The Role of Sexual Education in the Decline in Teen Births

Nicholas D.E. Mark
&
Lawrence L. Wu
New York University

Abstract submitted to be presented at the 2019 Population Association of America Conference Direct all correspondence to Nicholas D.E. Mark, Department of Sociology, New York University, Puck Building 4th floor, 295 Lafayette Street, New York, NY 10012-9605, nm2648@nyu.edu.

ABSTRACT

147 Words

The teen birth rate in the United States has fallen precipitously in the past few decades. During this time, state and federal policy has oscillated between support for abstinence-only and comprehensive sexual education. In this paper, we provide national estimates of the role this investment in sexual education played in the decline in teen births. We leverage cross-state differences in the timing of sexual education implementation and use fixed effects and difference-in-differences specifications to obtain estimates of the causal effect of abstinence-only and comprehensive sexual education on teen births. Our results for abstinence-only education confirm previous null findings, but we also find that comprehensive sexual education played a causal role in decreasing the teen birth rate in the 2000's. While specific magnitudes vary with model specification, we find that comprehensive sexual education reduced the teen birth rate in affected counties by somewhere between 1 and 3%.

INTRODUCTION

The United States has one of the highest teen birth rates among rich countries (Sedgh et al., 2015). Yet, while until the early 1990's the teen birth rate tracked the total fertility rate (TFR), since that time TFR has remained relatively constant while teen fertility has been declining rapidly (Santelli and Melnikas, 2010). Explanations for this decline have largely pointed to changes in contraceptive use (Lindberg et al., 2018), with some importance for other explanations such as declines in sexual activity in earlier years (Santelli and Melnikas, 2010; Lindberg et al., 2016). Yet little is known about how and why changes in contraception have occurred so rapidly.

One potential explanation for the decline in teen births is the large public investment in sexual education that occurred over this same period. This investment has elicited a lot of debate, and has generally been divided between two types of policies: those providing "comprehensive" sexual education (covering information about contraception and medically accurate information on pregnancy and sexually transmitted infections) and those stressing "abstinence-only until marriage" (Santelli et al., 2006). These investments occurred at both the state and federal level. States enacted mandates for specific types of sexual education being included in school curricula. The federal government began supporting abstinence-only education with the adoption of Personal Responsibility and Work Opportunity Reconciliation Act, which introduced welfare reform in 1996 and included funding for abstinence-only education. To receive federal funding for abstinence-only education, providers must meet an eight-point definition that requires programs to teach that sexual activity outside of marriage is wrong and harmful, and prohibits providers from advocating or discussing contraceptive methods except to emphasize their failure rates (NCFY, 2017). Federal funding for abstinence-only education expanded in the late 1990's through the 2000's to a peak of almost $180 million, but was reduced in 2009 to less than $60 million. After 2008, this funding pool was replaced by more than $180 million in funding for more comprehensive education through the Health and Human Services (HHS) Office of Adolescent Health (OAH) Teen Pregnancy Prevention (TPP) Program, which is a national evidence-based program that funds organizations working to prevent adolescent pregnancy (Farb and Margolis, 2016). Since 2016, federal financial support for abstinence-only education has again been on the rise, and that for comprehensive education on the decline. Given that comprehensive sexual education involves learning about how to access and effectively use contraceptives, while abstinence-only education explicitly does not, it is plausible that part of the relationship between improvements in contraceptive use and the teen birth rate are partly due to increased access to comprehensive sexual education.

Most evidence on the effect of these investments on teen birth rates either comes from district or school-level randomized control trials or analyses of survey data. These studies tend to find no effect for abstinence-only education on teen pregnancy or births (Kohler et al., 2008; Trenholm et al., 2008), but studies that examined comprehensive programs have found associations with lower risk of pregnancy, a later age at first sex, and increased probability of contraceptive use (Lindberg and Maddow-Zimet, 2012; Kohler et al., 2008).

At the population level, most work has focused on the effect of abstinence only education without comparing it to comprehensive education. This is surprising, given that federal funding has supported both types at different times. Carr and Packham (2016) used a difference-in difference-methodology and state-level data to study the effect of abstinence only sexual education on the rates of teen births, abortions, and sexually transmitted infections. While they find that state-level policies may affect teen sexually transmitted infection rates in some states, they find no effect on the other two outcomes. Earlier studies also found that state-level education policies played a limited role in the teen birth decline. Kearney and Levine (2012) included sexual education in their decomposition of demographic trends and found no relationship. Cannonier (2012) used a difference-in-differences specification on state-level panel data to study Title V funding for abstinence-only education and found an effect for no racial/ethnic or age group except Whites aged 15-17.

We extend these previous analyses in three ways. First, we include data on both comprehensive and abstinence-only education on a national scale, where previous population-level studies have only focused on abstinence-only education. Our findings with regard to abstinence-only education are consistent with previous work, and our findings with regard to comprehensive education are a new addition to the literature. Second, we employ data at the county level instead of at the state level. This allows us to more precisely identify the effects of funding for abstinence-only and comprehensive sexual education and permits the potential identification of heterogeneous effects across counties and subgroups that may be differentially distributed within states. All of our models include county-level fixed effects, eliminating the variation due to time-invariant local conditions. While our preliminary results are based on state-level policy variation, future drafts of this paper will include county-level funding data. Third, our data include a longer time frame, encompassing the entire teen birth decline from 1991 until the most recent data available (2016), allowing us to determine if the effects of each policy varied over time.

