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Damian Clarke
Universidad de Santiago de Chile and IZA

Hanna Mühlrad
Lund University

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IZA – Institute of Labor Economics

Schaumburg-Lippe-Straße 5–9
53113 Bonn, Germany

Phone: +49-228-3894-0
Email: publications@iza.org

www.iza.org

ABSTRACT

Abortion Laws and Women's Health*

We examine the impact of progressive and regressive abortion legislation on women's health and survival in Mexico. Following a 2007 reform in the Federal District of Mexico which decriminalised and subsidised early-term elective abortion, multiple other Mexican states increased sanctions on illegal abortion. We observe that the original progressive policy resulted in a sharp decline in maternal morbidity, particularly maternal morbidity due to haemorrhage early in pregnancy. We observe small or null impacts on women's health from increasing sanctions on illegal abortion. We find some evidence to suggest that these impacts were also observed when considering maternal mortality, though effects are less precisely estimated.

JEL Classification: I18, J13, K38, H75

Keywords: abortion, maternal morbidity, maternal mortality, political economy, legislative reform

Corresponding author:
Damian Clarke
Universidad de Santiago de Chile
Av. Libertador Bernardo O'Higgins 3363
Estación Central
Santiago de Chile
Chile
E-mail: damian.clarke@usach.cl

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1 Introduction

Appeals to women's health are frequently made when debating the merits of abortion legislation. These calls are made by both advocates of legal abortion, as well as those advocating for abortion to become, or remain, illegal. Such appeals are commonly made by so-called "pro-life" and "pro-choice" organizations, citing academic literature in support of their positions. The arguments backing up such claims are drawn from a range of sources, which are often correlational or based on small or non-representative samples of women.[1]

In this study we present the first population-level evidence of the impact of sub-national variation in abortion laws on maternal *morbidity*, as well as maternal mortality, using the universe of administrative health records from Mexico. We focus on a period in which considerable within-country reform of abortion policy was undertaken, with both a sweeping legalisation in the Federal District of the country (Mexico DF), and increasing sanctions on (illegal) abortion in other regions of the country. In this context, we are able to determine to what extent change in abortion laws, absent other major contraceptive revolutions, impact health indicators for the population of affected women.

In particular, we examine the effect of a sharply defined local abortion reform in the Mexico DF providing free access to legal and safe abortion services. This reform, occurring in April of 2007, resulted in a legislative backlash in other regions of the country, with 18 states following the announcement of the reform by modifying their own constitutions or penal codes to increase the sanctions attached to suspected abortions. The original Mexico DF reform—the so called legal interruption of pregnancy (or ILE for its name in Spanish)—was of considerable importance. During the pre-reform period of 2001-2007 a total of 62 legal abortions (available in restrictive conditions) were performed in Mexico DF. In the 5 years following the 2007 reform, more than 90,000 women accessed safe legal abortion. In this paper we combine the state-level variation over time resulting from legislative changes in abortion law with high-quality vital-statistics data recording over 30 million births, 18.4 thousand maternal deaths and 46 million inpatient

[1] The use of such arguments even when based on weak evidence is not isolated to non-governmental organisations. Similar arguments are also made by politicians. One such example is a fact sheet published on the US National Cancer Institute website by the Bush administration positing an (unfounded) link between abortion and breast cancer (Special Investigations Division, Committee of Government Reform, House of Representatives, 2003).

cases for causes related to maternal health.

This environment provides a unique opportunity to examine simultaneous expansions and contractions of abortion policies.[2] While much of the existing literature on the impact of abortion—and contraceptive policies more generally—focuses on expansions in access, there are a number of papers which focus on contractions in policies. These include historical restrictions in Romania (Pop-Eleches, 2010), the impact of parental consent or notification laws targeted at adolescents in the U.S. (Bitler and Zavodny, 2001; Joyce and Kaestner, 1996), and a recent hollowing out in the availability of providers due to state-specific legislation in the U.S. (Lu and Slusky, 2016; Fischer et al., 2017; Cunningham et al., 2017). However, the legalisation of abortion in Mexico DF and resulting spate of constitutional changes increasing the harshness of sentencing of illegal abortion provides the opportunity to examine the impact of a contemporaneous series of restrictive and permissive abortion policies in a single country and time.

We begin by bench-marking the reforms' impacts on fertility. We find—in line with literature on the fertility impacts of abortion reform in other settings documented in Table 1—that legalisation reduced birth rates by approximately 5-6 percent. We generally observe little evidence to suggest that the posterior regressive law changes had considerable impacts on fertility. In considering impacts of abortion laws on maternal health, we implement difference-in-differences (DD), event study, and synthetic control procedures based on state-level reforms. Across methodologies, we find clear evidence pointing to a reduction in maternal morbidity following the introduction of legalised abortion. This is driven by a sharp reduction in rates of haemorrhage early in pregnancy, which falls immediately by approximately 40%. We observe little evidence to suggest consistently estimated statistically significant changes in morbidity following increased sanctions on (illegal) abortion. In general we observe impacts on maternal *mortality* which agree with those when examining maternal morbidity. However, estimates are considerably less precise, suggesting that when examining only impacts of abortion law on maternal mortality, analyses fail to account for the full weight of abortion reform on women's health. We additionally document, using administrative

[2] As we discuss at more length in sections 2.3-2.4 of this paper, the change due to the ILE reform was considerably larger than subsequent legislative tightenings. In the case of the constitutional changes issued by states, in each case abortion was already illegal, and any changes owe to an increased threat of prosecution or sanction. Using the universe of legal decisions in the country, we do document evidence suggesting that these reforms increase the average length of sentences handed down to women.

records from the judiciary, that Mexico's regressive reforms did have a *De Facto* impact on legal sanctions, with the length of sentences handed down to women following these reforms increasing substantially.

This study adds to the existing literature on abortion reform (described at more length in section 2 of this paper) by providing evidence on the effect of abortion legalization absent simultaneous changes in other major contraceptive laws and reforms.[3] And to the best of our knowledge, this is the first study to provide well-identified population-level evidence of the impact of abortion legalization on maternal morbidity and mortality based on within-country variation in abortion availability. While an association between abortion legalization and lower abortion-related complications has been documented in previous studies, comprehensively capturing the impact of the passage of abortion law on abortion-related morbidity is a considerable challenging, especially in clandestine settings, where under-reporting may occur (Singh et al., 2010). Maternal mortality is considered the "tip of the iceberg", where the mass consists of maternal morbidity (Loudon, 1992). In many settings, analyses of the impact of abortion on population health focuses only on maternal mortality due to a lack of universal health records measuring maternal morbidity.

This paper joins a handful of studies on Mexico's ILE reform, spread across a range of fields including law (Johnson, 2013), public health (Contreras et al., 2011; Schiavon et al., 2012a; Becker, 2013), medicine (Madrazo, 2009), and demography (Gutierrez-Vazquez and Parrado, 2015).[4] The present paper, however is the first to harness the full power of vital statistics data, the first to collect and combine the ILE reform with the regressive law changes following this reform, and the first to consider how morbidity and mortality, as well as fertility and criminal sanctions handed to women, may be affected by abortion reform in Mexico. All in all, the paper provides strong evidence that abortion legalization in an emerging economy leads to rapid and discernible changes in political behavior, aggregate fertility rates, and (significant improvements in) maternal health.

[3] In Mexico, the country under study, contraception has been legal and freely provided by the government since a constitutional declaration in 1974.

[4] In examining the abortion reform and fertility outcomes, Gutierrez-Vazquez and Parrado (2015) use national vital statistics to examine the effect on fertility across ages. Due to the use of a limited amount of data and limitations inherent in the empirical design one cannot assign a causal interpretation to the results with confidence. More specifically, only three different years of data are used (1990, 2000 and 2010). In a study by Koch et al. (2015), maternal mortality is found to increase in areas with more liberal abortion laws. This paper however, has received strong criticism for highly misleading and inaccurate data selection Darney et al. (2017).

