The Effect of Abortion Legalization
on the Incidence of Sexually Transmitted Diseases

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Abstract

The risk of an unwanted pregnancy represents one of the major costs of sexual activity. When abortion was legalized in a number of states during the late 1960s and early 1970s (and nationally with the 1973 Supreme Court case of Roe v. Wade), this cost was reduced as women gained the option of terminating an unwanted pregnancy. We predict that abortion legalization led to an increase in sexual activity, accompanied by an increase in sexually transmitted diseases. Using CDC data on the incidence of gonorrhea and syphilis by state, we test the hypothesis that judicial and legislative decisions to legalize abortion lead to an increase in sexually transmitted diseases. We find that gonorrhea and syphilis incidences are significantly and positively correlated with abortion legalization. According to our estimates, abortion legalization might account for as much as one third of the average disease incidence.

I. Introduction

Sexually transmitted diseases (STDs) represent epidemics of "enormous health and economic consequence in the United States (Institute of Medicine 1997, p.43)." Because of this, the medical community has exhibited great interest in trying to understand the physiological and behavioral determinants of STD incidence. While there are hundreds of articles that examine the characteristics of those people most likely to contract STDs, very little research has been done on how changes in the cost of sexual practices affect STD infections. That is, medical researchers usually focus on general changes in social attitudes, changing demographics, and changing public health practices when investigating the determinants of STD incidence, effectively disregarding the importance of incentives for individual behavior.

This focus might stem from the general practice, found in most of the non-economic literature on sexuality, of attributing sexual decision-making to primarily biological and environmental influences. For example, Hardy and Zabin (1991) model adolescent pregnancy as being determined by biological make-up and development, as well as family structure and community characteristics. While these forces are important, they do little to shed light on how changing costs and benefits of sexual activities cause individuals to change their behavior. Analyses of sexual practices relying on this non-economic approach often offer no better explanation for changes in behavior than attributing it to a general change in social tastes and preferences.

For example, in a report discussing the rise of gonorrhea among teenagers during the early 1970s, the Centers for Disease Control (CDC) suggest that the increase occurred partially because "teenagers became more sexually active (Mascola, Cates, Reynolds, Blount, and Albritton 1983, p.29ss)." While this is a plausible explanation, it provides little insight into what generated the underlying change in sexual activity that led to the increase in gonorrhea. Without probing more

deeply, epidemiological models have little chance of explaining changes in the patterns of STDs. This general point is reflected in Kremer's (1996) work on AIDS. He points out that the general epidemiological assumption that behavior is exogenous to environment can lead to incorrect conclusions about the cause of disease patterns and, consequently, public health policy decisions.

In this paper, we examine whether abortion laws introduced in the late 1960s and early 1970s had an impact on STD incidence. We hypothesize that legalizing abortion lowered the cost of sexual activity, leading individuals to engage in more risky sex, causing an increase of gonorrhea and syphilis incidences.

Lately, several researchers have examined the ways in which access to abortion might affect social conditions and behavioral decisions. For example, Donohue and Levitt (2001) and Lott and Whitley (2001) examine the relationship between abortion legalization and the decrease in crime in the 1990s. Gruber, Levine, and Staiger (1999) find that individuals who have had abortions would have been forty percent more likely to live in poverty and fifty percent more likely to receive welfare had they instead become single parents. Akerlof, Yellen, and Katz (1996) relate abortion legalization to the decline in shotgun marriages. That abortion legalization had a large social impact is also evidenced in findings that state abortion reforms in 1970 led to a decrease in teen marriage, teen fertility, and teen out-of-wedlock childbearing (Angrist and Evans 1996).

Despite this wave of interest in the effects of abortion legalization, no previous work has examined the public health effects of abortion legalization. We attempt to fill this gap by examining the consequences of abortion legalization with respect to STDs. We use the judicial and legislative decisions to legalize abortion in five states during the period 1969-1970 and the national legalization that occurred with the 1973 Supreme Court decision in Roe v. Wade as exogenous changes in the cost of sexual activity. Using state-level panel data for the period 1963-2000, our

difference-in-difference analysis allows us to control for environmental factors and identify a causal abortion effect on STDs.[1] We find that much of the change in STD incidence during the 1970s can be attributed to a simple price effect. Abortion legalization accounts for as much as a third of the average syphilis and gonorrhea incidence during the period.

In Section II below, we present a model predicting that abortion legalization led to an increase in STDs. Section III describes the empirical model and data. We present our results in Section IV and conclude in Section V.

II. Conceptual framework

We use the standard assumption that individuals consider the costs and benefits of sexual activities before engaging in sexual intercourse (Posner 1992, Levine 2000). Costs include an unplanned pregnancy, and we will focus on this cost in order to develop our key predictions.[2]

There are numerous costs associated with a pregnancy, in addition to the financial costs of giving birth to and raising a child. For example, a pregnancy might lead the mother to forego educational opportunities and achieve lower benefits in the labor market (Angrist and Evans 1996). Additional costs accrue to mothers who have children from unwanted pregnancies, as these children might be more prone to health problems (Gruber, Levine, and Staiger 1999). Even in the case where the child is given up for adoption, the mother pays the physical costs of pregnancy and delivery, as well as the emotional costs that might arise when the baby is given to the adopting parents.

