112	
π_2								0.2395		0.1508		0.1134	
π_3										0.0452		0.1945	
π_4												0.0809	
R square	0.04	0.14	0.04										
Ln L				-5212.22	-3244.49	-8456.05		-8447.83		-8434.94		-8425.05	
F-test of joint significance of instruments		Ho rejected											
Wald test for joint significance of instruments				Ho rejected		Ho rejected		Ho rejected		Ho rejected		Ho rejected	
Validity of exclusion restrictions		Valid		Valid		Valid		Valid		Valid		Valid	

** significant at 1%; * significant at 5%; + significant at 10%. Standard errors are clustered by region. Excluded categories are White, raised in Catholic families, 1982, and Northeast region.

Both the F-test and the Wald tests were performed only for drink equation.

π_k is the 'probability' that the unobserved factor takes on the 'value' η_k.

Appendix W

Effects of variables included in 2-point and 3-point models

		2-point model		3-point model	
Pregnancy equation	Variable	Mean	Std. Dev.	Mean	Std. Dev.
Alcohol consumption	Endogenous	-0.0302	0.0110	0.0253	0.0168
Black	Binary	-0.0435	0.0157	-0.0282	0.0178
Hispanic	Binary	-0.0147	0.0056	-0.0078	0.0052
Raised as Atheist	Binary	0.0349	0.0146	0.0149	0.0099
Raised in a Baptist family	Binary	0.0082	0.0032	-0.0022	0.0015
Raised in other religion	Binary	-0.0053	0.0020	-0.0132	0.0087
Mother's education	Binary	-0.0008	0.0003	0.0017	0.0011
Father's education	Binary	0.0007	0.0003	0.0009	0.0006
2-parent household at age 14	Binary	0.0276	0.0101	0.0220	0.0139
Poverty status last year	Binary	-0.0581	0.0202	-0.0421	0.0232
Woman was married	Binary	-0.0990	0.0255	-0.1106	0.0369
In college	Binary	0.0649	0.0231	0.0322	0.0198
Year 1983	Binary	0.0039	0.0015	0.0038	0.0025
Year 1984	Binary	-0.0068	0.0026	0.0001	0.0000
Year 1985	Binary	0.0125	0.0049	0.0171	0.0114
North Central	Binary	-0.0266	0.0101	-0.0214	0.0142
South	Binary	0.0070	0.0027	-0.0083	0.0055
West	Binary	-0.0299	0.0111	-0.0276	0.0181
Drinking equation					
Black	Binary	0.1203	0.0255	0.1040	0.0181
Hispanic	Binary	0.1274	0.0286	0.1248	0.0210
Raised as Atheist	Binary	0.1255	0.0295	0.1409	0.0235
Raised in a Baptist family	Binary	0.0911	0.0189	0.0992	0.0176
Raised in other religion	Binary	0.0789	0.0190	0.0865	0.0181
Mother's education	Binary	-0.0092	0.0023	-0.0087	0.0013
Father's education	Binary	-0.0068	0.0015	-0.0068	0.0010
2-parent household at age 14	Binary	-0.0047	0.0011	-0.0043	0.0009
Poverty status last year	Binary	0.0049	0.0012	0.0052	0.0011
Woman was married	Binary	0.1489	0.0291	0.1515	0.0249
In college	Binary	-0.0070	0.0016	-0.0057	0.0013
Year 1983	Binary	0.0252	0.0059	0.0244	0.0052
Year 1984	Binary	0.0023	0.0005	0.0018	0.0004
Year 1985	Binary	0.0141	0.0033	0.0154	0.0033
North Central	Binary	-0.0190	0.0045	-0.0215	0.0047
South	Binary	0.0851	0.0166	0.0843	0.0154
West	Binary	0.0135	0.0032	0.0127	0.0027
Legal drinking age is 21	Binary	0.0187	0.0044	0.0241	0.0052
Legally eligible to drink	Binary	-0.0347	0.0080	-0.0329	0.0067
Beer tax	Continuous	-0.0560	0.0132	-0.0572	0.0124
Cigarette tax	Continuous	0.1620	0.0382	0.1517	0.0330
Per capita police expenditure	Continuous	0.0004	0.0001	0.0004	0.0001
Per capita distilled spirit consumption	Continuous	0.0738	0.0174	0.0795	0.0173

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