Table 1: Review of Estimates of Abortion Reform on Fertility

Authors	Context	Reform	Outcome	Estimate
Panel A: Progressive Law Changes				
Angrist and Evans (1996)	United States	1970 abortion reforms	Probability of teen motherhood	−0.045 (0.012) for black women and −0.012(0.04) for white women.[a]
Ananat et al. (2007)	United States	Roe v Wade	Number of children per woman up to age 39.	−0.054 (0.012).[b]
Ananat and Hungerman (2012)	United States	Abortion and the pill	Birth rate for women in ages 14-20.	−0.0476 (0.0135).[c]
Bailey (2009)	United States	Abortion and the pill	Probability of first birth before age 21.	Effect of abortion: −0.009 (0.026). Effect of abortion and the pill: −0.013 (0.024).[d]
Gruber et al. (1999)	United States	Roe v Wade	Birth rate for women 15-44.	−0.059 (0.005).[e]
Guldi (2008)	United States	Abortion and the pill	Birth rate for women in ages 15-21.	−0.100 (0.054) for white women −0.030 (0.048) for nonwhite women.[f]
Joyce and Kaestner (1996)	United States	Expansions in Medicaid income eligibility	Probability of abortion.	−2 to −5% points (significant at least at 10% level) among unmarried non-black women aged 19-22 and 23-27.[g]
Joyce et al. (2013)	United States (NY)	Roe v. Wade	Birth rate for women 15-44.	−0.36 births per 1000 given a mean distance of 23 miles.[h]
Levine et al. (1999)	United States	Roe v Wade	Birth rate women 15-44.	−0.050(0.008). [i]
Mølland (2016)	Norway	abortion in Oslo	Probability of teen motherhood (<20).	−0.029(0.009). [j]
Myers (2017)	United States	abortion	Probability of giving birth before age 19.	−0.0284(0.0070). [k]
Pop-Eleches (2010)	Romania	abortion plus contraception	Probability of giving birth.	−0.068(0.015) for women 20-24 with low education.[l]
Valente (2014)	Nepal	Access to an abortion center	Probability of giving birth conditional on conception women aged 15-49.	Living within 28.6 km to an abortion center led to −0.0737(0.0272). [m]
Our Estimate	Mexico	ILE reform	Birth rates women 15-49	−0.054(0.015)
Panel B: Regressive Law Changes				
Kane and Staiger (1996)	United States	Medicaid restriction and parental consent	Number of births to mothers 15-19.	White women, Medicaid: −0.0005(0.0002), parental consent: −0.0012(0.0002). [n]
Cook et al. (1999)	United States (NC)	Abortion funding	Log of birth count.	0.047(0.014) for black women and 0.015(0.010) for white women.[o]
Levine et al. (1996)	United States	Medicaid funding restrictions	Birth Rate women 15-44.	−0.582(0.400).[p]
Joyce et al. (2006)	United States (TX)	Texas Parental Notification Law	Rate ratio of birth among minors 17.50-17.74 years of age.	rate ratio, 1.04 (95 % CI, 1.00 to 1.08).[q]
Lahey (2014)	United States	Laws restricting abortion in the nineteenth century	ln(child woman ratio) for women aged 15-44.	4 − 12% increase.[r]
Our Estimate	Mexico	Regressive law changes	Birth rate women 15-49	−0.019(0.015)

Notes: [a] Columns 5 and 10 (3 years of exposure), table 3, p. 88. [b] Column 4, Table 1 p. 386. [c] Column 1, table 3 p. 43. [d] Table 2, p. 12. [e] Column 2, table 1 p. 279. [f] Column 1, table 3, p. 823. [g] Columns 2-4, table 2, p. 186. [h] Section 4.2.2. Regressions of birth rates on distance, p. 813. [i] Column 1, table 2, p. 19. [j] Column 1, row 1, table 1, p. 12. [k] Effect of "abortion legal" and Model 4, table 2 p. 45. [l] Column 2 (estimate: β_2), table 2, p. 983. [m] Table 1 p. 232. [n] Among nonwhite women, Medicaid: 0.0021(0.0011), parental consent:x -0.0003(0.0009). Column 4, Table 3 p. 485. column 4, Table 4 p. 486. [o] Table 6 p. 254. [p] Column 8, table 5, p. 33. [q] See text on p. 1030. [r] Table 2 p. 943.

2 Background

2.1 Abortion Laws, Access, and Women's Health

Globally, unintended pregnancies lead to approximately 46 million induced abortions each year (Van Lerberghe et al., 2005), and estimates suggest that worldwide, 25 million women sought unsafe abortions in 2014 (Ganatra et al., 2017). Unsafe abortions may result in as many as eight maternal deaths per hour (World Health Organization, 2004).[5] By the best available estimates, 13% of all maternal deaths are due to complications surrounding clandestine and unsafe abortion, with these numbers being much higher in certain settings (World Health Organization, 2011). The highest estimated rate of unsafe abortion is found in the Latin America and Caribbean region where each year an estimated 4.2 million unsafe induced abortions are carried out, accounting for 12% of all maternal deaths in the region (World Health Organization, 2011). This region also exhibits some of the world's most conservative laws on abortion (United Nations, 2014).

Laws codifying access to abortion date from as far back as the early 20th century (Doan, 2009). However, the issue of abortion legalization remains a highly controversial social topic, with considerable variation in the availability and legality of elective abortion worldwide. From the 1970s onwards a number of large-scale reforms have increased access to elective abortion, and these have been documented to have considerable impacts on the life courses of women, children and families (Ananat et al., 2009; Bailey, 2013; Mitrut and Wolff, 2011; Pop-Eleches, 2006, 2010). However, the political debate around abortion remains polarized worldwide, which is reflected by the huge differences in abortion laws across as well as within countries (Berer, 2017). While some countries have increased legal restrictions on abortion, such as the US, with as many as 334 abortion restrictions enacted during 2011-2016 (Conti et al., 2016), other countries such as Ireland have gone in the opposite direction, legalizing elective abortion during the first trimester (Li, 2018). With rapid globalisation, access to abortion is no longer a question only for local and national governments but also an issue in the global arena. For example, abortion restrictions are at the

[5] Unsafe abortion is defined by the WHO as a procedure for terminating an unintended pregnancy either by individuals without the necessary skills or in an environment that does not conform to minimum medical standards, or both (Organization et al., 1992).

center of recent global governance efforts made by the US government when the so called Mexico City Policy (the Global Gag Rule) was reinstated under the Trump administration in 2017 (Starrs, 2017).

While improved access to modern contraceptives and sexual education is essential for lowering rates of unwanted pregnancies and the demand for induced abortion that follows, unsafe abortion cannot be eliminated through these efforts only (Grimes et al., 2006).[6] Access to safe abortion is considered imperative to the health of women and children (Grimes et al., 2006). Lack of access to legal and safe abortion increases the risk of unsafe abortion methods with possibly severe complications including hemorrhage, sepsis, infection and trauma. Unsafe abortion procedures lead to hospitalisation in an estimated 20-50% of all cases, where severe complications from unsafe abortion lead to 367 deaths per 100,000 cases. This can be compared to the risk of death after safe abortion which is 0.7 deaths per 100,000 procedures (Grimes et al., 2006).