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[1]This use of state level panel data to identify a causal relationship is similar to that used by Donohue and Levitt (2001) to determine the causal relationship between these abortion law changes and the decrease in crime rates witnessed during the 1990s.

[2]We derive our predictions assuming heterosexual sexual activities. The implications of relaxing this assumption will be discussed below.

As an unplanned pregnancy is one of the costs of sexual activity, the effect of contraception availability is similar to the effect of abortion availability. If contraception is used, the probability of pregnancy decreases and thus the expected costs decline, leading to an increase in the quantity of sex demanded.[3,4]

The availability of abortion lowers the expected cost of sexual intercourse because the pregnancy can be aborted in the event of undesired conception, thus avoiding many of the costs mentioned above. There are, of course, additional costs associated with the abortion, such as the financial cost of the procedure itself, the physical and/or emotional discomfort induced by the abortion, social or familial opprobrium, and the like. However, the availability of abortion unambiguously lowers the expected cost of sexual intercourse for heterosexual couples relative to a situation in which no abortion option is available.[5]

The legalization of abortion, which occurred nationally in the U.S. with the 1973 Supreme Court case of Roe v. Wade, further reduces the expected cost of sexual activity relative to a situation where abortion is available but illegal. Expected costs fall because abortion legalization reduces the search costs for pregnant women in finding an abortion provider. Further, legalization also reduces the penalties for both receiving and providing abortions, thus increasing the supply of abortions and possibly lowering the monetary price of the procedure. Moreover, legalization is likely to lead to improvements in the safety of the procedure.

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[3]One could also think of the use of contraceptives as leading to an increase in the quantity supplied, if both parties to a sexual event are simultaneously producers and consumers.

[4]Levine (2000) presents a review of the economic literature on downward sloping demand curves for sexual activity, as well as empirical results supporting the claim that the sexual demand curves for sexual activity is downward sloping.

[5]We use the term "couple" generically to designate any pair of individuals who engage in sexual activities.

Since abortion legalization reduces expected costs of sexual activities, we predict that the legalization leads to an increase in the quantity of sexual activity among heterosexual couples. This is not to say that every women or man will increase their sexual activities. For example, some women who would not consider an abortion may not be affected by the decrease in expected costs.[6] It suffices for our argument that the decrease in expected costs of sexual activities, due to the noted law change, induces a change in behavior for at least some individuals.

STD infection rates are dependent on, among other things, the volume of sexual activity taking place. Since we predict that abortion legalization leads to increased sexual activities, we also predict a positive effect of abortion legalization on STD incidence.

Formally, if utility is a function of the quantity of sexual activity undertaken (S) and a composite good (X), and the cost of sex (C) includes the total cost of giving birth to (or alternatively, for the man, bearing responsibility for) an unwanted child, an individual chooses S to maximize total utility, generating the condition

$$\frac{\partial U(S, X)}{\partial S} = \frac{\partial C}{\partial S} \; . \tag{1}$$

Assuming U(S,X) is concave in S and that the cost of sexual activity is increasing as the quantity rises,[7] equation (1) predicts that when the cost of sexual activities decline, individuals will

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[6]However, even for these women the cost of rejecting sexual activities rises when abortion is legalized (Akerlof, Yellen, and Katz 1996). Thus these women may increase their sexual activities because the cost of rejecting sexual activities rises, but not because the cost of an unplanned pregnancy falls.

[7]This assumption seems reasonable if an individual's chances of having an unwanted pregnancy rise as the level of sexual activity increases.

increase these activities.[8] Essentially, this is an application of the moral hazard concept, or, more

fundamentally, the concept of downward sloping demand curves.[9]

In summary, we predict that the decrease in costs due to legalization of abortion leads to an

increase sexual activity. As the primary way to contract a sexually transmitted disease is by sexual

activity, the model predicts that abortion legalization leads to an increase of individuals with sexually

transmitted diseases.

III. Empirical Methods

Abortion legalization provides a natural experiment to determine the effect of abortion

availability on STD incidence. Analysis of this natural experiment requires incidence data before and

after the legalization period, which occurred between 1969 and 1973. To capitalize on the variation

offered by different legalization dates in different states, analysis of this experiment also requires

incidence data by state. Comprehensive incidence data by state fulfilling these criteria are only

available for gonorrhea and syphilis.

We examine the effect of abortion legalization on both of these STDs. Syphilis is more

difficult to treat than gonorrhea, and the U.S. government and medical community have engaged in

rigorous efforts to eliminate syphilis cases. These efforts have included increased screening and an

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[8]A more elaborate model, which generates the same outcome, can be found in Levine and
Staiger (2002). In their model, the individual makes decisions sequentially. At the last stage, the
individual will have an abortion if the abortion costs are lower than the costs of giving birth. Since
the abortion option is available, the individual is less likely to use alternate forms of contraception
when engaging in sexual activities.