While our results currently remain imprecise, and specific magnitudes depend on model specification, the direction of the effect is clear. We find that comprehensive sexual education, but not abstinence-only sexual education, played a role in decreasing the teen birth rate over the study period. However, this effect is only significant between 2000 and 2007, and neither type of sexual education appears to have had an effect on teen birth rates before or since. Prior to PAA, we will add time-varying covariates to improve the precision of our estimates, conduct subgroup analyses by racial/ethnic group, and analyze the effect of localized funding.

DATA

We merged data from three data sources to obtain county-level information on births, age-specific populations, and changes in sexual education policy over the twenty-six-year period from 1991 to 2016. County-level data on births were obtained from National Vital Statistics System restricted natality data. These data are derived from birth certificates, which are collected through a cooperation between the states and the National Center for Health Statistics (NCHS) and which record data on all births to women in all counties in the United States. Variables include the year of the birth, the mothers age to the nearest year at the time of birth, the race and ethnicity of the mother, the mothers level of education at the time of birth, and the county and state in which the mother resided at the time of birth. We have data on the entire population of births in the United States during our study period, for a total of 10,224,040 births. Across the study period, the average number of women aged 15-19 per county increased from 2651.9 in 1991 to 3254.5 in 2016. As has been extensively documented elsewhere, the teen birth rate went into stark decline, falling from a peak of 61.6 in 1991 to 26.3 births per 1000 women in 2016.

County-level population estimates by single year of age by race and Hispanic origin for years 1991-2016 were obtained from National Cancer Institutes (NCI) Survey of Epidemiology and End Results (SEER). The single year of age populations estimates for 2010-2016 were created using bridged-race population estimates by year, Hispanic origin and sex available from the NCHS web site. These estimates are produced by SEER in collaboration with the National Center for Health Statistics, and with support from the NCI through an interagency agreement, and they represent modification of the intercensal and 2016 annual time series of July 1 county population estimates by age, sex, race and Hispanic origin produced by the U.S. Census Bureau's Population Estimates Program. The race groups included in these estimates are White, Black, American Indian and Alaska Native and Asian/Pacific Islander. These groups were collapsed into three categories: White, Black, and Other. Using a separate indicator for Hispanic ethnicity in the NVSS data, any individual who reported identifying as Hispanic was recoded, resulting in four racial/ethnic groups: non-Hispanic White, non-Hispanic Black, Hispanic, and non-Hispanic Other. The variables derived from these data are the county-level estimates of population by age and race/ethnicity from ages 15-19. Merging these data with the natality records from the NVSS will allow us to calculate county-level, age and race/ethnicity specific birth rates for each year from 1991-2016.

To determine the effect of sexual education policies, we created variables indicating the timing and type of sexual education policies that were implemented. To do so, we follow Bass (2016) and combine reports from the Sexuality Information and Education Council of the United States (SIECUS) and the Guttmacher Institute. Using these reports, we classify states sexual education mandates into two categories: abstinence-only and comprehensive. We use classifications from years 1995-2013. States were coded as having implemented the policy in the year after a law was passed mandating a change in sexual education policy. The following states are coded as comprehensive in their corresponding years: Washington, DC (2005), Hawaii (1998)[1], Illinois (2004), Maryland (2002), Maine (2004), North Carolina (1996), New Jersey (1998), New Mexico (2010), Oregon (2009), and Tennessee (1996). The following states are coded as abstinence-only: West Virginia (1998), Kentucky (2000), Florida (2002), Tennessee (2002), Georgia (2005), North Dakota (2013), New Jersey (2005), Montana (2008), Minnesota (2012), Ohio (2012), North Carolina (2005). Each of these is coded as 1 in the post-policy period, and 0 in the pre-policy period. In some cases states enacted sexual education mandates that were neither comprehensive nor abstinence-only. These states remain part of the control group for regressions estimating the effect of both comprehensive and abstinence-only education. [2] All untreated states remain in the comparison group for regressions involving each policy.

Weighted and unweighted trends for counties in states enacting comprehensive sexual education and counties in all other states, including those that enacted abstinence-only policies, are displayed in Figure

[1]Birth certificate data does not exist on the county level for Hawaii until 2000, so data Hawaii's data are aggregated to the state level until that year, at which point they are divided into Hawaii's four counties.

[2]The counties in states that change policies from comprehensive to abstinence-only are problematic. The effects of educational policies play out through cohorts, such that even if the policy were changed, adolescents who were exposed to sexual education at one time point continue to inhabit those states in the next time point. As a result, the effect of the policy would be gradual as different cohorts age into and out of the age range we study. Therefore, for the regressions regarding comprehensive sexual education, counties within states that change policies from comprehensive to abstinence-only are coded as comprehensive until the year in which the policy changes, at which point they are coded as missing. New Jersey is coded as comprehensive from 1998-2005, Tennessee is coded as comprehensive from 1996-2002, and North Carolina is coded as comprehensive from 1996-2005.