Abortion legalization is associated with decreased maternal morbidity and mortality (Grimes et al., 2006). This association has been documented within the field of medicine and public health for multiple countries (Benson et al., 2011) including Albania (Sahatci, 1993), Bangladesh (Chowdhury et al., 2007), Nepal (Henderson et al., 2013), Romania (Serbanescu et al., 1995; Stephenson et al., 1992), Singapore (Singh and Ratnam, 2015) and South Africa (Rees et al., 1997). The impact of abortion legalization on women's health is significant, for example, abortion-related maternal mortality in Romania fell by 67% and by 40% in Singapore after induced abortion was legalized (Singh and Ratnam, 2015). A similar pattern of abortion legalization and abortion-related morbidity has been documented in multiple countries. Existing studies are mainly based on reviews of medical charts at selected hospitals in the US (Goldstein and Stewart, 1972; Stewart and Goldstein, 1971; Seward et al., 1973; Kahan et al., 1975), Guyana (Nunes and Delph, 1997), Nepal (Henderson et al., 2013) and South Africa (Mbele et al., 2006; Jewkes et al., 2002). There is also evidence of lower abortion-related morbidity related to abortion legalization based on survey data from hospitals in the US (Bracken et al., 1982) as well as South Africa (Jewkes et al., 2005).[7] We are,

[6]Even with perfect compliance and use of contraceptives, unwanted pregnancies will still remain as no modern method can prevent pregnancy by 100% Warriner and Shah (2006) and the fact that sexual intercourse can occur without consent of the woman.

[7]The study by Bracken et al. (1982) is based on data from Hospital Discharge Survey (HDS) provided by the National Center for Health Statistics for 1970 through 1977.

however, aware of no prior studies which are based on population-level data, and based on within-country variation in abortion reforms.

2.2 Fertility, family planning and abortion laws in Mexico

Between the years of 1975 and 2015, the fertility rate in Mexico declined rapidly from roughly 6 children per woman to approximately 2.2 children per woman. This major shift in fertility can be partially attributed to changes in access to modern contraceptive methods in the country (Juarez et al., 2013). In 1975, the Mexican government passed the General Population Law, which obliged the government to supply family planning services and provide contraceptives via the public health care sector free of charge. In 1995, family planning services were decentralized to the state level, where different states fund family planning to various degrees, possibly making family planning services differentially available across states. Although 67% of all women of childbearing age in Mexico report using modern contraceptive methods (and 5% use traditional and less efficient methods), it is estimated that more than half of all pregnancies are unintended.[8] Estimates suggest that up to 54% of these unintended pregnancies are terminated (Juarez et al., 2013).

Mexico consists of 32 federal entities, 31 of which are federal states plus the federal district of Mexico (also known as Mexico D.F. or Mexico City). In addition to the national constitution, each of the 32 federal entities has its own state or local constitution, defined by its own legislative power. Abortion laws in all of Mexico are determined at the state level (Becker, 2013). Mexico DF contains approximately 8% of the entire population (8.9 million of Mexico's 119.5 million inhabitants according to 2015 estimates) and, since 2007, is the only state that allows for elective abortion during the first trimester.

Prior to the reform in Mexico DF, abortion laws were quite uniform across the 32 federal entities of Mexico. Induced abortion continues to be considered a criminal offense with the risk of up to 30 years imprisonment in many states, and legal abortion was only permitted in the limited cases of rape, threat to the life of the mother, or severe malformation of the fetus. In practice, even in these limited cases, legal abortion has been described by human rights organizations as extremely difficult to access due to rigid

[8] Modern contraceptives are condoms, oral or/injectable/implants of hormones preventing ovulation, IUD, sterilization and emergency contraception. Traditional or less efficient methods are calendar method or rhythm method, coitus interrupts, herbs or teas. For a detailed account of modern and traditional methods, see for instance Hubacher and Trussell (2015).

legal barriers (Juarez et al., 2013). In the densely populated Mexico DF, only 62 abortions were legally performed during 2001-2007 (Becker, 2013).

Induced abortion is a procedure or medical treatment for terminating pregnancy, and while induced abortion under appropriately supervised settings is considered one of the safest medical procedures in modern medicine, unsafe abortion is associated with substantially increased risks of severe morbidity and mortality.[9] The estimated rate of induced abortions for Mexico in 2006 was 33 abortions per 1,000 women of fertile age (Juarez et al., 2008), which is considered high internationally (Becker, 2013). As a substitute to legal options, abortions were performed in clandestine and often unsafe settings. In 2006 alone, medical records from public hospitals show that an estimated 150,000 women in Mexico were treated for abortion-related complications (Juarez et al., 2008). The most common method of induced abortion is believed to be the abortifacient drug Misoprostol, which despite the strict legal restrictions in Mexico, has been available in pharmacies since 1985 (Lara et al., 2011).[10] Despite the fact Misoprostol and other abortifacients formally require a doctor's prescription in Mexico, studies show that abortifacients are frequently sold over the counter without prescription (Lara et al., 2011). While a safe and well recognised method for induced abortion when appropriately taken, instructions on dosage and usage of Misoprostol are generally not available at pharmacies, leading to considerable risks when self administered (see *eg* Grimes (2005)).

2.3 The 2007 legal interruption of pregnancy reform in Mexico DF

The legislative assembly of the Federal District of Mexico voted to legalize elective abortion (termed legal interruption of pregnancy, or ILE for its name in Spanish) on April 24, 2007, reforming Articles 145-148 of the penal code of Mexico DF, and Article 14 of the Health Code. These reforms were signed into law

[9]Induced abortions in a safe setting are carried out by professional health care providers in safe environment and in line with evidence based medicine. The procedure generally depends on gestational length of pregnancy. A safe induced abortion usually entails either a surgical operation or medical procedure. During a surgical operation, the products of conception are removed from the womb. The medical procedure is a non-invasive procedure that causes contractions of the womb, terminating the pregnancy. Medical abortion procedures are safer and more cost-efficient compared to other methods for first trimester abortions. It is common that the patient self-administers the medical abortion at home (Kulier et al., 2007). Induced abortion under safe conditions exhibits a mortality rate below 1 per 100,000 procedures (Grimes, 2005).

[10]Misoprostol (sometimes referred to as Cytotec, Arthrotec, Oxaprost, Cyprostol, Mibetec, Prostokos or Misotrol) is one of the recommended substance for induced abortion by the WHO (Lara et al., 2011). Misoprostol is a prostaglandin with the original purpose of curing gastric ulcers. It is also utilized for OB/GYN reasons such as induced abortion, post abortion procedures and induced labor for delivery (Kulier et al., 2007).

the following day, and published in the official Gazette of the Federal District on April 26, 2007 (Ciudad de México, 2007). The reforms, aiming at reducing the high number of unsafe abortions, were supported by a coalition of pro-choice NGOs together with a growing movement for women's reproductive health rights.[11] This immediately permitted women above the age of 18 to request legal interruption of pregnancy at up to 12 weeks of gestation without restriction. Access for minors requires parental or guardian consent. Under this law, induced abortion was made legal in both the public and private health care sectors.

Immediate implementation was made possible by collaboration between the Ministry of Health of Mexico DF, members of the health department and international NGOs, which had thoroughly designed a program for public provision of abortion services called the "the ILE program" and its implementation even before the law was passed (Singh et al., 2012a). As such, abortion services were made available via the public health care hospitals immediately after the law was passed in April 2007, although with lower capacity and efficiency compared to current conditions. Abortion services were also quickly available in the private health care sector (Blanco-Mancilla, 2011). Additionally, under this law sexual education in schools was improved, and post-abortion contraceptives were made freely available directly from the health clinics which provided abortions (Contreras et al., 2011). Records from public hospitals show that the demand for post-abortion contraceptives is high (approximately 82% of all women accept contraceptives) and that prevalence of repeated abortion procedures are low (Becker, 2013). On August 29, 2008 the decision to pass the ILE law was ratified by the Supreme Court of Mexico, making Mexico DF, together with Cuba and Uruguay, the most liberal jurisdiction in terms of abortion legislation in the entire Latin American and Caribbean region (Fraser, 2015).

