The Relationship between Abortion Liberalization and Sexual Behavior: International Evidence

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Economic theory predicts that abortion laws affect sexual behavior since they change the marginal cost of having risky sex. We estimate the impact of abortion laws on sexual behavior by reported gonorrhea incidence. Our data panel includes 41 countries for which consistent gonorrhea data are available for 1980–2000. Compared with laws permitting abortion only to save the pregnant woman's life or her physical health, the switch to more liberal abortion laws is associated with large increases in reported gonorrhea incidence. Our results help explain why birth rates do not decline at the same rate abortions increase when laws are liberalized. (*JEL*: I12, I18, J13, K00, K32, Z13)

1. Introduction

Over the last few decades, most industrialized countries have increased access to legal abortions. As a result, some 40% of the world's population currently resides in countries that permit abortion on demand. Another 25% has access to abortion on socioeconomic and mental health grounds which are, in most cases, broadly interpreted (Center for Reproductive Rights, 2008).

We examine the relationship between abortion access and sexual behavior for a sample of 41 North American, European, and Central Asian countries. This work extends previous studies by Klick and Stratmann

American Law and Economics Review
doi:10.1093/aler/ahs012
Advance Access publication September 17, 2012

(2003, 2008), who examine the relationship between abortion policies in the United States. In contrast to Klick and Stratmann, our panel allows us to consider the effects of a further class of abortion laws, namely abortion access that is conditioned on socioeconomic and/or mental health grounds.

Because internationally comparable data on sexual behavior do not exist, we approximate risky sexual behavior by reported gonorrhea incidence. This proxy for risky sex is not only attractive because of data availability; it also adds to our understanding of an important public health issue that has largely been ignored.

According to the World Health Organization (WHO) there are 62 million new cases of gonorrhea every year (World Health Organization, 2001), and, for the United States, lifetime treatment costs for each case are estimated between $60 for men and $303 for women (Chesson et al., 2006). Untreated, gonorrhea can lead to pregnancy complications, infertility, blindness in newborns infected by their mothers, septicemia, arthritis, endocarditis, and meningitis (World Health Organization, 2001). Existing public health models of STD incidence ignore the behavioral effect studied here. If, as we hypothesize in this article, increased abortion access leads to higher STD rates, there may be health benefits from the introduction of programs that proactively safeguard against adverse STD effects of abortion liberalization.

The paper is organized as follows. Section 2 outlines the theoretical background from which we derive our research question. In Section 3, we present our categorization of abortion laws that forms the basis of our empirical analysis and show how the country-year-cells in our sample fall into the different abortion law categories. The empirical approach to identify the relationship between abortion and reported gonorrhea incidence is illustrated in Section 4, and Section 5 discusses the data used in our estimation. Sections 6 and 7 present the econometric results and a set of robustness checks and Section 8 concludes.

2. Conceptual Framework

We hypothesize in this paper that changes in environmental factors such as abortion laws alter the costs and benefits of sexual behaviors and that rational individuals respond to such changes by adjusting their sexual activities.

The behavioral response can be formalized in a simple economic model. We assume that an individual's utility (U) positively depends on the "consumption" of sex that includes both its frequency and riskiness (S), and a composite good (X). We further assume that utility $U(S, X)$ is concave in S, i.e. that the marginal utility sex decreases in the level of its consumption. As we investigate the sexual behavior of heterosexual couples[1], the cost of sex (C) among other things includes the risk of unwanted pregnancy that increases with every additional sexual encounter. In formal terms, the marginal cost of sex is positive. This framework generates a downward sloping demand curve for sexual activity.[2] Assume, for instance, that the cost (price) of sex drops through some intervention. Because Equation (1) implies the utility maximum is achieved when the marginal utility of sex equals its marginal cost, a rational individual will respond to this change by extending the consumption of sex until the equivalence between marginal cost and benefit is reestablished. Thus, the hypothesized decision rule mirrors the rational decision rule that individuals follow for standard economic activities:

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

The cost associated with unwanted pregnancy (which is a component of C) goes beyond the financial burden of giving birth and raising a child. For example, pregnancy and motherhood can diminish earnings through their negative impact on educational opportunities and labor market participation (Angrist and Evans, 1999). Further, the opportunity to give up a child for adoption does not avoid the physical and financial cost of pregnancy and delivery, and can cause additional cost in the form of emotional hardship.

Induced abortion can reduce the costs of pregnancy and avoid those of motherhood. However, the procedure's legal status is an important

1. A "couple" here defines any pair of individuals who engage in heterosexual sexual activities.

2. Similar approaches to sexual behavior that base on costs and benefits are suggested, for instance, by Posner (1992) and Levine (2000). 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 in engaging in sexual activities.

determinant of its cost; therefore, it is a component of the cost of risky sexual behavior. If access to legal and safe abortions is restricted, these costs increase as a result of higher search and pecuniary costs, an increase in health risks[3], and the threat of criminal prosecution for both providers and seekers of illegal abortions. Consequently, our theoretical model predicts more and riskier sexual activities under more liberal abortion regimes.[4] This does not imply that every individual facing a more liberal abortion law will show riskier sexual behavior. For those who reject abortion regardless of its legal status, policy changes might be irrelevant.[5] However, for our prediction to hold, it suffices if at least some individuals adapt their sexual behavior to a change in abortion access.

3. Review of Abortion Laws

In the second half of the twentieth century, many countries have extended the circumstances under which abortions can legally be performed.[6] At the same time, there is a large variety of abortion legislation across countries. De jure abortion legislation is typically grouped into five categories (see, for example, Rahman et al., 1998). Starting with the most restrictive category, these are: abortion prohibited altogether or allowed only to save the woman's life; permitted to preserve her physical health; permitted to preserve her

3. The World Health Organization estimates that twenty million unsafe and illegal abortions are carried out every year, resulting in 78,000 maternal deaths and hundreds of thousands of disabilities. Today, since most developed countries have liberalized abortion-access, illegal abortion has primarily become a phenomenon of the developing world. See Cook and Dickens (1988), Cook et al. (1999), and Grimes et al. (2006).

4. It is also possible to generate this prediction with a simple model of condom use. If we assume that individuals use condoms to prevent conception and contracting STDs but that condoms are costly, abortion availability lowers the contraceptive benefits of condoms without changing their STD prevention capacity. This implies that once abortion becomes more widely available, individuals will be less likely to use condoms. Consequently, a ceteris paribus increase in STD incidence is predicted.

5. However, even for those individuals, the cost of rejecting sexual intercourse increases when abortion becomes widely accessible (Akerlof et al., 1996). These individuals may thus increase their sexual activities because of the higher cost of rejecting potential sexual partners and not because of the reduced risk of unplanned motherhood.

6. Investigating abortion policies worldwide, Cook and Dickens (1978, 1988), Cook et al. (1999), and Boland and Katzive (2008) identify 118 policy changes towards liberalization for 1967–2007. During the same period, more restrictive policies were implemented only 13 times.

mental health; permitted for socioeconomic reasons; and permitted on demand.

In our approach, we measure abortion access by grouping written abortion laws into three categories.[7] The first category incorporates the most restrictive legislation that permits abortion only when the woman's life or her physical health is at serious risk. These policies make it virtually impossible to obtain legal abortions on demand. The second category comprises laws that make abortion available for mental health and socioeconomic reasons. We use this generic category because the reading of mental health is in most cases rather liberal, so that mental health grounds often implicitly include socioeconomic reasons.[8] The third category covers all laws that permit abortion on demand.

We group the country periods in our sample group into the three categories as follows.

The first, most restrictive category that permits abortion only to preserve the pregnant woman's life or her physical health comprises Albania from 1980 until 1990[9], Ireland during the entire 1980–2000 sample period, Portugal from 1980 to 1983, and Spain from 1980 to 1985.[10]

7. The following categorization is based on the aforementioned five categories of the written abortion law. In addition to belonging to one of these categories, abortion laws also typically contain further provisions: Different third party authorization requirements involving physicians or committees of physicians, social workers, parents, or spouses in the abortion decision. Some laws make counseling and waiting periods mandatory. Financial support for the procedure also varies by country and by the reason for which abortion is obtained. While the cost of therapeutic abortions is commonly fully covered, abortions on demand often are paid for privately. Moreover, direct charges for abortions are not the only way in which income can affect abortion access. Additional costs typically accrue when health facilities that perform abortions are remote. This occurs not only in countries with few abortion facilities, but also if conscientious objection clauses are permitted and invoked by a large part of physician in an area, like in Southern Italy or Luxembourg. Also, in federal systems that regulate abortion at the state level, access can vary geographically.