1. During the 1990's teen birth rates fell in tandem across all three types of states. Beginning in the early 2000's, the period in which states started to enact comprehensive sexual education policies, teen birth rates in states without such policies began to level off or increase, while rates in those states with comprehensive sexual education policies continued to decline until around 2005, when they too began to level off. Around 2007 the trend changed again, and all types of states fell back into patterns of declining teen birth rates. Figure 2 displays the same information for counties in states that enacted abstinence-only policies compared to counties in all other states. It is clear that trends remain parallel throughout the study period.

METHODS

We first estimate a fixed effects model that tests whether the implementation of a statewide sexual education policy influences the teen birth rate of the county. This model includes county and year-level fixed effects, controlling for all factors at the county-level that do not vary with time as well as all time varying factors that influence each county equally. The remaining variation between the counties in states that implemented a sexual education policy and those in states that did not can be attributed to the policy. The outcome Y_{it} is the log of 1 + the number of births divided by the number of women aged 15-19 in county i in year t, multiplied by 1000, which can be interpreted as the percent change in the rate per 1000 women aged 15-19. C_{it} and A_{it} are time-varying indicators for whether the county-year observation is within a state that received a treatment, where C_{it} refers to a comprehensive education mandate and A_{it} refers to an abstinence-only sexual education mandate. F_{it} indicates whether the observation was in the period 5 years following the introduction of the sexual education policy. We include fixed effects for the year (υ_t) and the county (γ_i) corresponding to each county observation to control for variation between states and years. ϵ_{it} is the error term, which is clustered at the county level. As Solon et al. (2015) demonstrate, it is not obvious whether weighting by the size of the cluster (in this case the population of the county) makes the estimates more or less precise. Therefore, we report both weighted and unweighted estimates. We also report two sets of standard errors: unclustered and clustered at the county level. Results for these specifications can be found in Tables 2 and 4 for the effects of comprehensive and abstinence-only sexual education respectively.

Model 1:

$$Y_{it} = \beta_1 C_{it} + \upsilon_t + \gamma_i + \epsilon_{it}$$

$$Y_{it} = \beta_1 A_{it} + \upsilon_t + \gamma_i + \epsilon_{it}$$

Model 2:

$$Y_{it} = \beta_1 C_{it} + \beta_2 F_{it} + \beta_3 (F_{it} * C_{it}) + \upsilon_t + \gamma_i + \epsilon_{it}$$

$$Y_{it} = \beta_1 A_{it} + \beta_2 F_{it} + \beta_3 (F_{it} * A_{it}) + \upsilon_t + \gamma_i + \epsilon_{it}$$

Next, we employ a differences-in-differences approach to compare changes across time in treated states (states that implemented each type of sexual education policy) and untreated (those that implemented the opposite policy or had no policy). Time values for untreated states are centered on the average of the treatment years: 2003 for comprehensive regressions and 2001 for abstinence-only regressions. The general model takes the form of Model 3 below:

Model 3:

$$Y_{it} = \beta_0 + \beta_1 P_{it} + \beta_2 T_{it} + \beta_3 (P_{it} * T_{it}) + \upsilon_t + \gamma_i + \epsilon_{it}$$

where P_{it} is a dummy variable equal to 1 for each county-year in the post-policy period. T_{it} is an indicator for whether a county was in a state that was treated, i.e. implemented a sexual education policy. F_{it} is an indicator for whether the observation was in the period 5 years following the introduction of the sexual education policy. The coefficient β_3 on the interaction between P_{it} and T_{it} is the difference in differences, an estimate of the difference between the expected and observed change in the teen birth rate.

We also estimate a fourth model that interacts the indicator for whether the observation is five or more years post-policy with the difference-in-differences variables:

Model 4:

$$Y_{it} = \beta_0 + \beta_1 P_{it} + \beta_2 T_{it} + \beta_3 F_{it} + \beta_4 (P_{it} * T_{it}) + \beta_5 (F_{it} * T_{it} * P_{it}) + \beta_6 (F_{it} * T_{it}) + \beta_7 (F_{it} * P_{it}) + \upsilon_t + \gamma_i + \epsilon_{it}$$

In this model, the coefficient β_5 on the interaction between F_{it}, T_{it} is the difference in differences for the period after five years following the introduction of the policy. Results for the difference-in-differences specifications can be found in Tables 3 and 5 for the effects of comprehensive and abstinence-only sexual education respectively.

The most important assumption needed to interpret the results of a differences in differences regression causally is that the rate of change in teen birth rates was parallel for the treatment and comparison counties in the pre-treatment period. Formally, this means that the change in the outcomes for the control group is independent of treatment assignment. The assumption can be expressed as $D(0) \perp Z$, in which

$D(0)$ is the change in the outcome for the comparison group and Z is the treatment. Linear trends for the unweighted sample are displayed in Figure 1, and for the weighted sample in Figure 2. Prior to the period in which sexual education policies were implemented, the trends in all sets of counties fell in unison. These trends diverged in the early 2000's, when counties in states with comprehensive sexual education policies began to see a decline in their teen birth rates relative to other states, opening up a gap between the two groups that remained relatively constant for the duration of the study period. Counties in states that implemented abstinence-only policies experienced trends that were practically identical those in counties in all other states.