[9]It is also possible generate this prediction with a simple model of condom use. If we assume
that individuals use condoms to prevent conception and to prevent STD infection but that condoms
are costly, abortion availability lowers the contraceptive benefits of condoms without changing the
STD prevention value of condoms. This implies that once abortion becomes available, individuals
will be less likely to use condoms. As our model, this model predicts an increase in risky sexual
activity due to abortion legalization.

expanded treatment network (Gayle and Counts 2001). These efforts have minimized the importance of syphilis in epidemiological terms, as the average incidence of syphilis is 9 cases per 100,000 population over the 1963 to 2000 period, compared with the 280 cases of gonorrhea per 100,000 population over the same period. In 1999, a total of 6,657 syphilis cases in the U.S were reported, compared with a total of 360,076 gonorrhea cases (CDC 2000).

While, in principle, our key prediction applies to both diseases, there are reasons to suspect that the magnitude of the abortion effect might differ between the two. In this regard, of particular importance is the finding that syphilis incidence is more heavily influenced by homosexual sexual activity than is gonorrhea (Gayle and Counts 2001). Since our model and hypotheses do not apply to homosexual couples (for which unintended pregnancy is not an issue), we expect a smaller effect of abortion legalization on syphilis rates than on gonorrhea rates.[10] Further, is reason to believe that syphilis incidence might have been particularly influenced by the onset of AIDS in the early 1980s. Specifically, syphilis facilitates the transmission of HIV,[11] and some of the efforts to contain AIDS also involved increased screening and reporting of syphilis, thus increasing the number of reported syphilis cases.[12] Each of these considerations suggests that any effect of abortion legalization on syphilis will be weaker than the effect of legalization on gonorrhea incidence.

We estimate the regression equation

$$STDRate_{it} = \beta A_{it} + \mathbf{X}_{it}\,\boldsymbol{\gamma} + \lambda_i + v_t + \epsilon_{it},$$ (2)

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[10]See, for example, Fox, Whittington, Levine, Moran, Zaidi, and Nakashima (1998) and Hamers, Peterman, Zaidi, Ransom, Wroten, and Witte (1995).

[11]In fact, the CDC (2000) suggests that the outbreaks of syphilis in the homosexual community during the 1990s might be associated with the availability of antiretroviral therapy for HIV infection.

[12]However, there is some evidence that the gonococcal infections associated with gonorrhea also facilitate HIV transmission (Cohen, Hoffman, Royce, Kazembe, Dyer, Daly Zimba, Vernazza, Maida, Fiscus, and Eron, 1997).

where the dependent variable $STDRate_{it}$ measures the number of new cases diagnosed with either syphilis or gonorrhea per 100,000 individuals in state i during year t. The indicator A_{it} equals 1 if abortion is legal for state i during year t and zero otherwise. Our model predicts a positive sign on the coefficient β. $\mathbf{X}_{it}$ is a vector of time-varying state characteristics and $\boldsymbol{\gamma}$ its vector of coefficients. The term λ_i the state effect, v_t the year effect, and ϵ_{it} is the error term.

As with previous work that uses the state legalization of abortion and Roe v Wade as natural experiments when examining state incidences of particular variables, we estimate our empirical model by weighted least squares (Donohue and Levitt 2001). Consistent with previous work, we weigh our variables with the state population in all of our regressions. We will also examine the sensitivity of our results when we use an ordinary least square model with unweighted variables.

Equation (2) includes both state and time fixed effects. State effects allow us to control for state specific characteristics, such as moral norms, which are otherwise difficult to quantify.[13] Allowing for individual year effects controls for trends might exist in STD incidence, and for nationwide effects such as changes in sexual awareness or changes in guidelines for reporting cases. Moreover, our year indicators capture other variables that influence STDs nationwide, such as condom use and the use of the pill, which was introduced in the 1950s. As long as the use of these birth control methods does not systematically vary across states and over time, year and state indicators will capture the effects of these methods on STDs.[14]

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[13]One possibility could be to include moral proxies, such as religious membership in our regression equations. Comprehensive state data such as these are not available, but Posner (1992) cites a number of articles suggesting that, once economic variables are included, religious affiliation has little effect on abortion rates.

[14]We do not examine the effect of the use of contraceptives such as birth control pills or condoms, since, for most of the period under study, these data are only available at the national level and not at the state level. Given these data limitations and since we use year indicators in our specification, it would be impossible to identify the effects of this contraceptive use.

We use Donohue and Levitt's (2001) description of the changes in state abortion laws as our indicator of abortion legalization. While the U.S. Supreme Court effectively legalized abortion nationwide in 1973, a few states had taken this action previously. Specifically, the California Supreme Court legalized abortion in 1969, followed by the legislatures of Alaska, Hawaii, New York, and Washington in 1970. We list these changes in abortion laws in Table 2. In addition to this legalization, a number of states liberalized their abortion policies before 1973 to allow for legal abortions in cases where the mother's life was in danger. We focus on the former cases since they represent a clear-cut reduction in the cost of sexual activity.