8. Where not otherwise indicated, the following account draws from the United Nations *2002 International Review of Abortion Policies*. See United Nations (2002).

9. Albania fully liberalized its abortion law to make abortion on demand available in April 1991. For law changes that occur until June 15th of a given year, we group this year into the post-reform category. Correspondingly, when abortion law reform takes place in the second half of a given year, the reform year falls into the pre-reform abortion law category and only the next year is grouped into the post-reform category.

10. Prior to the 1981 reform which fully liberalized abortion, Dutch legislation did not permit abortion unless the woman's life was at risk, although the law was not strictly

Our second category that allows abortion for socioeconomic and mental health reasons includes all 1980–2000 country-time-cells for Poland[11], Cyprus, Finland, Iceland, Israel, Luxembourg, Switzerland, and the United Kingdom.

Moreover, the second abortion law category includes the pre-reform country-time-cells from six countries that moved from the socioeconomic and mental health grounds to the on demand category within the 1980–2000 period. These are Bulgaria from 1980 to 1989, the Czech Republic from 1980 to 1986, Hungary from 1980 to 1992[12], Romania from 1980 to 1989[13], West Germany from 1980 to 1992[14], and Canada from 1980 to 1987. For Portugal and Spain, countries which changed their abortion laws from the most restrictive to the socioeconomic and mental health grounds categories, the change occurred after 1983 for Portugal and after 1985 for Spain. Thus, they also fall into the second category that permits abortion on socioeconomic and mental health grounds.

Finally, the third, most liberal category of laws that permit abortion on demand includes the entire 1980–2000 period for the former Soviet

implemented. However, since for the Netherlands data on gonorrhea incidence are only available from 1982 onwards, we are not able to consider the 1981 reform in our analysis.

11. Poland is the only former socialist country that has continued to restrict abortion access. In fact, the democratically elected Polish governments have taken a tougher stance on abortion than their communist antecedents under whose rule abortion was legal in cases of unspecified "difficult living conditions." In 1993, all socioeconomic grounds were eliminated from the law, so that abortion remained legal only to preserve the woman's mental health. The socioeconomic grounds were briefly reinstated in 1997, but shortly after, a pro-life coalition regained the parliamentary majority and reestablished the more restrictive 1993 law.

12. In socialist Bulgaria, Hungary and, until 1986, Czechoslovakia, abortion was accessible on a number of socioeconomic grounds, including being unmarried. For married women, the socioeconomic criteria included a minimum number of existing children, age (typically 40 or over), a serious sickness of the husband, disintegration of the family, and difficult economic conditions

13. From the 1960s, in Romania, abortion was legal only for medical reasons and narrowly defined socioeconomic reasons. Abortion on socioeconomic grounds required abortion seeking women to already have five children under their care or to be older than 45 years of age.

14. The Western part of Germany operated under a law that allowed abortion on socioeconomic grounds since 1975. This legislation contrasted with that of the German Democratic Republic where abortion on demand was available. After unification, the separate legislations co-existed for almost three years until a Federal Constitutional Court ruling in 1993 made abortion on demand available in the entire country.

(Armenia, Azerbaijan, Belarus, Estonia, Georgia, Kyrgyzstan, Latvia, Lithuania, Moldova, Russia, Tajikistan, and Uzbekistan) and Yugoslavian States (Croatia, Serbia, Slovenia, and Macedonia) in our sample. It also includes Austria, Denmark, Italy, Norway, Sweden, and the United States. Moreover, the third category contains the post-reform years from the following countries that fully liberalized their abortion law during 1980–2000: Albania from 1991 to 2000, Bulgaria from 1990 to 2000, the Czech Republic from 1987 to 2000, Hungary from 1993 to 2000, Romania from 1990 to 2000, (West) Germany from 1993 to 2000, The Netherlands from 1981 to 2000, and Canada from 1988 to 2000.

For each country in our sample, Table 1 reports our coding of the abortion legislation, details of the law including its date of inception, and the periods for which gonorrhea incidence data are reported.

4. Empirical Strategy

The aim of this paper is to investigate whether a change in the cost of sexual activity leads to changes in sexual behavior. Given a lack of data on sexual activities (see, for instance, Fenton et al., 2001 and Hewett et al., 2008), we exploit the fact that certain infectious diseases are primarily transmitted through sexual intercourse. We use the reported incidence of a prominent STD, gonorrhea, as a proxy for risky sexual activities. For a number of reasons, the reported gonorrhea rate is attractive as a proxy for the frequency of risky sexual activity. It is one of the most frequent STDs[15], and time-series data are available for a large set of countries. Further, its latency period is short, minimizing the lag between infection and diagnosis and because it is easily cured, gonorrhea has simpler dynamics than other STDs (Klick and Stratmann, 2003, 2008). Finally, in contrast to syphilis, gonorrhea is not primarily transmitted among homosexual individuals.[16]

15. In 1995, global incidence was only higher for Trichomoniasis and Chlamydia (Gerbase et al., 1998).

16. For the United States, the share of gonorrhea cases that are contracted through homosexual intercourse is estimated to be 20%, while for syphilis, it is three times as large (Center for Disease Control, 2006).

Table 1. Abortion Legislation in 41 Countries and Periods Included in 1980–2000 Sample.

Country	Category	Abortion Law	In Sample
Former Soviet States			
Armenia	On Demand	Based on 1955 (23 Nov) Edict of the Soviet Union	1980–2000
Azerbaijan	On Demand	Based on 1955 (23 Nov) Edict of the Soviet Union	1980–2000
Belarus	On Demand	Based on 1955 (23 Nov) Edict of the Soviet Union	1980–2000
Estonia	On Demand	Based on 1955 (23 Nov) Edict of the Soviet Union	1980–2000
Georgia	On Demand	Based on 1955 (23 Nov) Edict of the Soviet Union	1980–2000
Kyrgyzstan	On Demand	Based on 1955 (23 Nov) Edict of the Soviet Union	1980–2000
Latvia	On Demand	Based on 1955 (23 Nov) Edict of the Soviet Union	1980–2000
Lithuania	On Demand	Based on 1955 (23 Nov) Edict of the Soviet Union	1980–2000
Moldova	On Demand	Based on 1955 (23 Nov) Edict of the Soviet Union	1980–2000
Russia	On Demand	Based on 1955 (23 Nov) Edict of the Soviet Union	1980–2000
Tajikistan	On Demand	Based on 1955 (23 Nov) Edict of the Soviet Union	1980–2000
Uzbekistan	On Demand	Based on 1955 (23 Nov) Edict of the Soviet Union	1980–2000
Former Yugoslavian States			
Croatia	On Demand	1978 (21 Apr) Law no. 1252-1978	1980–2000
Serbia	On Demand	1977 (30 Jun) Act on Termination of Pregnancy.	1980–2000
Slovenia	On Demand	1977 (20 Apr) Law on Right to a Free Decision regarding Birth	1980–2000
Macedonia	On Demand	1969 (26 Apr) Decree on Pregnancy Termination	1980–2000
Other Former Socialist Countries			
Albania	Life/Physical	1977 (15 Jun) Criminal Code, sect. 95	1980–1987, 1990
	On Demand	1991 (29 Apr) Law no. 7491, art. 16/1995 (7 Dec) Law no. 8045	1991–1999
Bulgaria	Mental/Socioec.	1973 (Apr) Decree no. 0-27 of Ministry of Public Health, amend.: 1974	1985, 1988–89

(continued)