Figures from the Secretary of Health's administrative data suggest that abortions were used by women of all ages, though were disproportionately sought by younger (21-25 year-olds) and older women (36 year-olds and above), with lower rates of abortion among 26 to 35 year olds. The proportion of all births by age and all abortions in public health clinics by age is presented in Appendix Figure A1. Approximately half of the abortions were sought by unmarried women (45.5% to single women, and 4.1% to divorced women), with the remainder nearly evenly split between married women, or those in a stable union. Information

[11] A broader discussion of the reform's social and legal setting is provided in Kulczycki (2011); Madrazo (2009), Blanco-Mancilla (2011) and Johnson (2013).

regarding the extent to which women below the age of 18 have access to abortion services is relatively scarce. However, according to a qualitative study by Tatum et al. (2012), the law on parental consent may be differentially enforced depending on the caregiver. While Public Hospitals require parental consent, only one out of three abortion providers in private health clinics require parental consent (Schiavon et al., 2010). Women with residency outside Mexico DF can also access the public provision of abortion through the Ministry of Health in Mexico DF (MOH-DF) but are charged with a sliding fee scale determined with regard to the woman's socioeconomic background. In 2010, 74% of all women who received an abortion through the public health care sector were women living in Mexico DF, 24% were living in the state of Mexico (which shares a border with Mexico DF) and 2% were living in other states (Mondragón y Kalb et al., 2011).

Information regarding the private provision of abortion services is limited due to a lack of supervision of the private market for legal abortion services (Becker, 2013). Despite the fact that safe abortion, at no or low cost, is provided by the public health system in Mexico DF, women do seek abortion services within the private sector. A descriptive study by Schiavon et al. (2012b) suggests that private abortion services are provided at high costs (157–505 US dollars) and quality of care is inferior to that in the public sector, given that the less safe and efficient "dilation and curettage" is used as the main method in the private sector (71%). A suggested explanation for the high rates of usage of private care relates to beliefs that the overall quality is higher in the private health sector (Schiavon et al., 2012b).

Records from public hospitals show that during the year of 2007, when the reform was implemented, more than 7,000 abortion procedures were performed at 14 selected MOH-DF clinics. Over the years, the MOH-DF abortion program expanded its services and became more efficient in meeting the high demand for elective abortion. The MOH-DF program offers both surgical and medical abortion procedures and is the main provider of medical abortion (Winikoff and Sheldon, 2012). The large shift from 25% of all abortion procedures being medical in 2007 to as much as 74% in 2011 have played a key part of meeting the demand and reducing complications and side-effects (Becker, 2013).[12] As of 2015, approximately 150,000 abortions were carried out at the MOH-DF clinics.

[12]Misoprostol alone was the main regimen for medical abortions in MOH-DF until 2011 when Mifepristone (combined with Misoprostol) was introduced, making the medical abortion procedures provided by the ILE program more efficient and safe.

2.4 Regressive law changes as a response to legalizing abortion in Mexico DF

Almost immediately following Mexico DF's ILE reform, a number of states began a series of counter-legislations to change the respective sections of their constitutions or penal codes, defining the beginning of human life as occurring at conception. Often, these legal responses directly referenced Mexico DF's ILE reform.[13] Even in cases where they did not directly refer to the ILE reform, it seems highly likely that the reform was a defining factor. For example, in the 20 years prior to the ILE reform there had been only two constitutionally defined changes to the articles relating to abortion in the penal codes of all states of Mexico (Gamboa Montejano and Valdés Robledo, 2014), compared to 18 changes between June 21, 2008 and November 17, 2009. Importantly, these reforms resulted in constitutional changes which recognised life as beginning at conception, opening the door for potential homicide charges.

In Appendix Figure A2 we display the geographical distribution of law changes (progressive, regressive or neutral) over the period under study. The only progressive reform refers to Mexico DF's ILE reform, while 18 states made regressive changes after the initial reform. We have compiled on a state-by-state basis the exact dates the reforms were passed into law, and these are displayed in Appendix Table A1. To the best of our knowledge, there exists no centralized record of the dates and laws which were altered in the post ILE era, and as such we compiled these from our reading of legal source documents. In section 4 of this paper we return to how we use the state and time variation in the passage of laws in our identification strategy.

3 Data

3.1 Maternal morbidity, maternal mortality and birth records

Complete data on morbidity and mortality are available for both the public and private health care systems in Mexico. Microdata on each hospital stay record the age and sex of the patient, the number of nights

[13]For example, the constitutional decree issued by the state of Nayarit when changing their penal code explicitly refers to the changes in the penal and civil code of Mexico DF (p. 14) (Gobierno de Nayarit, 2009).

in hospital, as well as the principal diagnosis based on ICD-10 codes. There are approximately 165 million single records for the period of 2004-2015 accounting for 558 million nights of hospitalisation. Of these, 46 million visits and 84 million nights of hospitalisation are related to "Pregnancy, childbirth and the puerperium" (the ICD-10 "O" code). These data are universal and include all hospital visits in the country.[14]

Complete microdata are released in three different formats depending on the hospital type where treatment is provided. Hospitals in the public health system are administered by one of two types of providers. The first, the Mexican Secretariat of Health, is the ministry of health of the national government, and accounts for 47.0% of all hospital stays related to pregnancy, childbirth and the puerperium in the period under study. The second are hospitals run by public Social Security providers, principally the Mexican Institute of Social Security (IMSS), and the State Workers' Institute of Security and Social Services (ISSSTE), which account for 29.5% of hospital stays in the ICD-10 "O" class. Finally, the remainder of hospital stays (23.5% of ICD-10 "O" cases) are treated in private hospitals. All private hospitals are required to provide information on each hospital stay in a standardised format, which is reported to the National Institute of Statistics and Geography (INEGI).

All public hospitalisation records are freely available as microdata files. However, data from hospitals run by the Secretariat of Health are available from 2000-2015 with the exact dates of hospitalisation, while data from hospitals run by Social Security Providers are available only from 2004-2015, and only provide the year of hospitalisation. Our principal analysis of impacts of abortion reform on maternal health use these databases, where we compile state by year measures for key causes of morbidity for each year between 2004-2015. Data from the private system are available for remote processing by request from INEGI. We follow a similar process with these microdata files, generating state by year values for the number of events in key morbidity classes defined below. However, while private hospitals provide information on the cause of hospitalisation, this is provided at a more highly aggregated level than public records. In particular, 10 different diagnosis classes are provided which map from the 76 diagnosis codes included in the three digit ICD-10 "O" codes. We document the mapping for each diagnosis in the public and private sector morbidity

[14]The only exception is that these databases do not include standard hospital-stays for newborns following birth.

data in Appendix Table A2. While our principal analysis focuses on the public data given the lower level of aggregation available, we show that results in aggregate private-sector data are consistent with our main results.

We focus on two particular morbidity classes when examining the impact of abortion reform on female health outcomes. These are abortion-related causes, and haemorrhage early in pregnancy. The first outcome is typically examined when considering the impacts of unsafe abortion on women's health in the medical and public health literature. It includes all forms of morbidity classified in ICD-10 codes O02-O08. A full discussion of this coding is provided in Singh and Maddow-Zimet (1999). We additionally consider the impact of abortion reform on haemorrhage in early pregnancy. This is classified as haemorrhage prior to 20 weeks of gestation, and is coded from ICD-10 code O20. We focus on this outcome given that haemorrhage (along with incomplete abortion) is one of the two most common complications of unsafe abortion (World Health Organization, 2018; Gerdts et al., 2013), and given the widespread use of misoprostol as an abortifacient agent in clandestine abortions prior to the ILE reform in Mexico DF. While bleeding is a normal side-effect of misoprostol use as an abortive agent, when taken in unsupervised settings misoprostol can lead to heavy bleeding and haemorrhage (Pourette et al., 2018).[15] Together these two outcomes cover 8 of the 76 ICD-10 code classes, but make up 11.1% of all maternal hospitalisations in the years under study, or 21.5% of maternal morbidity when excluding deliveries (refer to Appendix Table A2 for a full description of all maternal morbidity causes). The remainder of the ICD codes are not examined as outcomes as it is unlikely that they are sequelae of abortion (for example eclampsia or pre-eclampsia), or are morbidities occurring in the puerperium period, and so unable to be sequelae of abortion.