Using legalization as an independent variable (as opposed to number of abortions performed, for example) is attractive if the change in abortion laws is an exogenous shock. This assumption is reasonable, since it seems difficult to argue that the timing of the legal decisions was endogenous to STD incidence (or to sexual activity which is the underlying mechanism that generates STDs).[15] Thus, we assume that no unobserved variables simultaneously cause changes of the abortion laws and changes in state STD rates. If the assumption is correct, legalization is a natural experiment, which caused an exogenous decrease in the cost of sexual activity.

We estimate equation (2) for the 1963 to 2000 time period. We chose this time period because state STD data are available only form 1963 onwards. As a test for the robustness of our results and to reduce the possibility that unobserved variables may confound the relationship in later years (such as the AIDS epidemic), we will also examine the periods between 1963 and 1980 and between 1963 and 1975. Moreover, examining the shorter time periods allow us to determine

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[15]This assumption of exogeneity is consistent with previous empirical work on the effects of abortion legalization, such as Donohue and Levitt (2001).

whether the hypothesized change in behavior occurred rapidly, or whether it occurred slowly over time.

As another check for the robustness of our results, we will estimate separate regression equations for males and females, and test for the equality of the abortion law coefficient in both equations. This will allow us to determine whether our results are driven by one sub-group of the population, or whether the change in relative prices of sexual activities, caused by changes in abortion laws, acted uniformly on males and females. If the coefficients on the abortion legalization indicators for males and females are of equal size, the hypothesis is supported that males and females respond equally in terms of changing their sexual activity in response to changes in its cost.

The list of our control variables in the X vector in equation (2) includes per capita income. The predicted relationship between STD incidence and income is ambiguous. The medial literature suggests that STD infections are concentrated among the poor. However, if sexual activity is a normal good, we predict a positive relationship between incidence and income.[16] Moreover, STDs may increase with incomes if there is an implicit price involved in securing sexual activity.

We also include per capita transfer payments in our list of covariates.[17] Inclusion of this variable is motivated by evidence that transfer payments induce individuals to be less concerned about becoming pregnant since transfer payments often increase with the addition of a child (Moffitt 1998). We also examine the effect of per capita medical transfer payments. The expected effect of

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[16]Work by Turner, Rogers, Miller, Miller, Gribble, Chromy, Leone, Cooley, Quinn, and Zenilman (2002) indicates that under-diagnosis among the young is a large problem, especially among black women. Their research suggests that undiagnosed infections might equal the number of diagnosed infections. Fortenberry (1997) reports that, for women, the lag between the time when symptoms of STDs are first recognized and the time when medical care is sought is greater for those with lower household incomes. Each of these findings suggests a "diagnosis" effect, which might be related to income.

[17]Transfer payments represent all payments from federal and state government agencies to individuals.

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medical transfer payments is ambiguous. These payments might lower the cost of STD treatment, which should limit the amount of infection taking place in a given area; however, higher medical transfer payments might allow for more rigorous screening, reducing the amount of under-diagnoses. Thus, areas with more accurate diagnoses might report a more STD cases than states with missed diagnoses.

The medical literature suggests that young people are more likely to contract an STD than older people (Fox, Whittington, Levine, Moran, Zaidi, and Nakashima 1998).[18] We therefore include demographic variables such as the fraction of state population between the ages of 15 and 34.

Since the CDC reports that blacks account for a large proportion of STD cases (CDC 2000), we include percent of population that is black as one of our control variables.[19] Further, we include the percent of population with a secondary education in our regressions because educated individuals may be more knowledgeable about the fact that sexual activities have the risk of contracting a sexual disease.[20] However, more highly educated individuals may face a lower search cost, leading to more sexual activities and thus STDs.

We also include per capita alcohol consumption in our regressions, since there is evidence that alcohol consumption is highly correlated with STD incidence (CDC 2000 and Shrier, Harris, Sternberg, and Beardslee 2001).[21] Finally, we include an indicator variable for states that make divorce easier through no-fault divorce rules. A few states changed their rules regarding the grounds

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[18]The age data for inter-census periods are linearly interpolated. Although a smaller age range might be more appropriate to use, the range 15 to 34 is the only one that can be consistently calculated given changes in Census reporting procedures over the period from 1963 to 2000.

[19]For inter-census years we linearly interpolated the race variable.

[20]For inter-census years we linearly interpolated the education variable.

[21]Alcohol consumption data for 1963 to1969 are linearly extrapolated.

necessary for divorce during the same time period that abortion laws were changing. In order to

avoid conflating the two changes, we control for changing state divorce rules. Easier divorce rules

raise the cost of extra martial sexual activity, and thus we predict that fewer STDs are associated with

no-fault divorce rules. We report the means and standard deviations of our data in Table 1.

IV. Results

The results for gonorrhea are reported in Table 3 and the results for syphilis are reported in

Table 4. In each table we present three sets of estimates for three time periods, which are 1963-2000,

1963-1980 and 1963-1975. In each set of the estimates the first column and its corresponding

regression includes only the abortion legalization indicator, the second column includes all

covariates, except for the transfer payments and medical transfers variables and the third column adds

those latter two variables.[22]

The legalization coefficient is positive and statistically significant in all specifications of the

gonorrhea regressions (Table 3). For the 1963-2000 period the marginal effect of the law change is

estimated to be between sixty-one and ninety-eight extra cases of gonorrhea per 100,000 people.