Table 1. Continued

Country	Category	Abortion Law	In Sample
	On Demand	1990 (2 Feb) Decree no. 2 of Ministry of Health and Social Welfare	1990–2000
Czech Republic	Mental/Socioec.	1973 (16 May) Decree no. 69-71	1980–1986
	On Demand	1986 (Oct 20) Law no. 73	1987–2000
Hungary	Mental/Socioec.	1973 Resolution no. 1040 of Council of Ministers; 1973 ordinance no. 4 Minister of Health; 1986 (23 July) Ordinance 3	1980–1992
	On Demand	1992 (17 Dec) Law no. 79 on Protection of the Life of the Fetus	1993–2000
Poland	Mental/Socioec.	1956 (27 Apr) Law no. 61, 1990 (30 Apr) Ordinance of Ministry of Health and Social Welfare; 1993 (7 Jan) Law on Termination of Pregnancy, repealed in 1996, re-enacted in 1997	1980–2000
Romania	Mental/Socioec.	1966 (29 Sep) Council of State Decree no. 770, last amended in 1985	1980–1989
	On Demand	1989 (26 Dec) repeal of former law; 1996 (5 Nov) Law no. 140	1990–2000
Western Europe and Israel			
Austria	On Demand	1974 (23 Jan) Federal Law	1980–2000
Cyprus	Mental/Socioec.	1974 Criminal Code, sec. 167–169 and 169A, amend.: 1986 Law no. 186	1984–2000
Denmark	On Demand	1973 (13 June) Law no. 350, amend.: 1995 (14 June) Law no. 389	1980–2000
Finland	Mental/Socioec.	1978 (14 July) Law no. 564; 1985 (12 July) law no. 572	1980–2000
(W.) Germany	Mental/Socioec.	1976 (18 May) penal code sect. 218	1980–1989, 1991–1992
	On Demand	1993 (28 May) Const. Court decision, new law in effect 1995 (1 Oct)	1993–2000
Iceland	Mental/Socioec.	1975 (27 May) Law no. 25	1980–2000
Ireland	Life/Physical	1861 Constitution, Offences against the Person Act	1989–2000

(continued)

Table 1. Continued

Country	Category	Abortion Law	In Sample
Israel	Mental/Socioec.	1979 (16 Dec) Amendment of 1977 (31 Jan) Penal Law	1980–2000
Italy	On Demand	1978 (22 May) Law no. 194	1980–2000
Luxembourg	Mental/Socioec.	1978 (15 Nov) Penal Code, title VII, chapter I, art. 348–353	1980–2000
Netherlands	On Demand	1981 (1 May) Law on Termination of Pregnancy	1982–2000
Norway	On Demand	1978 (16 Jun) Law no. 66, Sec. 1–14	1980–2000
Portugal	Life/Physical	1886 (16 Sep) Criminal Code, sect. 385	1980–1983
	Mental/Socioec.	1984 (11 May) Law no. 6, sect. 139–141	1984–2000
Spain	Life/Physical	1800s	1982–1985
	Mental/Socioec.	1985 (5 July) Organic Law No. 9	1986–2000
Sweden	On Demand	1974 (14 June) Abortion Law (no. 595), amended 1995 (18 May)	1980–2000
Switzerland	Mental/Socioec.	1937 (21 Dec) Penal Code, art. 118–120 (last amended 1942)	1980–2000
UK[a]	Mental/Socioec.	1967 Abortion Act, amended 1990	1980–2000
North America			
US	On Demand	Nationwide: 1973 Supr. Court decisions (*Roe v. Wade*; *Doe v. Bolton*)	1980–2000
Canada	Mental/Socioec.	1969 Criminal Code, sec. 251	1980–1987
	On Demand	1988 Const. Court decision (*R v. Morgentaler*)	1988–2000

Source: United Nations.
[a]Excluding Northern Ireland.

With an unbalanced panel of 41 countries and 21 years from 1980 to 2000, we estimate the following regression equation:

$$\text{GONRATE}_{it} = \beta_1 \text{on demand}_{it} + \beta_2 \text{socment}_{it} + \gamma X_{it} + \lambda_i + \nu_t + \varepsilon_{it}. \quad (2)$$

The independent variable GONRATE_{it} is the number of newly diagnosed reported gonorrhea cases per 100,000 individuals per year t and country i.

ε_{it} represents an idiosyncratic error term. We estimate these models with weighted least squares using a country's population as a weight.[17]

To model the relationship between abortion access on the reported incidence of gonorrhea, our model includes two abortion law dummy variables. ondemand$_{it}$ equals 1 if country i permits abortion on demand in period t, and 0 otherwise. Correspondingly, socment$_{it}$ equals 1 if the current legislation permits abortion on socioeconomic or mental health grounds. The omitted reference category is laws that permit abortion only to save the pregnant woman's physical health or her life. In an alternative specification, we use an abortion law dummy that equals 1 if abortion is available on demand or on socioeconomic or mental health grounds and 0 if abortion is only legal to save the pregnant woman's life or her physical health. Since we use the most restrictive regimes that only permit abortion to save the woman's life or physical health as the implicit comparison group, our theory predicts positive abortion law coefficients β.

The vector X_{it} contains control variables and γ is the corresponding vector of coefficients. The controls include two macroeconomic measures to capture a country's level of societal development. Namely, we include gross domestic product (GDP) per capita in 2005 US-dollars and the annual change in a consumer price index (CPI) measured by three indicator variables: between 5 and 25%, between 25 and 100%, and $>100\%$. The omitted reference category is a change of $<5\%$. Theory does not provide clear guidance for the signs of coefficients on income and inflation. On the one hand, poverty and economic volatility may coincide with a shortage in contraceptive supply and worse healthcare in general, leading to high gonorrhea incidence (Jones et al., 2002). On the other hand, if sexual activity is a normal good, wealthier societies may show higher STD rates.

17. This weighting is common in studies examining rates as the dependent variable, since a larger population is likely to generate lower sampling variance leading to heteroskedasticity that is related to population size (see, e.g., Greene, 2011). However, a few recent sources have cautioned against using weighted least squares as a solution for heteroskedasticity (see, e.g., Wooldridge, 2008 and Angrist and Pischke, 2008). These sources suggest that White robust standard errors handle heteroskedasticity sufficiently well, without giving rise to a potential bias that accompanies weighted least squares estimation. Although we provide non-weighted estimates as a robustness check, we prefer the weighted estimates for reasons suggested below.

The vector X_{it} also includes the percent share of the population aged 15–24. Since this is the age group with the highest likelihood of contracting gonorrhea (Lowndes and Fenton, 2004b), we expect a positive coefficient on this variable. Furthermore, we incorporate urbanization and population density to account for the role of remoteness and agglomeration in the development of legal norms and the transmission of STDs (Dehne et al., 2002). Finally, as from the previous work by Dee (2008), it has been found that the right to same-sex-marriage can lead to changes in STD incidence, we also include an indicator variable that equals 1 if a country grants such rights and 0 otherwise.

Our regression controls for common period effects in reported gonorrhea incidence through ν_t. The country-fixed effects λ_i absorb time-invariant country characteristics like cultural and religious norms that may affect both abortion legislation and the incidence of gonorrhea. The country effect is also useful because it allows us to control for the country difference in gonorrhea surveillance systems that we discuss in the appendix. Furthermore, we include country-specific time trends to control for differential trends not captured by the year indicators and our other controls.

We identify the relationship between abortion access on reported gonorrhea incidence by the discrete changes in abortion laws in the nine countries that substantially reformed their abortion legislation in the sampled period, namely Albania, Bulgaria, Canada, the Czech Republic, Germany, Hungary, Portugal, Romania, and Spain. The control group consists of the 32 other countries in our sample which did not change between our abortion law categories in the sampled periods. The identification strategy thus hinges on the comparability of the law-changing and non-law changing countries once we control for the covariates included in equation (2). However, since one might wonder if the countries changing their laws in this period are somehow different from the others that maintain constant abortion access for the entire 20-year period, we present most of our results restricting attention to only those law-changing countries. Our results survive this sample restriction, despite the reduction in statistical power resulting from a reduction from 41 countries to a mere nine.