Additionally, our results represent an a "intent-to-treat" estimand. We have no data on how the sexual education policies were actually implemented by local education agencies, schools, and teachers. The literature on policy implementation in education suggests that it is unlikely that the process was very straightforward across states or within states. Furthermore, our estimates are at the county level and school district boundaries are often not the same as county lines, implying that any effects measured at the county level can capture effects from multiple, or less than whole, school districts. Nevertheless, given that the policy change happens at the state level and all counties are nested within states, we can be confident that we are estimating the effect of changing a state-level sexual education policy on county-level teen birth rates.

RESULTS & DISCUSSION

Results from all three methods indicate that comprehensive sexual education contributed to the decline in the teen birth rate by between 1 and 3%, whereas abstinence-only education had no effect. Our results for abstinence-only education are consistent with prior research at both the population level (e.g. Carr and Packham 2016) and at smaller scales (e.g. Trenholm et al. 2008). Our estimates are noisy, possibly owing to the nature of education policy and its reliance on street-level bureaucrats for implementation. Schools in counties that saw policy changes may not have implemented the changes uniformly. Some schools may have had similar policies in place prior to the policy change (or in states or counties where sexual education policy did not change), while others may have failed to effectively provide the required course content despite the policy change. The definition of comprehensive education is also less clear than that of abstinence-only, so the range of policies included in that category is wider.

Interestingly, the effects we observe appear to be large in the five years following the introduction of the policy and nonexistent later. In both the difference-in-difference models and the fixed-effects models, the interaction with the indicator of an observation being at least 5 years post policy was positive. The descriptive graphs and the synthetic control visualizations [3] both also support these results. It appears that a short time frame in the mid-2000's, from 2000 to 2007, accounts for almost all of the effects of comprehensive education.

Before PAA, we will extend these analyses in three ways. First, we will include county-year co-variates, such as the racial/ethnic composition of the counties, education levels, and unemployment rates. Second, we will conduct subgroup analyses to determine if there are heterogeneous treatment effects across racial/ethnic or age-specific subgroups. Third, we will combine data on federal grants programs targeting comprehensive or abstinence-only education [3] to test the effects of local programs. We will match funding receipt to counties and estimate the effect of localized funding per teenage woman for abstinence-only and comprehensive sexual education on teen birth rates. These three steps should help us estimate the effect of these policies much more precisely, and will also help to answer whether federal funding played a role in the effectiveness of efforts to reduce teen births.

[3] See the Appendix

[3] This information is publicly available at https://www.usaspending.gov/

Table 1: Summary Statistics

	All Years	1991	2016
Number of County-Year Observations	78,692	3,131	2,925
Average Population Size (Women 15-19)	3154.0 (10113.0)	2685.2 (8632.6)	3288.2 (10455.8)
Average Birth Rate (per 1000 women 15-19)	46.1 (25.2)	61.8 (28.1)	26.3 (15.4)

Figure 1: Trends in Teen Births for Counties in States that Implemented Comprehensive Sexual Education vs. All Counties in All Other States