Finally, measures of maternal mortality by state and year are generated from INEGI's full mortality register. This register classifies maternal deaths according to ICD-10 codes.[16] Mexico's register of maternal deaths is recognised to be of high quality, with Mexico being classified as belonging to the "A-class"

[15]Accounts of self administered abortion in a case study in Brazil described in Grimes et al. (2006), suggest that even though the use of Misoprostol as an abortifacient increased safety, hospitalisation due to haemorrhage was the outcome in cases of complications. They state: "Women would self-administer the drug orally and then seek medical assistance if the uterine bleeding did not stop" (Grimes et al., 2006, p. 1916).

[16]Formally, maternal deaths are defined by the WHO as "The death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and the site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management, but not from accidental or incidental causes".

(World Health Organization, 1987) in the latest WHO report on maternal mortality trends. This data has had particular improvements from 2001, and as such, we restrict our period of analysis to 2001-2016 (see Schiavon et al. (2012b)).

Summary statistics of maternal morbidity and mortality are provided in Table 2. The total number of cases of each morbidity class are described in panel A, and mortality outcomes, both for all maternal deaths, and those only classified as owing to abortion, are provided in panel B. On average, morbidity outcomes are various orders of magnitude higher than mortality outcomes. For example, the average quantity of hospitalisations for abortion related causes was 8366 per state and year, versus 36 maternal deaths on average, or 3 maternal deaths when considering only those classified as owing to abortive causes.

In order to benchmark the Mexico abortion reforms' impact on fertility with respect to the wider literature, we also require aggregate data on fertility by state. We generate these state-level measures from publicly available microdata on births provided by INEGI. We use each birth register occurring to women aged 15-49 over the time period of 2001-2013; a sample of 30,340,544 births. State by year averages of the number of births and birth per 1,000 fertile aged women are displayed in panel C of Table 2.

Vital statistics for births in Mexico are compiled by INEGI based on birth registries completed by each parent or guardian at the civil registry, rather than being based on birth certificates issued at hospitals (as is the case, for example with the National Vital Statistics System in the USA and in various developing and emerging economies, like Chile and Argentina).[17] The birth register is released once per year, containing all births *registered* in that year, as well as the year the birth occurred. In order to avoid problems of under-reporting, differential reporting over time, and double-reporting, we collate all birth registers between 2002-2016, and then keep all births registered within 3 years of the date of birth.[18] This implies that we have complete birth registers based on birth years up to (and including) 2013.[19] Unregistered births will

[17]Using data from the 2010 census and birth records up until 2009, a recent (backward looking) analysis suggests that 93.4% of all births in Mexico were registered within 1 year of birth of the child, and in total, 94.2% of births are eventually registered at the national level (Instituto Nacional de Estadística y Geografía, 2012).

[18]This allows us to record births even when they are registered months after birth (up to 36 months following the birth). Considering additional registration lags results in virtually unchanged estimates, as nearly all ever-registered births are registered within 3 years of birth. This is very similar to the methodology employed by Mexico's population authority in their calculation of official demographic trends (Consejo Nacional de Población, 2012).

[19]While these birth registers are not universal, they are considered as being of very good quality compared to many other registry systems in developing economies. On average, dated estimates suggest that across all developing countries 41% of births are unregistered, and this figure for Latin America alone is 14% (UNICEF, 2005).

Table 2: Summary Statistics on Morbidity in All Public Primary Care

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Panel A: Morbidity Outcomes					
Total Number of Deliveries in Public Hospitals	384	44405	34708	7109	211999
Total Inpatient Cases for ICD O codes, except births	384	47018	32696	9085	172656
Total Inpatient Cases for Abortion-Related Causes	384	8366	6587	1454	37857
Total Inpatient Cases for Haemorrhage Early in Pregnancy	384	1765	1208	252	6426
Total Inpatient Days for Abortion-Related Causes	384	11841	9681	1805	49671
Total Inpatient Days for Haemorrhage Early in Pregnancy	384	3812	2961	495	14781
Panel B: Mortality Outcomes					
Total Number of Maternal Deaths	512	36	33	1	182
Total Number of Maternal Deaths due to Abortion	512	3	3	0	15
Panel C: Demographic Outcomes					
Population of 15-49 Year-old Women	512	860298	741558	116430	4196244
Total Number of Births	416	72934	58531	10980	300227
Birth rate per 1,000 women	416	88	10	63	129

Each observation is a state×year cell. Mexico is composed of 32 States. The number of cells varies due to the number of years of data availability. In panel A, morbidity data is displayed for 12 years (2004-2015). Values are generated from all inpatient cases as classified from microdata from the primary care (hospital) records from all public hospitals, both those administered by the Secretariat of health and the Social Security System. Each type of morbidity is classified by ICD-10 codes. In Panel B, mortality outcomes are displayed for 16 years (2001-2016). In panel C, data on population is displayed for 16 years (2001-2016), and data on births is displayed for 13 years (2001-2013). Following CONAPO, the last three years of birth outcomes are suppressed to account for reporting outside of the period of birth.

only be a problem if rates of birth registration change differentially between regions of Mexico over the period under study. Empirical evidence on changes in birth records between 1999 and 2009 do not suggest a strong relationship between reform and non-reform areas, and changes in rates of coverage (Instituto Nacional de Estadística y Geografía, 2012).

The INEGI Birth Register contains information about the date of birth, actual birthplace and the official residency of the mother. In addition, information on maternal characteristics such as age, total fertility, educational attainment, marital status and employment status are recorded. In principal analysis we examine full state by year aggregate figures for each of the 32 states. Summary statistics are provided in Table 2. In additional specifications we consider birth rates for quinquennial age groups (15-19, 20-24, 25-29, 30-34, 35-39 and 45-49), where state aggregates are calculated in an identical manner, however subsetting only to births occurring to each women aged in the relevant group at the moment she gives birth.

3.2 Administrative records on criminal offenses, survey data on sexual behaviour and additional data sources

To examine *De Jure* sentencing of abortion, we use administrative records from Mexico's Judicial Statistics on Penal Matters provided by INEGI. These records contain microdata registering each prison sentence handed down by the Mexico judiciary, the reason for the sentence, and the length of each sentence. It comprise the universe of judiciary decisions in the country based on the first legal judgment, and so does not include any subsequent appeals. We calculate prison sentence lengths from a categorical variable which records sentence lengths in binned windows (ranging from 0-2 months to > 20 years). These bin widths in microdata do not change over the period under study, and are identical in each state of the country. Trends in *De Jure* sentencing of abortion are presented in Appendix Figure A3.

For a small number of supplementary tests we use survey data from the Mexican Family Life Survey (MxFLS). The MxFLS is a nationally and regionally representative longitudinal data set that follows the Mexican population over time, covering various topics regarding the well-being of individuals including information on reproductive health.[20] The survey was conducted in three waves during 2002-2003, 2005-2006 and 2009-2012.

We use the reproductive health module from the MxFLS which collects information on contraceptive knowledge and usage as well as information on sexual behavior such as the number of sexual partners. This sample consists of a panel of women aged 15-44 who completed the reproductive health questionnaire resulting in a total of 5,404 women. Summary statistics for reproductive health across regions are provided in Appendix Table A3) and show that average knowledge of at least any kind of modern contraceptive methods are generally high across all regions, while the average usage of any kind of contraceptives and modern contraceptives are higher in Mexico DF compared to other states.