5. Data

We obtained gonorrhea incidence data[18] for Europe and Central Asia from WHO's European Health for All Database (World Health Organization, 2009). The WHO collects data from national sources. For the United States and Canada, we obtained incidence data directly from their national STD surveillance agencies (Center for Disease Control, 1994, 1998, 2002, and Public Health Agency of Canada, 2008).

Because there are no internationally binding guidelines for the collection of gonorrhea data, the accuracy and detail of reported incidence rates vary between countries and across time. Countries differ in their capacity to identify individuals who have contracted gonorrhea. Furthermore, even though we only consider countries which mandate physicians to report gonorrhea cases to the national surveillance agency, physician reporting rates differ across countries (See Lowndes and Fenton, 2004a, Panchaud et al., 2000, Dehne et al., 2002, Van Duynhoven, 1999). We describe the variation in data collection methods and data quality in further detail in the appendix. As discussed in the previous section, the inclusion of country-fixed effects and country-specific time trends in our model enables us to control for some of these differences.[19] Also, to the extent that differential fastidiousness generates dependence within the data for a given country, using standard errors clustered at the country level accounts for such effects.

We obtained the GDP per capita and CPI time-series online from the United States Department of Agriculture's Economic Research Service (United States Department of Agriculture, 2009). To obtain estimates of the total population, the share of the population aged between 15 and 24, the degree of urbanization and population density, we used the United Nation's World Population Prospect (United Nations, 2007). Because these data are

18. For the robustness checks in Section 7, we also acquired data on syphilis, malaria, and tuberculosis.

19. Gonorrhea incidence data are missing for 28 of the 861 country-time cells in our sample, namely for Albania 1988, 1989, and 2000, for Bulgaria 1980–1984, and 1986–1987, for Cyprus 1980–1983, for Germany 1990, Ireland 1980–1988, for The Netherlands 1980–1981, and for Spain 1980–1981. Because in no case the missing data points fall into the immediate vicinity of abortion law changes (one period before or after), and usually occur at the beginning of a country time series, we assume the data gaps to be random with respect to abortion law. The issue of missing data is addressed in further detail in Section 7.

Table 2. Summary Statistics.

Variable	Description	Mean	SD	Source
Disease				
Gonorrhea	Reported gonorrhea cases per 100,000 residents	54.92	66.42	US: CDC
Syphilis	Reported syphilis cases per 100,000 residents	14.46	32.27	Can: PHAC
Malaria	Reported malaria cases per 100,000 residents	4.05	28.88	Others
Tuberculosis	Reported tuberculosis cases per 100,000 residents	32.45	24.39	WHO
Abortion/Births				
Abortions	Estimated abortions per 1,000 women age 15–44	37.56	18.61	AGI
Births	Reported births per 1,000 residents	12.34	1.81	UN
Abortion Law				
On Demand/ Socioec./Mental	=1 if abortion legal to preserve woman's mental health, for socioeconomic reasons, or on demand; =0 otherwise	0.95	0.21	UN
Socioec./Mental	=1 if abortion legal to preserve woman's mental health or for socioeconomic reasons; =0 otherwise	0.31	0.46	UN
On Demand	=1 if abortion is legal on demand; =0 otherwise	0.65	0.48	UN
Control Variables				
GDP	Real GDP per capita in 2005 US dollars	15,316	14,744	USDA
$5\% \leqslant \text{CPI} < 25\%$	=1 if annual inflation between 5 and 25%; =0 otherwise	0.29	0.45	USDA
$25\% \leqslant \text{CPI} <$ 100%	=1 if annual inflation between 25 and 100%; =0 otherwise	0.08	0.27	USDA
$\text{CPI} \geqslant 100\%$	=1 if annual inflation is 100% or greater; =0 otherwise	0.08	0.28	USDA
Population 15–24	Percent of population aged 15–24 (linearly interpolated)	15.70	2.25	UN
Urbanization	Percent of population living in urban areas (linearly interpolated)	64.73	15.46	UN
Population Density	Population per square kilometer (linearly interpolated)	98.08	82.28	UN
Same Sex Marriage	=1 if same sex marriage legal; =0 otherwise	0.04	0.19	Dee (2008)

Note: Abortions variable only calculated for Bulgaria, Canada, Czech Republic, and Hungary for years covered in Henshaw et al. (1999). CDC: Centers for Disease Control, PHAC: Public Health Agency of Canada, WHO: World Health Organization, UN: United Nations, USDA: United States Department of Agriculture.

available only in five-year intervals, linear interpolation was used to fill the data gaps. Data on same-sex-marriage laws was acquired from Dee (2008) and other online sources.

Table 2 presents summary statistics for the variables in our empirical models.

6. Results

Before examining our regression results, we provide Figure 1 which graphically examines the change from pre-existing trends in gonorrhea rates occurring at the time the legal changes were made in Albania, Bulgaria, Canada, Czech Republic, Germany, Hungary, Portugal, Romania, and Spain. In each graph, we provide an extrapolation of the pre-law trend, the actual observation, and a reference line noting when the law changed.

While graphs can be misleading, primarily because they do not condition on other changing variables, it is interesting to note that Albania, Bulgaria, Czech Republic, Hungary, Portugal, and Romania all provide at least weak patterns consistent with our hypothesis. In each of these cases, the observation (within a year or two) following the law change diverges

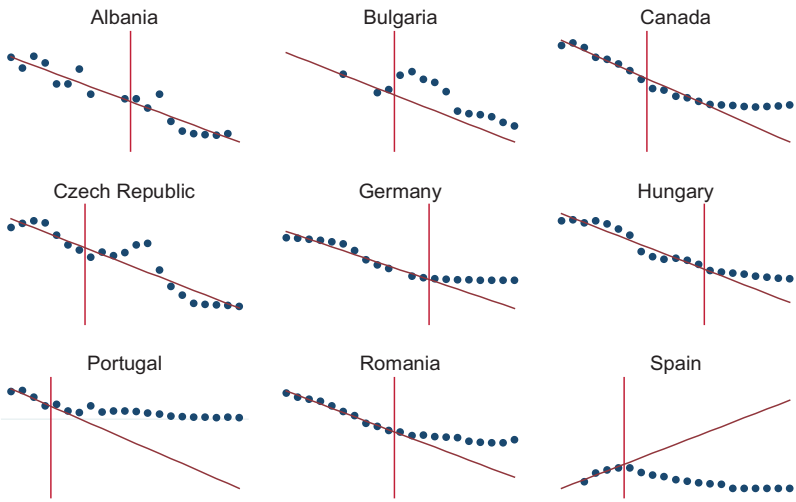

Figure 1. Gonorrhea Changes Associated with Law Changes.

upward from the projected trend. Canada's and Germany's pre-existing trends both suggest negative rates in the year following the law change, making it difficult to discern much of an effect. Spain appears to go in the opposite direction, though, as we note, Spain is among the group of countries with relatively poor gonorrhea surveillance in our sample.

Because simple time-series trends can be misleading, we exploit the panel nature of our data. Table 3 presents the results of our econometric analysis. Columns 1 and 2 of Table 3 report coefficient estimates for models that measure abortion access with an indicator variable that equals 1 if abortions are available on demand or on socioeconomic or mental health grounds, and 0 if abortions are legal only to save the woman's physical health or life.

Columns 3 and 4 of Table 3 present results for models that include two separate indicator variables for laws that permit abortions on demand and for laws that permit it on socioeconomic or mental health grounds. Columns 1 and 3 do not include covariates other than the country- and time-fixed effects and a country-specific time trend, whereas columns 2 and 4 add the full set of covariates captured in the vector X_{it} discussed in Section 4.

Because in all four specifications our reference category are laws that allow abortion only to save the woman's life or to preserve her physical health, the reported coefficients measure the impact of increased access to abortion relative to the most restrictive legislation. Below each coefficient estimate, we report standard errors with clustering at the country level in parentheses.[20]

The results presented in columns 1 and 2 suggest that changes in legislation from the most restrictive abortion laws to a law that makes abortion available on demand or on socioeconomic or mental health grounds leads to an increase of 35 cases of gonorrhea per 100,000 residents. This represents an increase of more than 60%. Column 2 shows that this result declines slightly when additional covariates are included in the model. Both

20. We also estimated specifications allowing for multi-way clustering (see Cameron, 2011) along the country and year dimensions to account both for the normal time series dependence within a country as well as cross-sectional dependence arising from sources such as changes in WHO reporting conventions, etc. Those results are qualitatively similar to the results presented here.