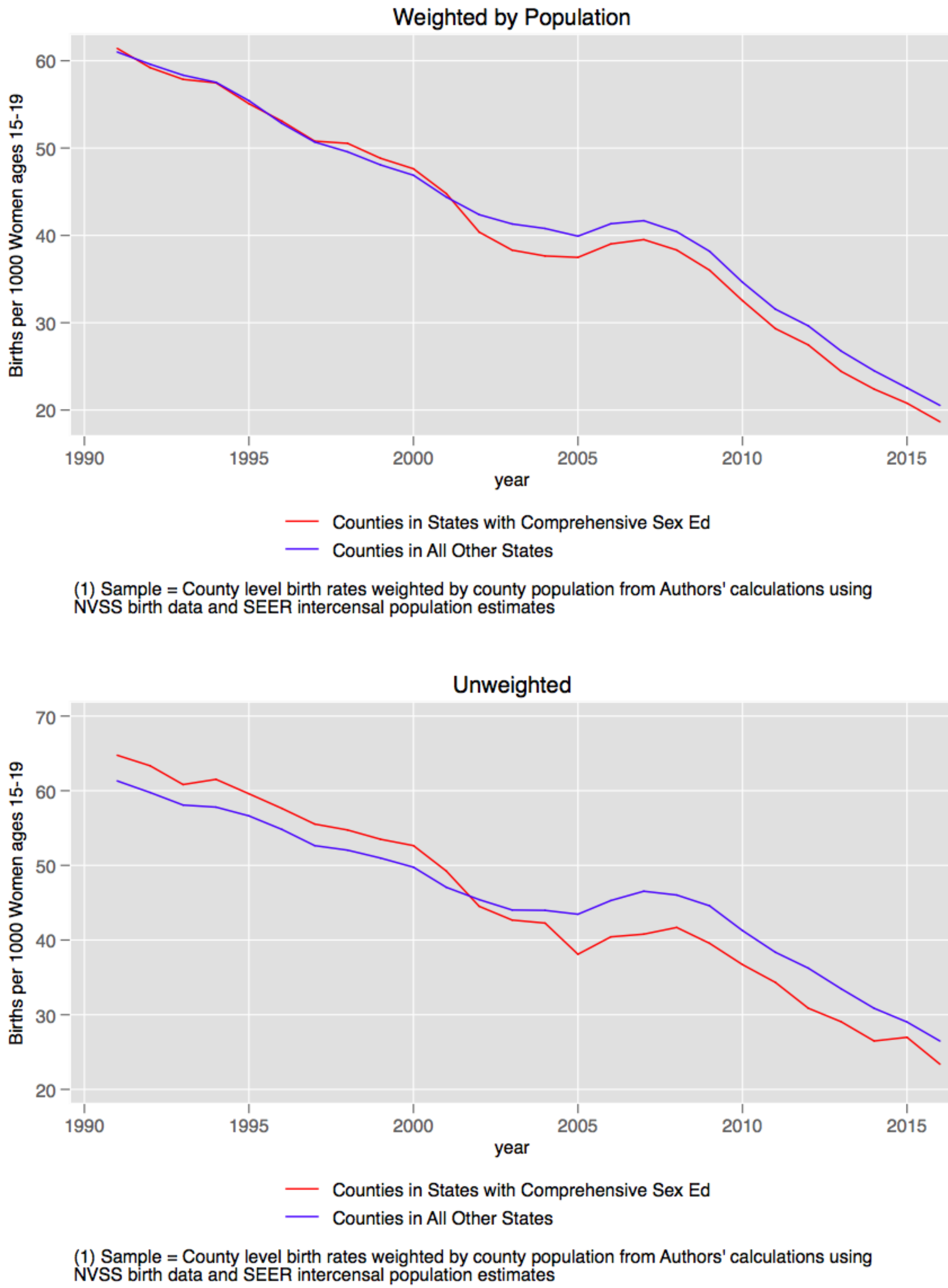
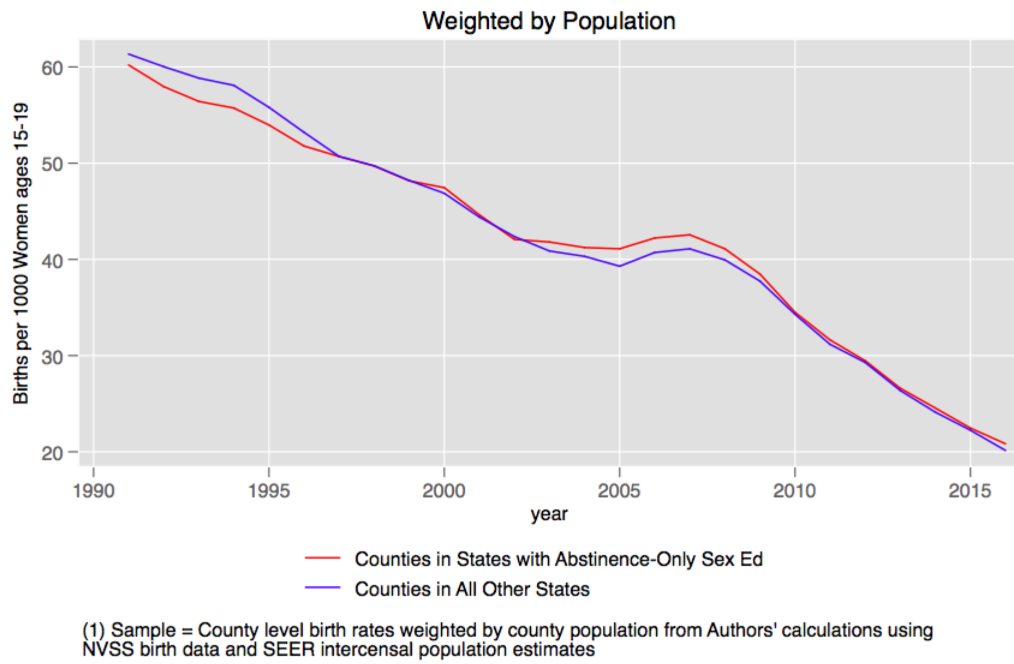


Figure 2: Trends in Teen Births for Counties in States that Implemented Abstinence-Only Sexual Education vs. All Counties in All Other States