We collect a number of additional variables measured at the level of state and year. These are either used to calculate rates of exposure for health and fertility outcomes (in the case of population), or

[20] The MxFLS dataset is publicly available, developed and operated by the Iberoamerican University (UIA) and the Center for Economic Research and Teaching (CIDE) and also supported by multiple institutions in both Mexico (INEGI and National Institute of Public Health) and the USA (Duke University and Universities of California, Los Angeles).

as time-varying controls in regression analyses. The population of women aged from 15-49 by state is accessed from the National Population Council of Mexico (CONAPO). Time-varying controls are compiled to capture possible confounders of abortion policy, namely education, health investment and access, economic development, and women's social inclusion. We collect measures for each state and year from 2001 to 2016 describing the proportion of each state living in poverty, the proportion of women who are economically active, the average level of completed schooling of the population, the average salary paid to full-time workers, the proportion of the population with access to health-care facilities, and the rollout of the national health insurance program *Seguro Popular*.[21] Summary statistics for each variable as well as a list of sources are provided in Appendix Table A4. These variables are merged by year and state to the morbidity, mortality, and birth data discussed earlier in this section.

4 Methodology

In order to examine the joint impact of the ILE reform and the regressive law changes in a single model, we begin by estimating the following difference-in-differences (DD) specification:

$$Health_{st} = \beta_0 + \beta_1 \text{ILE}_{st} + \beta_2 \text{Regressive}_{st} + X'_{st}\Gamma + \phi_s + \mu_t + \varepsilon_{st}. \quad (1)$$

Here $Health$ refers to average rates of morbidity or mortality in state s at time t, and ILE and Regressive refer to the post-ILE and post-Regressive Law changes in affected states. Our parameters of interest are β_1 and β_2. We include state and year fixed effects as ϕ_s and μ_t respectively, and examine stability to the inclusion of the time-varying controls X_{st} listed in section 3.2.[22] There are 32 states in Mexico (including the

[21] Mexico's General Health Law underwent a major reform in 2003, which intended to provide 50 million Mexican citizens lacking social security with subsidized and publicly financed health insurance. The core of this reform was the health insurance program *Seguro Popular* (SP). The "People's Insurance" or *Seguro Popular* was launched in 2002, offering health service free of charge or subsidized to those without formal health insurance.

[22] Given the dynamics observed in raw outcomes (refer to Appendix Figures A4, A5 and A6), we believe it is inappropriate to estimate DD models with state-specific linear time trends, $\phi_s \cdot t$. As is well known, the inclusion of state-specific linear time-trends in DD models where the reform impact is not captured by a simple trend break tends to result in biased parameter estimates, and this problem is "exacerbated when only a few observations are available before the policy shock" (Wolfers, 2006, p. 1807). This is precisely the situation in the empirics of this paper, with impacts often not becoming fully appreciable in the first reform year (2007), or emerging with the adoption of new abortion technologies. As such we do not estimate DD models with state-specific time trends, preferring to estimate full event studies examining trends, and showing robustness to synthetic

Federal District), and these laws are defined at the level of the state. In order to account for the possibility of unobserved correlations of outcomes for women within a state, standard errors are clustered by state. In practice, the quantity of clusters (32) is on the border of 'rule-of-thumb' type minimum cluster sizes for asymptotic validity of traditional clustered standard errors, and additionally, the states vary considerably in size. Given this, we estimate standard errors using a wild bootstrap, with Rademacher resampling weights.

Our outcomes of interest for this procedure are the measures of maternal morbidity and mortality discussed in section 3, as well as fertility in order to quantify any reform effect on birth rates. We thus implement the procedure for a measure of all abortion morbidity, morbidity due to haemorrhage early in pregnancy, and total maternal mortality and maternal mortality due to abortion. In each case in the main outcomes, we focus on rates of morbidity and mortality per the population of fertile aged women. We express our outcomes in this way for two reasons. The first is that it allows us to capture the full effect of the reform. As we will show that the abortion reform reduces fertility, if we express our outcomes as morbidity or mortality per live birth, this is equivalent to a partial impact, removing any impact of the reform which flows from the ability to avoid undesired, and potentially risky, births. In practice, we are interested in the total impact of the reform, which consists of the reduction in morbidity and mortality due to fewer births, as well as any direct impact the reform may have on the composition of mothers giving birth. Secondly, this allows us to ignore any challenges arising from the endogenous decision of whether or not to engage in legal abortion. If we instead report the impact of the law on rates of morbidity and mortality per live birth, we will be confounding our estimates due to the fact that a non-random group of women choose to proceed with births following the reform, and this group may be selectively more or less healthy than the women who elect to abort.[23]

For difference-in-difference estimates to capture the causal effects of abortion laws, we require a parallel trend assumption to hold, or that outcomes in each of the "Regressive", "ILE" and untreated states would have evolved similarly in the absence of abortion reforms. We provide a partial test of this, and ad-

control methods.

[23] Among other things, women seeking abortions are younger and more likely to come from lower socioeconomic background compared to the average Mexican mother (40% of women seeking abortion in ILE during 2008-2010 had 9 or less years of schooling, only 30% were employed and 75% are younger than 30 (Mondragón y Kalb et al., 2011)). Thus, these women may be either less or more healthy on average, and less or more likely to suffer complications conditional on giving birth.

ditionally quantify any dynamic reform effects, by estimating the following DD event-study specification:

$$Health_{st} = \alpha_0 + \sum_{j=-3}^{8} \delta_{-j} \Delta \text{ILE}_{s,t+j} + \sum_{k=-5}^{7} \gamma_{-k} \Delta \text{Regressive}_{s,t+k} + X_{st}'\Gamma + \phi_s + \mu_t + \varepsilon_{st} \qquad (2)$$

we normalise both δ and γ setting $\delta_{-1} = 0$ and $\gamma_{-1} = 0$. These event-study specifications are increasingly common in DD settings, and here we adopt the notation of Freyaldenhoven et al. (2018). In this specification, we are interested in the leads and the lags of the policy changes, where leads capture any prevailing trends prior to the reform, and lags show the change in health outcomes following the reform's implementation. In specification 2, we present the model for morbidity data available from 2003 to 2015. In this case we are able to estimate 3 leads and 8 lags of the ILE reform, and 5 leads and 7 lags of regressive law changes. In the case of mortality or fertility where longer periods of data are available, lags and leads are modified to provide a fully saturated model in each case. As in specification 1, year and state fixed effects absorb time-invariant and state-invariant factors, and standard errors are clustered by state with a wild bootstrap.

Although specification 2 provides evidence in favour of parallel (pre-)trends if we can reject that each $\delta_j = \gamma_j = 0 \; \forall \; j < 0$, we may nonetheless be concerned with unobserved heterogeneity between treated and non-treated states. As an additional test and a plausability check of estimates from equations 1-2 *for the impact of the ILE reform only*, we construct a synthetic control estimate to compare with Mexico DF. This procedure is particularly suitable to quantify the effect of the ILE reform in Mexico DF where there is a single treated unit, however not for the Regressive policy changers where a number of states adopt at different points in time. Our interest is to quantify the impact of the ILE reform, by comparing health outcomes in Mexico DF, the treated area, with outcomes in the rest of Mexico. This consists of determining the counterfactual state for a single treated state, following Abadie et al.'s (2010) synthetic control method where the single counterfactual "synthetic control" unit is generated based on a re-weighted pool of all the untreated states. This counterfactual is chosen to minimise the matrix norm based on the distance between average outcomes in the pre-treatment period, and the estimated average treatment effect on the treated (ATT) is inferred as the difference between the treated unit and the synthetic control unit in the post-treatment period. Our implementation of the synthetic control procedure is standard, as outlined in

Abadie et al. (2010). The "donor" pool from which we calculate synthetic controls include each of the remaining states with the exception of neighbouring Mexico State, in which a non-trivial proportion of abortions were accessed by women. We return to examine spillover impacts more completely in section 5.4.