Table 3. Relationship between Abortion Access and Reported Gonorrhea Incidence Rate for Full Sample of Countries.

	(1)	(2)	(3)	(4)
On Demand/	35.19***	32.79***		
Socioec/Mental	(5.06)	(8.17)		
On Demand			35.97*	37.11**
			(18.43)	(18.15)
Socioec. / Mental			35.14***	32.43***
			(5.78)	(8.86)
GDP per Capita		0.01*		0.01*
		(0.00)		(0.00)
5% ⩽ CPI < 25%		1.73		1.60
		(2.81)		(2.91)
25% ⩽ CPI < 100%		15.09***		15.01***
		(4.27)		(4.14)
CPI⩾100%		59.40**		59.26**
		(2.44)		(22.55)
Population 15–24		5.50**		5.59**
		(2.44)		(2.45)
Urbanization		1.12		1.17
		(4.26)		(4.18)
Population		−5.00*		−5.03*
Density		(2.81)		(2.78)
Same Sex		10.90		10.91
Marriage		(18.11)		(18.18)
Country Effects	Yes	Yes	Yes	Yes
Time Effects	Yes	Yes	Yes	Yes
Country Trend	Yes	Yes	Yes	Yes
R^2	0.97	0.98	0.97	0.98

Robust standard errors with clustering at the country level are presented in parentheses.
The dependent variable is the number of individuals per 100,000 residents who are diagnosed with gonorrhea in year t in country i. Columns 1 and 2 show estimation results for models that use the indicator abortion variable that equals 1 if abortion is legal on demand or on socioeconomic or mental health grounds and 0 if abortion is only legal to save the woman's life or to preserve her physical health. Columns 3 and 4 show estimation results for models that use indicator variables derived from the three category abortion law categorization. Each regression is estimated with population weights. Sample period: 1980–2000. $N = 833$.
$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

coefficients are statistically significant at the 1% level. The results are in line with our expectation that easier access to abortion leads to higher reported gonorrhea incidence.

Columns 3 and 4 represent results for the specifications that use separate indicators for laws that make abortion available on demand and laws make it available on socioeconomic or mental health grounds. The results are qualitatively similar to those for the single abortion indicator. Although the on

Table 4. Relationship between Abortion Access and Reported Gonorrhea Incidence Rate Using Only Countries Changing Law During Sample Period.

	(1)	(2)	(3)	(4)
On Demand/	47.68***	34.09***		
Socioec./Mental	(9.87)	(7.80)		
On Demand			52.74***	41.81***
			(12.13)	(9.37)
Socioec./Mental			47.11***	33.15***
			(10.74)	(7.69)
Controls	No	Yes	No	Yes
Country Effects	Yes	Yes	Yes	Yes
Time Effects	Yes	Yes	Yes	Yes
Country Trend	Yes	Yes	Yes	Yes
R^2	0.96	0.98	0.96	0.98

Robust standard errors with clustering at the country level are presented in parentheses.
The dependent variable is the number of individuals per 100,000 residents who are diagnosed with gonorrhea in year t in country i. Columns 1 and 2 show estimation results for models that use the indicator abortion variable that equals 1 if abortion is available on demand or on socioeconomic or mental health grounds and 0 if abortion is only legal to save the woman's life or to preserve her physical health. Columns 3 and 4 show estimation results for models that use indicator variables derived from the three category abortion law categorization. Models indicating that controls were used include all the control variables used in Table 3. Each regression is estimated with population weights. Sample period: 1980–2000. $N = 176$.
$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

demand coefficient is statistically significant at the 10 and 5% levels in the no controls and full controls specifications, respectively, in both cases, the two abortion law coefficients are jointly significant at the 1% level.

The socioeconomic/mental exception law coefficient is smaller than the on demand coefficient in both cases, but it is statistically significant at the 1% level in both specifications, owing to greater precision. In neither case is the difference between the two laws' coefficients statistically significant, suggesting that the requirement to provide socioeconomic or mental health grounds to be granted access to abortion may not be rigorously enforced.

In Table 4, we restrict attention to only those nine countries that change their law during our sample period. Although doing so reduces statistical power, it reduces the chance that unobserved heterogeneity is driving our results if the law changing countries systematically differ from the rest of the sample.

In all cases, the law coefficients increase in magnitude, and each is statistically significant at the 1% level. Interestingly, once attention is restricted to the law changing countries, the differential between the

relationship between the on demand regime and regimes conditioning access on socioeconomic/mental health concerns grows. In both cases, the on demand coefficient is larger in magnitude, and the difference between the two effects is statistically significant at the 1% level. This raises the possibility that enforcement of the socioeconomic/mental health conditions is more serious in this subset of countries.

7. Robustness Checks

In the specifications presented in Tables 3 and 4, we examined the level of the gonorrhea rate consistent with the earlier work of Klick and Stratmann (2003, 2008). However, one concern may be that our results are driven by outliers. To address this concern, Table 5 presents the full control specification from the previous table, using only the law-changing countries, and compares the level results with coefficients estimated using log gonorrhea rate as the dependent variable. Interestingly, the magnitude of the relative effect increases in the log specification. While this may suggest that our main results actually understate the true relationship between abortion liberalization on gonorrhea rates, at a minimum, it mitigates concerns that outliers are driving the result.[21]

Another concern involves the use of a weighted least squares estimation technique. Although WLS is the normal approach to modeling rates as dependent variables, some have raised concerns. Namely, if heteroskedasticity robust standard errors are used, the usual justification for WLS, that it accounts for the lower sampling variation found in large population areas, seems to be weakened. Some (e.g., Angrist and Pischke, 2008) even suggest that WLS can introduce bias into the estimates.

In some sense, the bias issue depends on interpretation. It is almost surely the case that there is heterogeneity in the relationship we estimate. Given that, the question arises about how to average over that heterogeneity. If the

21. We have also estimated the relationship using leverage robust regression techniques (e.g., Stata's rreg command). This approach also mitigates any concerns about the influence of high leverage observations since we get qualitatively similar results to those presented here.

Table 5. Relationship between Abortion Access and Level and Log Reported Gonorrhea Incidence Rates Using Different Weighting Schemes. Sample Restricted to Countries Changing Their Law During the Sample Period.

	(1) Level Population Weighting	(2) Log Population Weighting	(3) Level Equal Weighting	(4) Log Equal Weighting
On Demand	41.81***	2.09***	24.98*	1.58**
	(9.37)	(0.20)	(10.94)	(0.49)
Socioec. / Mental	33.15***	1.93***	18.27*	1.58***
	(7.69)	(0.13)	(9.72)	(0.42)
Controls	Yes	Yes	Yes	Yes
Country Effects	Yes	Yes	Yes	Yes
Time Effects	Yes	Yes	Yes	Yes
Country Trend	Yes	Yes	Yes	Yes
R^2	0.98	0.94	0.96	0.95

Robust standard errors with clustering at the country level are presented in parentheses. The dependent variable in columns 1 and 3 is the number of individuals per 100,000 residents who are diagnosed with gonorrhea in year t in country i. Columns 2 and 4 use the natural log of this measure. The presented coefficients show estimation results for models that use indicator variables derived from the three category abortion law categorization. All models include the control variables used in Table 3. Regressions for columns 1 and 2 use population weights. Sample period: 1980–2000. $N = 176$.
$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

research question involves what a country can expect to happen, on average, when it liberalizes its abortion access laws, equal weighting is appropriate (assuming heteroskedasticity is dealt with appropriately). If, instead, the research question involves the microeconomic issue regarding how a randomly chosen representative individual's behavior is likely to change in the face of a legal change, population weighting is correct independent of its use as a solution to the heteroskedasticity problem. Failing to weight by population would put too much weight on a small country's heterogeneous effect, while putting too little on a large country's effect.