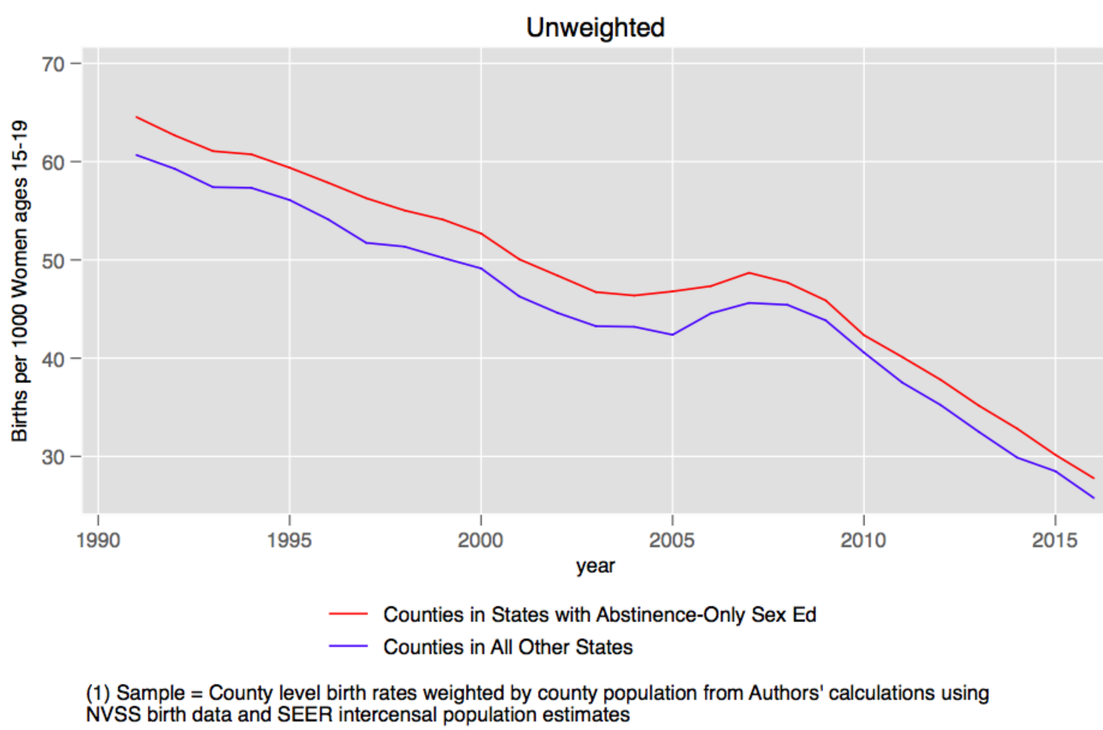


Table 2: Effect of Comprehensive Sexual Education - Fixed Effects Specification - Selected Coefficients

VARIABLES	Model 1	Model 1	Model 2	Model 2	Model 1	Model 1	Model 2	Model 2
Comprehensive	-0.7009*	-0.7009	-1.2114**	-1.2114**	-0.6807***	-0.6807	-0.6809**	-0.6809
	(0.2990)	(0.4059)	(0.4268)	(0.3584)	(0.1566)	(1.9997)	(0.2174)	(1.1873)
Comprehensive*5+			0.8765	0.8765			-0.0019	-0.0019
			(0.5295)	(0.5377)			(0.2583)	(1.5086)
Observations	78,692	78,692	78,692	78,692	78,692	78,692	78,692	78,692
R-squared	0.7729	0.7729	0.7729	0.7729	0.8991	0.8991	0.8991	0.8991
Population Weighted	No	No	No	No	Yes	Yes	Yes	Yes
Clustered SE's	No	Yes	Yes	Yes	No	Yes	Yes	Yes

Outcome = 1000*Log(1+ Births per Female aged 15-19)

*** p<0.0005, ** p<0.005, * p<0.05

Note: All models include county and year fixed effects

Table 3: Effect of Comprehensive Sexual Education - Difference-in-Differences Specification - Selected Coefficients

VARIABLES	Model 3	Model 3	Model 4	Model 4	Model 3	Model 3	Model 4	Model 4
DID	-0.8867*	-0.8867	-1.8332***	-1.8332***	-0.9466***	-0.9466	-1.2219***	-1.2219
	(0.3313)	(0.4800)	(0.5092)	(0.4441)	(0.1692)	(2.3345)	(0.2487)	(1.6269)
DID*5+			1.3350*	1.3350*			0.3892	0.3892
			(0.5677)	(0.5208)			(0.2726)	(1.2429)
Observations	78,692	78,692	78,692	78,692	78,692	78,692	78,692	78,692
R-squared	0.7729	0.7729	0.7729	0.7729	0.8992	0.8992	0.8992	0.8992
Population Weighted	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Clustered SE's	No	No	Yes	Yes	No	Yes	Yes	Yes

Outcome = 1000*Log(1+ Births per Female aged 15-19)

*** p<0.0005, ** p<0.005, * p<0.05

Note: All models include county and year fixed effects

Table 4: Effect of Abstinence-Only Sexual Education - Fixed Effects Specification - Selected Coefficients

VARIABLES	Model 1	Model 1	Model 2	Model 2	Model 1	Model 1	Model 2	Model 2
Abstinence	-0.1417	-0.1417	-0.4462	-0.4462	2.4123***	2.4123	1.5171***	1.5171*
	(0.2008)	(0.3963)	(0.2682)	(0.3404)	(0.1300)	(1.6901)	(0.1715)	(0.5754)
Abstinence*5+			-0.7552*	-0.7552			1.5436***	1.5436
			(0.2759)	(0.4352)			(0.1915)	(2.4312)
Observations	78,692	78,692	78,692	78,692	78,692	78,692	78,692	78,692
R-squared	0.7729	0.7729	0.7710	0.7710	0.8996	0.8996	0.8997	0.8997
Population Weighted	No	No	No	No	Yes	Yes	Yes	Yes
Clustered SE's	No	Yes	Yes	Yes	No	Yes	Yes	Yes

Outcome = 1000*Log(1+ Births per Female aged 15-19)
*** p<0.0005, ** p<0.005, * p<0.05
Note: All models include county and year fixed effects

Table 5: Effect of Abstinence-Only Sexual Education - Difference-in-Differences Specification - Selected Coefficients