This represents an increase of between twenty-two and thirty-five percent, relative to the average

state incidence over the time period.[23] The coefficient on the abortion legalization indicator is also

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[22]Prior to estimating equation (1) we compared the STD means of abortion-allowing states
and abortion prohibiting states for the entire time period (i.e., controlling for no covariates, year, or
state effects) in a weighted least squares regression. We found that the mean gonorrhea incidence for
state periods in which abortion was legal was 77 cases per 100,000 population higher, representing a
35 percent increase over the average in state periods where abortion was illegal. For syphilis
incidence, the mean for periods in which abortion was allowed was higher by 0.1 cases per 100,000
population, representing an increase of 1 percent over the weighted average incidence during periods
where abortion was illegal. Thus, our hypothesis finds support in a simple comparison of STD means
of before and after abortion legalization.

[23]We also estimated regressions for all time periods in which we interacted the abortion
indicator with a time trend to discern whether this effect grew with time, implying perhaps that

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positive and statistically significant in all specifications when we examine the 1963 to 1980 time period. When we include our sets of covariates (Table 3, columns 5 and 6), we find that the marginal effect of abortion legalization is about twenty percent larger in the 1967 to1980 specification relative to the 1963 to 2000 specification. This suggests that our findings are not driven by later periods and that the inclusion of later periods actually decreases the marginal effect of abortion legalization.

The estimates for the syphilis regressions in Table 4 show that for the 1963 to 2000 period, the statistical significance of the abortion effect is sensitive to specification of the regression equation. This may reflect the confounds for syphilis that we discussed above. When we examine the shorter 1963 to 1980 time period, all abortion legalization coefficients have the hypothesized positive sign. The effect of abortion legalization on syphilis rates is statistically significant, when we include our covariates in the syphilis regressions. These results suggest that abortion legalization leads to an increase of one to two cases of syphilis per 100,000 population. This represents an about ten to twenty percent increase over average incidence. That we find the effect when restricting our data to the time period prior to 1980 suggests that the unobserved variables that influenced syphilis rates due to the AIDS epidemic after 1980 may confound our point estimate on abortion legalization for the longer time period.[24]

We have suggested several reasons why we expected a smaller marginal effect of abortion legalization for syphilis, as opposed to gonorrhea, and our results show a smaller effect of

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behavior changed slowly. We did not find such an effect. Specifically, it appears as though behavior changed quickly with abortion legalization leading to an immediate and relatively constant increase in baseline incidence.

[24]The results for gonorrhea incidence are qualitatively similar if an OLS model is estimated. For syphilis, the significance of the abortion coefficient is sensitive to which covariates are included in the specification. Also, the results for gonorrhea and syphilis were qualitatively similar if we used log(incidence) as our dependent variables. The relationship between abortion legalization and incidences of gonorrhea and syphilis are positive in all specifications, though, in some of the time periods, the relationship was not statistically significant at the 5 percent level.

legalization for syphilis. Next we restrict our analysis to the period from 1963 to 1975. This restriction may provide the clearest picture of the effect of abortion legalization, because it minimizes the possibility that there are missing variables in our regressions, as some variables may become important in later years, but are of no importance in the earlier time period. Moreover, because there is no additional variation in the abortion indicator after 1973, later years shed little light on the effect of abortion on STD incidence if the change in behavior occurred rapidly, as opposed to gradually over time.

In the 1963 to 1975 regressions we find that the effects of abortion legalization on gonorrhea incidence (Table 3, columns 7 to 9) and syphilis incidence (Table 4, columns 7 to 9) remain statistically significant and positive. We estimate the magnitude of the abortion effect to be between fifty-six to seventy-three extra cases of gonorrhea per 100,000 population. This effect implies an increase of gonorrhea incidence between twenty and twenty-six percent relative to the average incidence over this time period. For syphilis, the abortion effect implies an increase in incidence between 1.9 and 2.3 extra cases per 100,000 population, representing an increase between twenty and twenty-four percent.[25] Depending on the specification, we find that the marginal effect of abortion legalization for the shorter time periods is either similar to or larger than the 1973-2000 time period, suggesting that the changes in behavior did not occur gradually, but rather quickly.

With respect to the other covariates included in our regressions, the coefficients on per capita personal in By examining at the effects of abortion legalization prior to the national legalization in Roe v. Wade, we can determine whether the national change in 1973 is driving our results. For both syphilis and gonorrhea, the abortion effect is significantly positive for the period 1963-1972. come

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are consistently positive and statistically significant for both STDs, with the exception of syphilis for

the 1963 to 1975 period where the coefficient is negative but statistically insignificant. This finding

is consistent with the hypothesis that sexual activity is a normal good.[26]

In accord with indications from the medical literature, gonorrhea incidence is positively

correlated with alcohol consumption (Table 3). The relationship is statistically significant and

positive in every specification.[27] This statistically significant positive relationship is also found for

syphilis during the 1963-2000 period, but the coefficient on alcohol consumption turns negative,

though statistically insignificant, when we examine shorter time periods (Table 4).