Because we view this issue as primarily one of micro behavior, we prefer the WLS approach. That said, we also provide equally weighted OLS estimates in columns 3 and 4 of Table 5. We continue to estimate a statistically significant positive relationship between both law types (on demand: $p = .052$ in level specification, $p = .012$ in log specification; socioeconomic/mental: $p = .097$ in level specification, $p = .006$ in log specification).

Although the log specifications mitigate concerns about outliers, the point estimates in these specifications are problematic. While the level specifications suggest a relative relationship between moving to abortion on demand of 84 and 61% in the population weighted and equal weighted models, respectively, the log models suggest relative changes that are an order of magnitude larger. Similar effect differences are observed with respect to abortion on socioeconomic or mental health grounds. This huge difference seems to be completely driven by the inclusion of Germany, Portugal, and Spain, each of which have very poor reporting rates, averaging less than 50% of all cases. If these countries are excluded from the analysis in Table 5, the log specifications generate effect sizes of about 50% which is comparable to our original findings in the level specifications.

Another concern arises given that some of our law-changing countries have incomplete gonorrhea data throughout the sample period. If we restrict our attention to the six law-changing countries whose data are complete in the period 1982–2000,[22] we find comparable results, as shown in Table 6.

We are also concerned about the possibility that we are picking up some unobserved shift in health awareness. That is, perhaps underlying gonorrhea rates are not changing, but, rather, it is merely diagnoses that are increasing as people receive more health resources. To address this possibility, we examine other communicable diseases for which we have data for the law-changing countries. In principle, these diseases should not exhibit any increase in infection rates related to the law changes, but they could exhibit increasing diagnosis rates if the legal changes just happen to occur coincidentally with some increase in health awareness.

The diseases for which data are available are syphilis, malaria, and tuberculosis. As mentioned above, although syphilis is an STD, it is a disease that is primarily an issue in the male homosexual community, suggesting that it will not be affected by our proposed causal mechanism. As shown in Table 7, we find no effect for syphilis or malaria. Interestingly, we do

22. Canada, Czech Republic, Hungary, Portugal, Romania, and Spain. Data for Spain are missing for the very beginning of the sample period (1980 and 1981), so we restrict our analysis to 1982–2000. However, if we leave Spain out and use the full time series for the other five countries, our results are qualitatively similar. Moreover, the results we obtain when also including countries with complete gonorrhea data that did not change their abortion laws during the sampled period are also qualitatively similar to those shown in Table 3.

Table 6. Relationship between Abortion Access and Reported Gonorrhea Incidence Rate Using Only Countries Changing Law During Sample Period that Allow for a Balanced Sample.

	(1)	(2)
On Demand	35.57**	23.60***
	(10.60)	(4.98)
Socioec. / Mental	43.32**	21.18
	(13.83)	(10.60)
Controls	No	Yes
Country Effects	Yes	Yes
Time Effects	Yes	Yes
Country Trend	Yes	Yes
R^2	0.93	0.97

Robust standard errors with clustering at the country level are presented in parentheses. The dependent variable is the number of individuals per 100,000 residents who are diagnosed with gonorrhea in year t in country i. The presented coefficients show estimation results for models that use indicator variables derived from the three category abortion law categorization. All models include the control variables used in Table 3. All regressions use population weights. Only those countries that had complete data availability for 1982–2000 are included in the analyses presented in this table. $N = 114$.
$^{*}p < .10$, $^{**}p < .05$, $^{***}p < .01$.

Table 7. Relationship between Abortion Access and Incidence Rates of Other Infectious Diseases Using Only Countries Changing Law During Sample Period.

	(1) Gonorrhea	(2) Syphilis	(3) Malaria	(4) Tuberculosis
On Demand	41.81***	0.54	0.11	6.79**
	(9.37)	(0.66)	(0.26)	(2.84)
Socioec. / Mental	33.15***	−0.06	0.30	7.07**
	(7.69)	(2.04)	(0.25)	(2.51)
Controls	Yes	Yes	Yes	Yes
Country Effects	Yes	Yes	Yes	Yes
Time Effects	Yes	Yes	Yes	Yes
Country Trend	Yes	Yes	Yes	Yes
R^2	0.98	0.96	0.85	0.97

Robust standard errors with clustering at the country level are presented in parentheses. The dependent variable in columns 1–4 is the number of individuals per 100,000 who are diagnosed with gonorrhea (1; $N = 176$), syphilis (2, $N = 157$), malaria (3; $N = 170$), and tuberculosis (4; $N = 183$) in year t in country i. The presented coefficients show estimation results for models that use indicator variables derived from the three category abortion law categorization. All models include the control variables used in Table 3. All models use population weights. Sample period: 1980–2000.
$^{*}p < .10$, $^{**}p < .05$, $^{***}p < .01$.

find a statistically significant increase in tuberculosis. Upon further examination, however, this appears to make sense. Namely, tuberculosis is often co-morbid with gonorrhea since gonorrhea weakens a person's immune system.[23] It is interesting to note that the tuberculosis effect is much smaller, absolutely and relatively, than the gonorrhea effect, suggesting it is unlikely that people are being diagnosed for gonorrhea ancillary to being treated for tuberculosis.

One last analysis we perform is an attempt to provide greater context for our results. Namely, if increasing abortion access does not affect the underlying rate of sexual activity, any additional abortions should be reflected in a comparable decline in birth rates. If, instead, increasing abortion access leads individuals to engage in more sex or be more likely to engage in sex without using a condom, on the margin, abortion rates should increase more than birth rates decline. To examine this issue, we use data from the Alan Guttmacher Institute (Henshaw et al., 1999) on cross country abortion rates during the sample period under consideration here. Unfortunately, abortion data for many countries are not available. However, high quality abortion data are available for four of our law changing countries: Bulgaria, Canada, Czech Republic, and Hungary.

In Table 8, we examine the change in gonorrhea rates, birth rates, and abortion rates associated with these countries' (denoted as the limited sample in the table) movement from abortion for socioeconomic/mental reasons to abortion on demand. We find that while abortion rates increase by about 7%, birth rates only decline by 2%. Gonorrhea rates increase by about 28%. These results are consistent with a model in which individuals engage in more risky sex when abortion access increases.

While it is difficult to calibrate these results precisely, they are not implausible. While some estimates place the likelihood of a woman getting pregnant in a given sexual encounter at 20%, these estimates generally assume the sex occurs at the most fertile period of the woman's cycle. This implies that the likelihood for any given sexual encounter is well below 10% (Wilcox et al., 1995). On the other hand, credible estimates suggest that a

23. See, for example, the CDC Gonorrhea Fact Sheet available at http://www.cdc.gov/std/gonorrhea/stdfact-gonorrhea.htm. In addition to generally weakening an individual's immunities, gonorrhea also leads to a greater susceptibility to HIV, and HIV greatly increases one's likelihood of contracting tuberculosis.

Table 8. Relationship between Abortion Access and Log Reported Gonorrhea Incidence Rate, Log Births per 1,000 Population, and Log Abortions per 1,000 Women of Fertile Age.

	Ln(gonorrhea rate)		Ln(birth rate)		ln(abortion rate)	
On Demand	0.23**	0.25**	0.21***	−0.02	0.95***	0.07
	(0.10)	(0.06)	(0.05)	(0.03)	(0.06)	(0.11)
Socioec. / Mental	0.26		0.21***		0.86***	
	(0.26)		(0.05)		(0.14)	
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Country Effects	Yes	Yes	Yes	Yes	Yes	Yes
Time Effects	Yes	Yes	Yes	Yes	Yes	Yes
Country Trend	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.98	0.98	0.97	0.99	0.99	0.99
Sample	Expanded	Limited	Expanded	Limited	Expanded	Limited

Robust standard errors with clustering at the country level are presented in parentheses.
Models estimated on expanded sample include all countries with gonorrhea reporting rates above 50% that also have abortion estimates available from Henshaw et al. (1999). Models estimated on limited sample use data from countries changing abortion law to "on demand" abortion for which abortion estimates are available from Henshaw et al. (1999): Bulgaria; Canada; Czech Republic; and Hungary. All models include the control variables used in Table 3. All models use population weights. Sample period for gonorrhea and births: 1980–2000. Years covered for abortions: 1980, 1982, 1984, 1986, 1988, and 1990–1996.
$^{*}p < .10$, $^{**}p < .05$, $^{***}p < .01$.

woman will contract gonorrhea with a probability of at least 60% in a given sexual encounter with a man infected with gonorrhea (National Institute of Health 2001). Whether or not the random abortion law-induced encounter is likely to be with someone with gonorrhea is unknowable, but, if it is, and pregnancy is less likely than gonorrhea contraction by a factor of 6, then the "missing" 5% decline in births is consistent with a 30% increase in gonorrhea incidence. While we do not place that much confidence in the precision of our point estimates, especially since the relevant data set is very small, the results in Table 8 suggest the effect sizes we find are completely plausible.