VARIABLES	Model 3	Model 3	Model 4	Model 4	Model 3	Model 3	Model 4	Model 4
DID	0.1118	0.1118	0.0444	0.0444	3.0196***	3.0196	2.6627***	2.6627*
	(0.2175)	(0.4675)	(0.3400)	(0.4429)	(0.1397)	(2.1627)	(0.2123)	(1.0838)
DID*5+			0.0406	0.0406			0.5335*	0.5335
			(0.3490)	(0.5139)			(0.2210)	(1.9830)
Observations	78,692	78,692	78,692	78,692	78,692	78,692	78,692	78,692
R-squared	0.7729	0.7729	0.7729	0.7729	0.8998	0.8998	0.8998	0.8998
Population Weighted	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Clustered SE's	No	No	Yes	Yes	No	Yes	Yes	Yes

Outcome = 1000*Log(1+ Births per Female aged 15-19)
*** p<0.0005, ** p<0.005, * p<0.05
Note: All models include county and year fixed effects

REFERENCES

Abadie, A., Diamond, A., and Hainmueller, J. (2010). Synthetic Control Methods for Comparative Case Studies: Estimatint the Effect of California's Tobacco Control Program. *Journal of the American Statistical Association*, 105(490):493–505.

Bass, B. (2016). The Effect of State Mandated Sex Education on Teenage Sexual Behaviors and Health.

Bertrand, M., Duflo, E., and Mullainathan, S. (2004). How Much Should We Trust Difference-in-Differences Estimates? *Quarterly Journal of Economics*, (February).

Cannonier, C. (2012). State abstinence education programs and teen birth rates in the US. *Review of Economics of the Household*, 10(1):53–75.

Carr, J. B. and Packham, A. (2016). The Effects of State_Mandated Anstinence-Based Sex Education on Teen Health Outcomes. *Health Economics*.

Farb, A. F. and Margolis, A. L. (2016). The teen pregnancy prevention program (2010-2015): Synthesis of impact findings. *American Journal of Public Health*, 106:S9–S15.

Kearney, M. S. and Levine, P. B. (2012). Explaining Recent Trends in the U.S. Teen Birth Rate.

Kohler, P. K., Manhart, L. E., and Lafferty, W. E. (2008). Abstinence-Only and Comprehensive Sex Education and the Initiation of Sexual Activity and Teen Pregnancy. *Journal of Adolescent Health*, 42(4):344–351.

Lindberg, L., Santelli, J., and Desai, S. (2016). Understanding the Decline in Adolescent Fertility in the United States, 20072012. *Journal of Adolescent Health*, 59(5):577–583.

Lindberg, L. D. and Maddow-Zimet, I. (2012). Consequences of sex education on teen and young adult sexual behaviors and outcomes. *Journal of Adolescent Health*, 51(4):332–338.

Lindberg, L. D., Santelli, J. S., and Desai, S. (2018). Changing Patterns of Contraceptive Use and the Decline in Rates of Pregnancy and Birth Among U.S. Adolescents, 20072014. *Journal of Adolescent Health*, 63(2):253–256.

NCFY (2017). State Abstinence Education Grant Program. Technical report, National Clearinghouse on Families nd Youth.

Santelli, J. S. and Melnikas, A. J. (2010). Teen Fertility in Transition: Recent and Historic Trends in the United States. *Annual Review of Public Health*, 31(1):371–383.

Santelli, J. S., Morrow, B., Anderson, J. E., and Lindberg, L. D. (2006). Contraceptive use and pregnancy risk among U.S. high school students, 1991-2003. *Perspectives on sexual and reproductive health*, 38(2):106–111.

Sedgh, G., Finer, L. B., Bankole, A., Eilers, M. A., and Singh, S. (2015). Adolescent pregnancy, birth, and abortion rates across countries: Levels and recent trends. *Journal of Adolescent Health*, 56(2):223–230.

Solon, G., Haider, S. J., Wooldridge, J. M., Autor, D., Chetty, R., Dinardo, J., Elder, T., Elsby, M., Jackson, O., Lange, F., Lindo, J., and Ziliak, J. (2015). What Are We Weighting For? *Journal of Human Resources*, 50(2):301–316.

Trenholm, C., Devaney, B., Fortson, K., Clark, M., Quay, L., and Wheeler, J. (2008). Impacts of Abstinence Education on Teen Sexual Activity, Risk of Pregnancy, and Risk of Sexually Transmitted Diseases. *Journal of Policy Analysis and Management*, 27(2):255–276.

Appendix

One problem of both the fixed-effects and difference-in-differences models is that the county-level fixed effects demean the outcome using the average value across the range of years in the study period. This problem is smallest when the ratio of pre-treatment years to post-treatment years is high, but can become substantial when the ratio is low (Bertrand et al., 2004). Additionally, the errors are correlated across time within each county because the outcome being measured is serially correlated. We therefore employ a fourth model, recommended by Bertrand et al. (2004) to mitigate these problems. This model combines all observations in each county-period group into one pre-treatment and one post-treatment observation per county. This model is identical to Model 3, except that it omits the county and year fixed effects and employs the collapsed data. Results from this model are displayed in Table 6.