The results for most of our other covariates are sensitive to the time period and STD

examined. For example, a coefficient on the fraction of young people in the population is negative in

the gonorrhea regressions but positive in the syphilis regressions. In both cases, statistical

significance depends on the specification.

The relationship between secondary education and STD incidence is sensitive to the

specification. This might reflect the theoretical ambiguity of education's effect on STDs. That is,

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[26]Another explanation might be a diagnosis effect. If wealthier people were more likely to
have gonorrhea diagnosed than are poorer people, our dependent variable would be measured with
error because gonorrhea among the poor goes largely undetected. Since access to healthcare
services, including regular doctor visits, is positively correlated with income, this might be plausible.
However, much of the CDC's sample comes from sources other than diagnoses in private medical
facilities. Specifically, the CDC's data sources include public clinics, Jail STD Monitoring Projects,
the U.S. Army, and the Indian Health Service, whose clientele is likely to represent a relatively high
proportion of lower income individuals (CDC 2000). Thus, it is unlikely that a diagnosis effect is
causing the positive correlation between income and STD rates.

[27]The alcohol consumption variable measures gallons of per capita consumption of ethanol
via beer, wine, and liquor by state. These data are only available beginning in 1970, so we
constructed the alcohol consumption variable for the years 1963 to 1969 by both linear extrapolation
and by using the 1970 observation for prior years. The magnitude and significance of the
relationship between incidence and alcohol consumption was largely independent of which method
was used extrapolate the alcohol data.

while schooling increases general health awareness, more educated individuals may face lower search costs in the sex market, leading to increased sexual activity.

No-fault divorce laws have the predicted negative effect on STD rates when examining the 1963 to 2000 period. However, for the shorter periods the effect is generally positive, with statistical significance depending on the specification. This might reflect differing effects of the laws over time. While no-fault divorce policies might discourage extra-marital sexual relationships in a steady state, they also lower the costs of divorcing, generating more divorce (Brinig and Buckley 1998). If divorced individuals engage in more risky sex after the separation, the divorce law changes will lead to more STD infections.

We noted above that the predictions derived from the changing cost of sexual activities do not apply for homosexual sexual activities. Assuming that homosexual behavior did not change at the same time that abortion laws changed and that heterosexual matching is roughly proportional (i.e., it is not the case that a relatively small number of men engage in sexual activity with a large number of women, or vice versa), our model predicts that the relationship between STD incidence and abortion legalization is the same for men and women. In particular, we predict the same marginal effect of legalizing abortion for men and for women.

To test this hypothesis, we examined the data for male and female state gonorrhea and syphilis rates separately. The seemingly unrelated regression (SUR) model allows us to test for the equality of the legalization coefficients in the male STD equation and female STD equation. We report the male and female abortion legalization coefficients from the SUR model for gonorrhea in Table 5. Regardless of the time period or the gender gonorrhea rate examined, all coefficients on abortion legalization are positive and statistically significant. In all specifications the chi-square test

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for equality of the legalization coefficient in the male and female regressions allows us to reject equality at the five percent level.

Table 6 reports the legalization coefficients for both genders in the syphilis regressions. We reject equality of the coefficients in the male and female regressions in all regressions that include covariates. For two periods, where we estimate a regression that has no control variables besides the legalization indicator, we reject the equality of legalization coefficients. In both cases the male infection rate associated with legalization is higher than that of women.

Overall, we therefore find that once we control for other factors that influence STDs, besides abortion legalization, the marginal effect of legalization on STD rates is the same for women and for men. Thus both genders respond equally to a fall in the cost of sexual activities.

This result is interesting in another respect. Specifically, it rules out the possibility that the abortion legalization effect is merely an artifact of increased diagnoses due to abortion. That is, if abortion providers generally perform STD tests on their patients, we might see a relationship between abortion and STD incidence that is related merely to an increased probability of diagnosis rather than a change in sexual activities. Since this form of diagnosis occurs only for women, and if a diagnostic effect were driving our result, we would find a bigger effect for women's incidence than for men's. Since we find no such difference, we can reject this possibility.

V. Conclusion

The legalization of abortion in the United States led to many changes socially, economically, and medically. While much recent attention has focused on its effect with respect to the reduction in unwanted pregnancies, there has been little work that examines the consequences of the increase in sexual activity that likely followed legalization.

We investigate the natural experiment provided by state abortion legalization laws to determine the effect of changing the expected costs of sexual activity on the incidence of sexually transmitted diseases. Changes in abortion laws present a natural experiment since a number of states legalized abortion in various years prior to the national legalization that came with Roe v. Wade in 1973. Legalizing abortion provided extra incentives to engage in risky sexual activity.

Legalization led to a lowering of the cost of abortions and this has a qualitatively and quantitatively important effect on STD rates. The estimation results show that abortion legalization led to an increase of sexually transmitted diseases; this result is robust to a wide range of time periods and covariates and is constant across the sexes. The point estimates indicate that legalization caused and increase of gonorrhea by up to thirty-five percent and an increase in syphilis by up to thirty-eight percent.