Despite the plausible claim that gonorrhea may exhibit a greater response to abortion liberalization than abortion rates themselves do, as laid out above, it is reasonable to suggest that the small abortion effect we find casts doubt on our primary results. Intuitively, since abortion rates are generally higher in many countries than are gonorrhea rates, one might expect a larger effect on abortions themselves if our posited mechanism is at work. While such a claim relies on certain assumptions regarding who is the marginal individual for whom easier abortion access leads to a change in behavior

(if it is someone likely to have sex with a partner infected with gonorrhea or not, as discussed above, then it is reasonable to think that any gonorrhea effect will be larger than any change in abortion rates), it is valuable to see if we can better identify the abortion relationship. To do this, we also provide results from an expanded sample, which includes all countries with available abortion data that also have gonorrhea reporting rates above 50%.[24] By including these additional countries, we can better estimate the underlying time effects common to all countries.

This expanded sample generates a comparable gonorrhea effect, while liberalized abortion access appears to be associated with statistically significant increases in both the birth rate and the abortion rates. Both of these results are consistent with a story whereby increased access to abortion leads people to engage in more risky sex.

8. Conclusion

The aim of this paper is to investigate whether decisions on sexual activity are in part driven by considerations of costs and benefits. To test this hypothesis, our empirical approach relates abortion laws of different restrictiveness to reported gonorrhea incidence which is our proxy for risky sexual behavior. In our econometric analysis, we use data from 41 countries for the 1980–2000 period, as well as a more focused analysis of the nine countries that change their abortion laws during the sample period.

Consistent with our theoretical prediction and consistent with the results of Klick and Stratmann (2003, 2008), we find that compared with legislation that only permits abortion to save the woman's life or her physical health, less restrictive abortion policies lead to significantly higher reported gonorrhea incidence. Our results are robust against a set of alternative model specifications that include the use of different weighing schemes and subsamples. Results for non-sexually transmitted diseases suggest that our findings are likely not driven by omitted variable bias arising from factors that make diagnosis more likely.

24. As noted above, including the countries with low reporting rates leads to implausibly large estimates in the log specifications.

A concern remains that the countries whose legal variation we examine are idiosyncratic in ways that make one suspicious of drawing causal inferences from these results. Namely, Portugal and Spain both have relatively poor reporting systems for gonorrhea, missing a majority of cases. For Albania, Bulgaria, Czech Republic, Germany, Hungary, and Romania, concerns that the mechanism generating the change are related to the political changes these countries experienced around the time of abortion law changes (as opposed to the laws themselves having an effect on behavior) are impossible to rule out.

However, despite these concerns, the basic result that increased abortion access is associated with an increase in risky sex has now been demonstrated in three separate samples covering different periods, countries, and types of laws. Our results suggest that human disease spread models might be improved by including a behavioral component to generate more reliable results. Further, the finding that more liberal abortion laws are associated with an increase in risky sex may help practitioners to quantify and safeguard against possible public health repercussions of abortion liberalization.

References

Akerlof, George A., Janet L. Yellen, and Michael L. Katz. 1996. "An Analysis of Out-of-Wedlock Childbearing in the United States," 111 *Quarterly Journal of Economics* 227–317.

Angrist, Joshua D., and William N. Evans. 1999. "Schooling and Labor Market Consequences of the 1970 State Abortion Reforms," 18 *Research in Labor Economics* 75–113.

Angrist, Joshua D., and Jörn-Steffan Pischke. 2008. *Mostly Harmless Econometrics: An Empiricist's Companion*. Princeton, NJ: Princeton University Press.

Boland, Reed, and Laura Katzive. 2008. "Developments in Laws on Induced Abortion: 1998–2007," 34 *International Family Planning Perspectives* 110–20.

Cameron, A. Colin, Jonah B. Gelbach, and Douglas L. Miller (2011). "Robust Inference with Multiway Clustering." *Journal of Business and Economic Statistics*, 29(2): 238–249.

Center for Disease Control. 1994. *1993 Sexually Transmitted Disease Surveillance Report*. Atlanta: Center for Disease Control, Division of STD/HIV Prevention. Available online at http://wonder.cdc.gov/wonder/STD/OSTD3202/Table_1.html (accessed May 17, 2009).

Center for Disease Control. 1998. *Sexually Transmitted Disease Surveillance 1997*. Atlanta: Center for Disease Control, Division of STD/HIV Prevention. Available online at http://www.cdc.gov/std/stats97/default.htm (accessed May 17, 2009).

Center for Disease Control (2002). *2001 Sexually Transmitted Disease Surveillance Report*. Atlanta: Center for Disease Control, Division of STD/HIV Prevention. Available online at http://www.cdc.gov/std/stats01/default.htm (accessed May 17, 2009).

Center for Disease Control (2006). *Together We Can. The National Plan to Eliminate Syphilis from the United States*. Atlanta: US Department of Health and Human Services.

Center for Reproductive Rights. 2008. *The World's Abortion Laws*. New York: Center for Reproductive Rights. Available online at http://reproductiverights.org/en/document/world-abortion-laws-2008-fact-sheet (accessed May 18, 2009).

Chesson, Harrell W., Thomas L. Gift, and Amy L.S. Pulver. 2006. "The Economic Value of Reductions in Gonorrhea and Syphilis Incidence in the United States, 1990–2003," 43 *Preventive Medicine* 411–5

Cook, Rebecca J., and Bernard M. Dickens. 1978. "A Decade of International Change in Abortion Law: 1967–1977," 68 *American Journal of Public Health* 637–44.

Cook, Rebecca J., and Bernard M. Dickens. 1988. "International Developments in Abortion Laws 1977–88," 78 *American Journal of Public Health* 1305–11.

Cook, Rebecca J., Bernard M. Dickens, and Laura E. Bliss. 1999. "International Developments in Abortion Laws 1988–1998," 89 *American Journal of Public Health* 579–86.

Dal Conte, Ivano, Anna Lucchini, Enza Contuzzi, Giovanni Di Perri, and James Bingham. 2001. "Sexually Transmitted Infection in Italy: an Overview," 12 *International Journal of STD & AIDS* 813–8.

Dee, Thomas S. 2008. "Forsaking All Others? The Effects of Same-sex Partnership Laws on Risky Sex," 118 *The Economic Journal* 1055–78.

Dehne, K., G. Riedner, C. Neckermann, O. Mykyev, F. Ndowa, and U. Laukamm-Josten. 2002. "A Survey of STI Policies and Programmes in Europe: Preliminary Results," 78 *Sexually Transmitted Infections* 380–4.

Fenton, Kevin A., Anne M. Johnson, Sally McManus, Bob Erens. 2001. "Measuring Sexual Behaviour: Methodological Challenges in Survey Research," 77 *Sexually Transmitted Infections* 84–92.

Gerbase, Antonio C., Jane T. Rowley, and Thierry E. Mertens. 1998. "Global Epidemiology of Sexually Transmitted Diseases," 351 *The Lancet* S2–S4.

Greco, D., M. Giuliani, B. Suligoi, M. Panatta, and A. Giannetti. 1990. "Sexually Transmitted Diseases in Italy: Clinical Returns Versus Statutory Notifications," 66 *Genitourinary Medicine* 383–6.

Greene, William H. 2011. *Econometric Analysis, 7th ed*. New York: Prentice Hall.

Grimes, David A., Janie Benson, Susheela Singh, Mariana Romero, Bela Ganatra, Friday E. Okonofue, Iqbal H. Shah. 2006. "Unsafe Abortion: The Preventable Pandemic," 368 *The Lancet* 1908–1919.