In order to conduct inference on the estimated treatment effect, we similarly follow Abadie et al. (2010), and undertake permutation inference. In graphical analysis, we calculate identical synthetic controls for the 30 untreated donor states, and generate placebo reform estimates assuming an identical reform timing. We then compare the true reform impact in each year with the impact for each of the placebo estimates in this year, to determine whether the estimated impact in the treated region is large compared with placebo cases where no substantial impact should be observed. When considering inference on a single ATT based on the mean post-treatment decline, we implement permutation inference comparing our main effect with the effect in all potential control states, and all potential treatment periods, as suggested in Abadie et al. (2010, p. 497).[24] This provides a larger pool of placebo outcomes, giving greater precision to reported p-values resulting from permutation inference.

5 Results

5.1 Abortion Laws and Fertility Outcomes

The impact of changes in the cost or availability of legal abortion on fertility outcomes have been well documented in the economic literature. Estimates from a range of contexts are summarised in Table 1. We present estimates of the impact of abortion laws which result the loosening of restrictions in Panel A, and those which result in the tightening of access or increasing of sanctions in Panel B. Across studies on

[24] In particular, the p-value associated with the ATT for the impact of ILE on health outcomes is calculated as:

$$p = \frac{\sum_{s=2}^{31}\sum_{t=2004}^{2014} 1\{|\hat{\alpha}_{1,2007}| \leq |\hat{\alpha}_{t,s}|\}}{N_{s,t}}$$

where $\hat{\alpha}_{s,t}$ refers to the average post-treatment difference between the treated (or placebo) unit and its synthetic control for state s where the (placebo) treatment is assigned as occurring in year t. Here state $s = 1$ refers to Mexico DF and the true treatment year is $t = 2007$, and so $\hat{\alpha}_{1,2007}$ is the true treatment effect, while permutations of each state×year pair $(2, \ldots, 31)\times(2004 \ldots 2014)$ are placebo trials. $N_{s,t}$ refers to the total number of placebo permutations.

abortion legalization in the US, Nepal, Norway and Romania we observe a drop in fertility (mainly among younger and low SES women) of between 1.2-7% (see panel A in Table 1). Studies on the impact of regressive abortion law changes (including parental consent laws and restricted funding of abortions) find considerably more heterogeneous results, with results ranging from significant reductions in birth rates (Kane and Staiger, 1996), insignificant impacts (Levine et al., 1996), and increases in rates of birth (Lahey, 2014) (refer to panel B in Table 1).

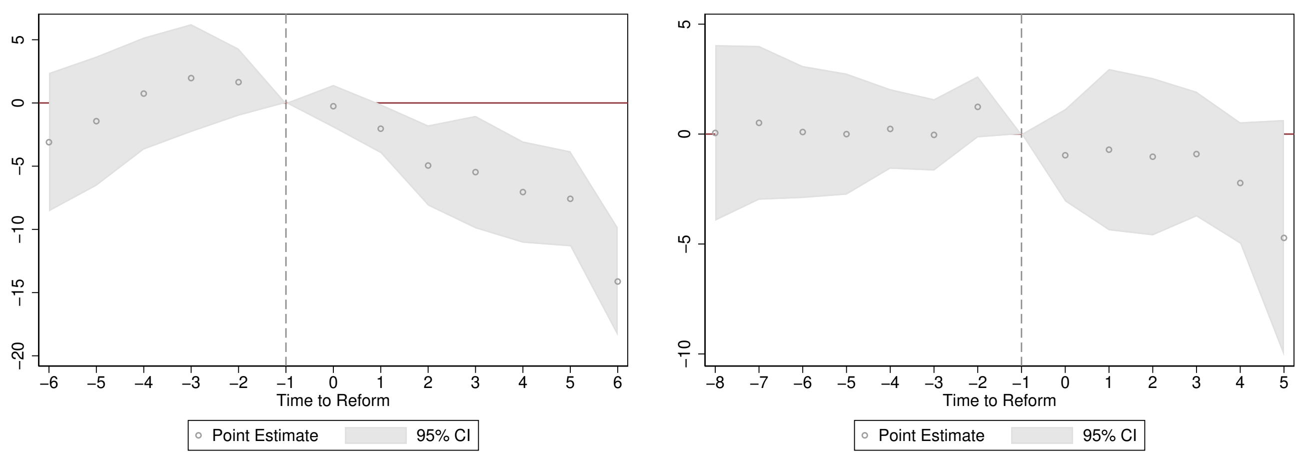
Table 3: Difference-in-Differences Estimates of Abortion Reforms on Fertility

	Births per 1,000 Women			
	(1)	(2)	(3)	(4)
Post-ILE Reform (DF)	-6.091***	-5.608***	-4.600***	-4.838***
	(0.671)	(0.698)	(1.202)	(1.367)
Post Regressive Law Change	-1.824*	-1.752	-1.901*	-1.802
	(1.100)	(1.248)	(1.058)	(1.318)
Observations	416	416	416	416
Mean of Dependent Variable	87.643	87.643	87.643	87.643
Mean of Dependent Variable (Mexico DF)	89.021	89.021	89.021	89.021
Mean of Dependent Variable (Regressive States)	90.561	90.561	90.561	90.561
State and Year FEs	Y	Y	Y	Y
Population Weights		Y		Y
Time-Varying Controls			Y	Y

Each column displays a difference-in-differences regression of the impact of abortion reform on rates of fertility. Fertility is measured as the number of births per 1,000 fertile aged women each year. Time-varying controls are documented in section 3.2. All standard errors are clustered at the level of the state using a wild clustered bootstrap procedure.

Our results from the Mexican abortion reforms suggest broadly similar fertility impacts to those observed in other settings following the elimination of abortion restrictions. We provide a summary DD estimate for Mexico in the case of progressive (ILE) and regressive reforms for comparison in Table 1. These estimates are taken from Table 3 which displays DD estimates of the impact of reforms on birth rates. In Table 3 we present population-weighted and unweighted results, where the population refers to the total number of fertile aged women in each state by year cell. Columns 1-2 are baseline DD models including only time and state fixed effects, while columns 3-4 add in time-varying control described in section 3.2. In general, across specifications, results are quite stable in suggesting a significant reduction in births in Mexico DF following the ILE reform. Depending on estimation weights, we observe a reduction of between 4.6 and 6.1 births per 1,000 women, or a reduction of between 5.3 and 6.8% in fertility rates compared with pre-reform levels in the state. Our preferred estimates are those including population weights with full time-varying controls, which suggest a reduction of 4.8 births per 1,000 women of fertile age in the years following the ILE reform, or a 5.4% reduction in birth rates in Mexico DF. We note that this reduction is similar to that documented following Roe v. Wade in the US (Levine et al., 1999; Gruber et al., 1999; Ananat et al., 2007), though slightly smaller than that reported by Pop-Eleches (2010) in Romania. In the case of states passing regressive laws altering their penal codes or state constitutions related to abortion, we observe much weaker evidence to suggest any notable effect on fertility, though if anything estimates point to a slight reduction in rates of fertility in the years following reforms. Depending on the model, point estimates vary from -1.9 to -1.7 births per 1,000 women, or a 1.9 to 2% reduction in rates of fertility. In preferred estimates weighting for the population of fertile women, these results are not statistically significant at the 10% level. We return to examine the nature of these legal reforms in more detail in section 5.4, revisiting the small estimated impacts on birth rates.