Model 5:

$$Y_{it} = \beta_0 + \beta_1 P_{it} + \beta_2 T_{it} + \beta_3 (P_{it} * T_{it}) + \epsilon_{it}$$

Table 6: Two-Period Model

VARIABLES	(1) Comprehensive	(2) Comprehensive	(3) Abstinence-Only	(4) Abstinence-Only
DID	-2.9117***	-3.1245***	0.1681	-0.0181
	(0.5699)	(0.5635)	(0.4110)	(0.4076)
Treated	3.7272***	3.8185***	3.7499***	3.8216***
	(1.0282)	(1.0297)	(0.8816)	(0.8815)
Post	-13.4830***	-13.0024***	-14.3732***	-13.9245***
	(0.1800)	(0.1766)	(0.1934)	(0.1899)
Observations	6,195	6,195	6,195	6,195
R-squared	0.1119	0.1049	0.1191	0.1130
Population Weighted	No	Yes	No	Yes
Clustered SE's	Yes	Yes	Yes	Yes

Outcome = 1000*Log(1+ Births/Woman aged 15-19)

*** $p<0.0005$, ** $p<0.005$, * $p<0.05$

As a test of our models, we employ a third method of causal inference, the synthetic control method (Abadie et al., 2010). Essentially, this technique is an attempt to improve the comparability of the treatment and control groups by matching the treatment group with a control group using pretreatment trends and variables. In this case, we matched the group of states that implemented a comprehensive or abstinence-only sexual education policy with a combination of states exhibiting a comparable trend in teen birth rates in the seven years leading up to the introduction of the policy. The results are displayed graphically in Figures 3 and 4, for comprehensive and abstinence-only policies respectively. Because the synthetic control specification does not allow us to center the counties on specific years, we assign the introduction of the policy to the earlier year, 2001.

Figure 3: Counties in States with Comprehensive Sexual Education Vs. Synthetic Control Group

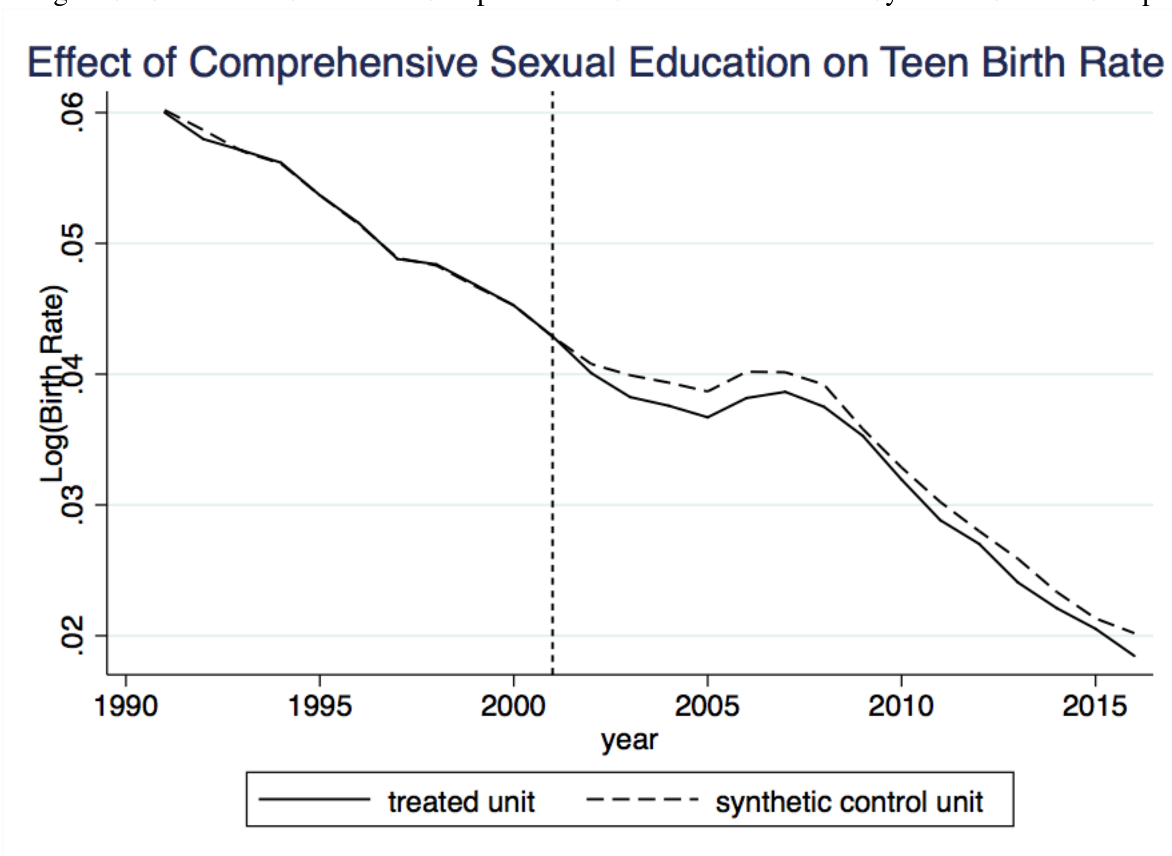


Figure 4: Counties in States with Abstinence-Only Sexual Education Vs. Synthetic Control Group