Henshaw, Stanley K., Susheela Singh, and Taylor Haas. 1999. "Recent Trends in Abortion Rates Worldwide," 25 *International Family Planning Perspectives* 44–8.

Hewett, Paul C., Barbara S. Mensch, Manoel Carlos S. de A. Ribeiro, Heidi E. Jones, Sheri A. Lippman, Mark R. Montgomery, and Janneke H.H.M. van de Wijgert. 2008. "Using Sexually Transmitted Infection Biomarkers to Validate Reporting of Sexual Behavior within a Randomized, Experimental Evaluation of Interviewing Methods," 168 *American Journal of Epidemiology* 202–11.

Jones, Rachel K., Jacqueline E. Darroch, and Stanley K. Henshaw. 2002. "Patterns in the Socioeconomic Characteristics of Women Obtaining Abortions in 2000–2001," 34 *Perspectives on Sexual and Reproductive Health* 226–235.

Klick, Jonathan, and Thomas Stratmann. 2003. "The Relationship between Abortion Legalization on Sexual Behavior: Evidence from Sexually Transmitted Diseases," 32 *Journal of Legal Studies* 407–33.

Klick, Jonathan and Thomas Stratmann. 2008. "Abortion Access and Risky Sex Among Teens: Parental Involvement Laws and Sexually Transmitted Diseases," 24 *Journal of Law, Economics and Organization* 2–21.

Levine, Phillip B. 2000. "The Sexual Activity and Birth Control Use of American Teenagers," Working Paper No. w7601, *NBER*. Cambridge, MA.

Levine, Phillip B., and Douglas Staiger. 2002. "Abortion as Insurance." Working Paper No. 8813, *NBER*. Cambridge, MA.

Lowndes, C., and Kevin A. Fenton. 2004a. "Surveillance Systems for STI in the European Union: facing a changing epidemiology," 80 *Sexually Transmitted Infections* 264–71.

Lowndes, Catherine M., and K. Fenton. 2004b. "Recent Trends in the Epidemiology of Sexually Transmitted Infections in the European Union," 80 *Sexually Transmitted Infections* 255–63.

National Institutes of Health. 2001. *Workshop Summary: Scientific Evidence on Condom Effectiveness for Sexually Transmitted Disease (STD) Prevention*. Bethesda, MD: National Institutes of Health. Available online at www.niaid.nih.gov/about/organization/dmid/documents/condomreport.pdf (accessed August 22, 2010).

Panchaud, Christine, Shusheela Singh, Dina Feivelson, and Jacqueline E. Darroch. 2000. "Sexually Transmitted Diseases among Adolescents in Developed Countries," 32 *Family Planning Perspectives* 24–32 & 45.

Posner, Richard A. 1992. *Sex and Reason*. Cambridge, MA: Harvard University Press.

Public Health Agency of Canada. 2008. "Reported cases and rates of gonorrhea by age group and sex, 1980 to 2007," *Public Health Agency of Canada*. Available online at http://www.phac-aspc.gc.ca/std-mts/sti-its_tab/gonorrhea1980-07-eng.php (accessed May 17, 2009).

Rahman, Anika, Laura Katzive, and Stanley K. Henshaw. 1998. "A Global Review of Laws on Induced Abortion, 1985–1997," 24 *International Family Planning Perspectives* 56–64.

United Nations. 2002. *Abortion Policies: A Global Review*. New York: United Nations Population Division, Department of Economic and Social Affairs. Available online at http://www.un.org/esa/population/publications/abortion (accessed April 30, 2009).

United Nations. 2007. *World Population Prospects: The 2006 Revision*. New York: United Nations Population Division, Department of Economic and Social Affairs. Available online at http://www.un.org/esa/population/publications/wpp2006/wpp2006.htm (accessed May 17, 2009).

United States Department of Agriculture. 2009. *International Macroeconomic Data Set*. Washington, DC: Economic Research Service, United States Department of Agriculture. Available online at http://www.ers.usda.gov/Data/Macroeconomics/ (accessed May 17, 2009).

Van Duynhoven, Yvonne T.H.P. 1999. "The epidemiology of Neisseria gonorrheae in Europe," 1 *Microbes and Infection* 455–464.

Wilcox, Allen J., Clarice R. Weinberg, and Donna D. Baird. 1995. "Timing of Sexual Intercourse in Relation to Ovulation—Effects on the Probability of Conception, Survival of the Pregnancy, and Sex of the Baby," 333 *New England Journal of Medicine* 1517–21.

Wooldridge, Jeffrey M. 2008. *Introductory Econometrics: A Modern Approach.* Mason, OH: South-Western Publishing.

World Health Organization. 2003. *Global Prevalence and Incidence of Selected Curable Sexually Transmitted Infections*. Geneva, Switzerland: World Health Orgnization. Available online at http://whqlibdoc.who.int/hq/2001/WHO_HIV_AIDS_2001.02.pdf (accessed July 10, 2009).

World Health Organization. 2009. European Health for All database. Geneva, Switzerland: WHO Regional Office for Europe. Available online at http://data.euro.who.int/hfadb/ (accessed May 18, 2009).

Appendix: Gonorrhea Surveillance across Countries

The most common method to collect data on the frequency of gonorrhea is to mandate physicians or laboratories to report new cases to a central surveillance agency. Other surveillance systems, like those of Belgium and France obtain incidence data from voluntary sentinel studies in which participation is however often low or varies substantially over time (Lowndes and Fenton, 2004a; Panchaud et al., 2000).[25] We therefore limit our sample to countries where incidence data are obtained through mandatory case reporting.

Nevertheless, even in the limited sample certain comparability issues remain. Despite case reporting being mandatory in all sample countries, the share of diagnosed gonorrhea cases physicians actually report to surveillance agencies differ substantially between countries (Lowndes and Fenton, 2004a). For Canada, the United Kingdom, Ireland, the Scandinavian and the former socialist countries, the reporting rates are estimated to be 70% or higher, whereas they are 50–70% for the United States and Switzerland. For Germany, Austria, the Netherlands, Spain, Portugal, and Italy[26], underreporting is most severe with at least every second diagnosed case not being registered in the official statistics. These differences are often ascribed to the setup of healthcare systems. If private providers and general practitioners play an important role, reporting tends to be lower than in public healthcare systems with specialized STD care institutions. Further, not all countries require laboratory confirmation of diagnosed cases before they are registered in the official gonorrhea statistics (Lowndes and Fenton, 2004a and Panchaud et al., 2000).

Moreover, countries vary in their capacity to identify gonorrhea cases in the first place. The difference between the number of infections and the

25. For Belgium, the sentinel system covers up to 40% of laboratories but does not include the Brussels metropolitan region that represents some 10% of the population. For France, it is estimated that only 5% of laboratories that test for gonorrhea participate in the studies. See Panchaud et al. (2000)

26. For Italy, Greco et al. (1990) estimate that gonorrhea-cases are 5–150 times less likely to be reported in comparison to other European and North American countries. According to Lowndes and Fenton (2004a) the situation has somewhat improved in the 1990s, but reporting rates remain low.

number of diagnosed cases has several causes. In poorer and sparsely populated areas, the remoteness of healthcare facilities reduces diagnosis rates as people often resort to self-medication (Dehne et al., 2002). Self medication is also more frequent in societies that stigmatize STDs.[27] Other factors are partner notification requirements in the case of a diagnosed infection and the extent of screening programs.[28]

27. For Italy, Dal Conte (2001) report that while only 3303 gonorrhea cases were officially registered in 1981, 127,000 units of gonorrhea medication were sold during the same year.

28. Most countries subject only certain high-risk groups like sex workers to routine screenings. More universal screening may lead to much higher reported incidence because gonorrhea can in many cases remain asymptomatic. See Van Duynhoven (1999).

Screening and partner notification are more comprehensive in the newly independent states and Scandinavia. In Canada, the United Kingdom, and the United States partner notification is recommended but not mandatory. Belgium, France, West Germany, the Netherlands, and Switzerland, do not have partner-notification policies.