In addition to providing further evidence that sexual behavior responds to economic incentives, the results provide an insight into the epidemiology of gonorrhea and syphilis specifically, and, perhaps, STDs in general. Our results attribute a large increase in gonorrhea and syphilis rates to changing behavior, which was induced by abortion law changes. However, CDC and medical authorities in general have not considered this effect, nor that changes in institutions can cause changes in the relative prices faced by individuals. Instead, the medical community tends to attribute the changes in STD rates to fluctuating social mores, changing demographics, and changing diagnosis patterns.[28] As indicated by our results, ignoring the effects of changing incentives precludes an accurate understanding and modeling of this epidemiological phenomenon.

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[28]See, for example, Mascola, Cates, Reynolds, Blount, and Albritton (1983).

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Table 1
Summary Statistics

Variable	Description	Mean	Std.dev.	Source
Gonorrhea Incidence	gonorrhea cases per 100,000 population	282.00	308.50	CDC
Female Gonorrhea Incidence	gonorrhea cases per 100,000 women	219.43	203.83	CDC
Male Gonorrhea Incidence	gonorrhea cases per 100,000 men	348.78	449.90	CDC
Syphilis Incidence	syphilis cases per 100,000 population	9.13	14.23	CDC
Female Syphilis Incidence	syphilis cases per 100,000 women	6.58	10.82	CDC
Male Syphilis Incidence	syphilis cases per 100,000 men	11.85	18.82	CDC
Abortion Legal	Abortion Indicator = 1 if abortion is legal	0.75	0.44	Donohue & Levitt (2001)
Secondary Education	percent of population with secondary schooling (inter-census years linearly interpolated)	65.70	13.62	U.S.Census
Personal Income	per capita personal income adjusted by CPI-W	12,437	3,133	BEA, BLS
Transfer Payments	per capita transfer payments adjusted by CPI-W	1.37	0.56	BEA, BLS
Medical Transfers	per capita medical transfer payments adjusted by CPI-W	0.17	0.15	BEA, BLS
Population 15 to 34	percent of state population aged 15-34 (1963-1969 linearly interpolated)	0.32	0.03	U.S. Census
Alcohol Consumption	per capita ethanol consumption (gal); 1963-1969 and 1999-2000 linearly interpolated	2.51	0.84	NIH
Black Population	percent of state population that is black (inter-census years linearly interpolated)	0.10	0.12	U.S. Census
No-Fault Divorce	no fault divorce indicator = 1 if state allowed	0.50	0.50	Edlund and Pande (forthcoming)

Table 2
States Legalizing Abortion

1969	1970	1971	1972	1973
California	Alaska Hawaii New York Washington			Nationwide

Table 3
Panel Estimation Relating Abortion Legalization to Gonorrhea Incidence
(standard errors in parentheses below coefficient estimates)

	1963-2000			1963-1980			1963-1975		
	(i)	(ii)	(iii)	(i)	(ii)	(iii)	(i)	(ii)	(iii)
Abortion Legal	98.45	62.25	60.86	57.71	77.33	81.71	55.90	70.80	72.97
	(16.23)	(15.58)	(15.69)	(14.35)	(12.87)	(13.12)	(13.89)	(12.69)	(13.23)
Secondary Education	–	3.45	3.11	-	-24.83	-24.93	-	-33.62	-33.56
		(1.06)	(1.13)		(3.74)	(3.79)		(5.43)	(5.55)
Personal Income	–	0.02	0.02	-	0.06	0.06	-	0.05	0.05
		(0.00)	(0.00)		(0.01)	(0.01)		(0.01)	(0.01)
Transfer Payments	–	–	20.27	–	–	-.23.52	–	–	-13.53
			(27.28)			(42.65)			(61.06)
Medical Transfers	–	–	-5.93	–	–	-101.18	–	–	-29.68
			(57.91)			(121.38)			(150.38)
Population 15-34	–	-950.66	-970.88	–	-5,841.44	-5,888.45	–	-3,142.40	-3,181.77
		(326.91)	(328.97)		(603.86)	(618.54)		(833.14)	(840.91)
Alcohol Consumption	–	91.57	93.36	–	87.87	84.48	–	73.62	72.92
		(10.93)	(11.08)		(12.16)	(12.34)		(14.14)	(14.22)
Black Population	–	1968.23	1924.87	–	1151.85	1411.92	–	31.30	164.01
		(237.52)	(253.02)		(364.33)	(394.89)		(453.04)	(508.82)
No-Fault Divorce	–	-14.88	-13.52	–	20.68	20.50	–	15.68	15.53
		(8.04)	(8.18)		(8.48)	(8.51)		(9.49)	(9.55)
State Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.84	0.86	0.86	0.89	0.92	0.92	0.88	0.91	0.91

Note: The dependent variable is the number of individuals per 100,000 who are diagnosed with gonorrhea in year t in state i. N=1,950 for 1963-2000, N=918 for 1973-1980, and N=663 for 1963-1975. Each regression is estimated with population weights.

Table 4
Panel Estimation Relating Abortion Legalization to Syphilis Incidence
(standard errors in parentheses below coefficient estimates)

	1963-2000			1963-1980			1963-1975		
	(i)	(ii)	(iii)	(i)	(ii)	(iii)	(i)	(ii)	(iii)
Abortion Legal	3.46	0.43	1.29	1.01	1.47	1.66	2.33	1.88	1.93
	(1.39)	(1.37)	(1.37)	(0.80)	(0.79)	(0.81)	(0.81)	(0.81)	(0.84)
Secondary Education	–	0.34	0.54	–	-1.25	-1.19	–	-1.25	-1.40
		(0.09)	(0.10)		(0.23)	(0.23)		(0.35)	(0.35)
Per Capita Income	–	0.00	0.00	–	0.00	0.00	–	-0.00	-0.00
		(0.00)	(0.00)		(0.00)	(0.00)		(0.00)	(0.00)
Per Capita Transfers	–	–	-12.87	–	–	-4.55	–	–	7.37
			(2.38)			(2.63)			(3.89)
Per Capital Medical Transfers	–	–	12.91	–	–	7.07	–	–	-21.19
			(5.05)			(7.47)			(9.58)
Population 15-34	–	85.48	89.61	–	223.78	209.74	–	102.68	112.41
		(28.77)	(28.67)		(37.17)	(38.07)		(53.30)	(53.58)
Alcohol Consumption	–	6.30	5.37	–	-0.90	-1.09	–	-1.51	-1.63
		(0.96)	(0.97)		(0.75)	(0.76)		(0.90)	(0.91)
Black Population	–	1.46	8.31	–	9.05	14.24	–	95.71	108.04
		(20.90)	(22.05)		(22.43)	(24.31)		(28.98)	(32.42)
No-Fault Divorce	–	-1.59	-2.10	–	-0.02	0.06	–	0.07	-0.06
		(0.71)	(0.71)		(0.52)	(0.52)		(0.61)	(0.61)
State Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.62	0.67	0.67	0.81	0.83	0.83	0.83	0.84	0.84

Note: The dependent variable is the number of individuals per 100,000 who are diagnosed with gonorrhea in year t in state i. N=1,950 for 1963-2000, N=918 for 1973-1980, and N=663 for 1963-1975. Each regression is estimated with population weights.

Table 5
Male-Female Comparison of SUR Results for Gonorrhea Incidence
(standard errors in parentheses below coefficient estimates)

	1963-2000		1963-1980		1963-1975	
	No Covariates	All Covariates	No Covariates	All Covariates	No Covariates	All Covariates
Abortion Legal						
Male	102.49	53.22	45.67	77.81	57.04	73.57
	(22.03)	(21.10)	(17.38)	(15.80)	(17.86)	(16.80)
Female	93.74	69.32	68.90	85.28	54.39	71.72
	(13.16)	(13.21)	(13.15)	(12.25)	(11.25)	(10.95)
Test of equality of coefficients						
Chi-square statistic	0.27	0.94	3.08	0.35	0.04	0.02
p-value	(0.60)	(0.33)	(0.08)	(0.55)	(0.84)	(0.89)

Note: The SUR estimation involves a two-equation system with annual male and female gonorrhea infections per 100,000 of the male, respectively female population as the dependent variables. All specifications include state and year fixed effects. In each system the independent variables are identical. (With the exception of the abortion legalization coefficient, we do not report the individual coefficient estimates). The SUR estimation provides a convenient way to test for the quality of the abortion legalization coefficient in the male and female gonorrhea equations. The covariates in the "All Covariates" regressions are: secondary education: per capital personal income, per capital transfer payments; per capital medical transfer payments; population 15-34; alcohol consumption; black population; and no fault divorce law. N=1,950 for 1963-2000, N=918 for 1973-1980, and N=663 for 1963-1975. Each regression is estimated with population weights.

Table 6
Male-Female Comparison of SUR Results for Syphilis Incidence
(standard errors below coefficients estimates)

	1963-2000		1963-1980		1963-1975	
	No Covariates	All Covariates	No Covariates	All Covariates	No Covariates	All Covariates
Abortion Legal						
Male	6.03	1.67	0.91	2.13	2.99	2.24
	(1.71)	(1.65)	(1.02)	(1.00)	(0.99)	(1.00)
Female	1.12	1.07	1.21	1.28	1.78	1.66
	(1.10)	(1.11)	(0.62)	(0.62)	(0.63)	(0.66)
Test of equality of coefficients						
Chi-square statistic	28.30	0.51	0.21	1.94	4.32	1.11
p-value	(0.00)	(0.48)	(0.65)	(0.16)	(0.04)	(0.29)

Note: The SUR estimation involves a two-equation system with annual male and female gonorrhea infections per 100,000 of the male, respectively female population as the dependent variables. All specifications include state and year fixed effects. In each system the independent variables are identical. (With the exception of the abortion legalization coefficient, we do not report the. The SUR estimation provides a convenient way to test for the quality of the abortion legalization coefficient in the male and female syphilis equations. The covariates in the "All Covariates" regressions are: secondary education: per capital personal income, per capital transfer payments; per capital medical transfer payments; population 15-34; alcohol consumption; black population; and no fault divorce law. N=1,950 for 1963-2000, N=918 for 1973-1980, and N=663 for 1963-1975. Each regression is estimated with population weights.