Figure 1: Event Studies for Fertility Rates in Progressive and Regressive Abortion Reforms



(a) Progressive Abortion Reform (ILE) (b) Regressive Abortion Laws (Legislative Tightening)

Notes: Event studies document the evolution of birth rates per 1,000 women surrounding the passage of abortion reforms. Each point estimate refers to the change in rates between treated and non-treated states, compared to their baseline differential (1 year prior to the reform). The left-hand panel shows the difference between Mexico DF and untreated states surrounding the passage of the ILE reform. The right-hand panel shows the difference between regressive policy changers and non-changers around the (time-varying) date that each reform was passed. In each case the 95% confidence intervals are shaded, and are based on wild-bootstrap clustered standard errors.

We provide full event studies corresponding to the passage of progressive and regressive reforms in

Figure 1. In the left-hand panel we observe a reduction in rates of fertility in Mexico DF when compared with all non-reform states, which becomes statistically significant from 1 year post-reform (2008) onwards. This is in line with lags in birth rates expected to be observed approximately 7-9 months following the passage of abortion reforms due to the gestational period and limits on gestational length when undertaking abortion. In the pre-reform period, all estimates are not statistically distinguishable from zero, providing some supporting evidence of the parallel trends assumption in the pre-reform period. While we note that point estimates seem to suggest a slight upwards trend, we return to examine the stability of these estimates to a judiciously chosen synthetic control group in the paragraphs below.

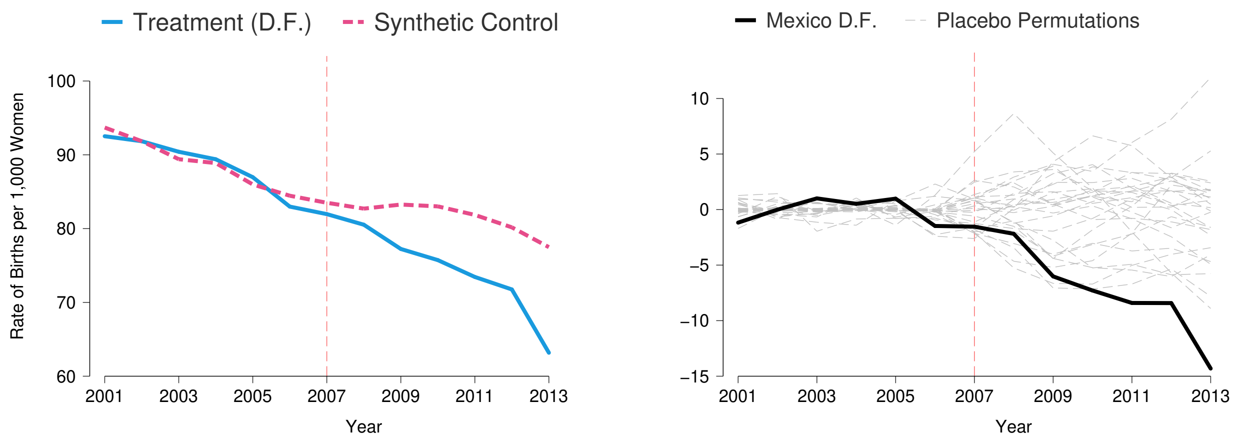
The right-hand panel of Figure 1 documents similar point estimates and standard errors for states altering their constitutions or criminal codes to increase legal sanctions on abortion. While estimates are displayed in separate panels, as described in equation 2 these are estimated in a single specification implying both figures control for reforms implemented in other states. In the case of regressive reforms, event studies agree with average DD estimates in suggesting no statistically distinguishable effects of the reform, while point estimates point to, if anything, a slight reduction in fertility in the post-reform period. Once again, there is no evidence of statistically distinguishable prevailing trends in the pre-reform period.

DD and event study estimates base the control group on all non-reform states. As a consistency check on these results and to ensure that estimates for the impact of the ILE reform are not driven by any pre-existing differential trends, we also compare outcomes in Mexico DF with those in a single synthetic control state. The difference between outcomes in Mexico DF and the synthetic control state are documented in Figure 2. Here we observe that while there was a downward trend in birth rates in DF including prior to the reform,[25] synthetic control results suggest that this decline accelerated following the implementation of ILE in 2007 when comparing Mexico DF with the synthetic control state. Figure 2a shows the trend in Mexico DF (solid line) as compared to the synthetic control (dashed line), where the synthetic control is chosen to minimise the RMSE in the difference between these two rates prior to the reform. The fertility rates in Mexico DF are substantially below those of the synthetic control, and appear to diverge over time. The average difference in rates of birth per 1,000 women over the time-period under study is 6.8 births

[25]This is in line with a general trend in declining fertility across the country, which began in the 1960's or 1970's depending on the state (Tuiran et al., 2004).

(comparable to the DD results discussed above), and this difference is as large as 15 births per 1,000 women 6 years following the ILE reform. When cast in terms of the average fertility rates of Mexico DF in the pre-reform period (89 births per 1,000 women), this accounts for approximately a 7.5% reduction.

Figure 2: Fertility in Mexico DF and a Synthetic Control Group



(a) Synthetic Control

(b) Inference

Notes: Left-hand panel displays birth rates per 1,000 women aged 15-49 in Mexico DF (solid line), and a synthetic control formed from the remaining 30 states (excluding Mexico DF and Mexico State). The synthetic control is chosen based on birth rates in all *pre*-reform years (2001-2006). Right hand panel displays the difference between Mexico DF and its synthetic control (thick solid line), and 30 other placebo permutations, where the remaining states are considered as treated in 2006, and their synthetic control is determined based on an identical procedure as in Mexico DF.

In Figure 2b, we compare the synthetic control estimates for Mexico DF with a series of placebo reforms for each of the remaining 30 states to determine whether the estimated impacts are relatively large compared with contexts in which a zero impact would be expected. In initial years, particularly in 2008, we do not observe that outcomes in Mexico DF are extreme when compared to placebo cases, and so cannot suggest an immediate statistically significant effect. However, in general we observe that over time, differences in Mexico DF become more extreme than all placebo outcomes. From 4 years post-reform, the difference between Mexico DF and its synthetic control is larger in absolute terms than any of the 30 placebo changes. In Appendix Figure A7 we compare this mean outcome with a null distribution based on permutations of treatment by state and year. We observe that the outcome observed in Mexico DF is extreme with respect to the null distribution. Only 4.2% of placebo iterations have a more extreme outcome than that observed in Mexico DF following the ILE reform, and this falls to 0.3% if considering only those which suggest a larger reduction than in Mexico DF (corresponding to two- and one-tailed p-values of 0.042 and 0.003 respectively).

5.2 Maternal Morbidity

Estimates for the impact of abortion reforms on maternal morbidity are presented based on a range of methodologies, and for the maternal health measures outlined in section 3. Difference-in-difference estimates of the impact of the ILE reform and subsequent restrictive law changes on morbidity are presented in Table 4. All coefficients are cast as the effect of law changes on morbidity per 1,000 women. We observe that, on average, conditional on subsequent restrictive reforms, the ILE reform resulted in a reduction in morbidity by approximately 0.85 to 1.1 cases per 1,000 women when considering all abortion-related morbidity, or be 0.8 to 0.9 cases per 1,000 women when considering the incidence of haemorrhage early in pregnancy. When compared to average rates of morbidities of these conditions, this is approximately a 10% reduction in abortion related morbidity, and a 40% reduction in rates of haemorrhage. Results are robust to weighting or not by the population of each state, and to the inclusion of time-varying controls.

In the case of subsequent restrictive reforms, we find in general quite weak and noisy evidence when examining whether these reforms shifted morbidity outcomes. For abortion related morbidity, we find no significant impacts across specifications reported in Table 4. And in the case of haemorrhage early in pregnancy, in unweighted DD models we observe a marginally significant reduction in morbidity following a regressive change in laws, however this is rendered insignificant with the introduction of population weights, suggesting that if anything, this reduction is driven by smaller states. In general, this evidence does not suggest a consistently significant result of the introduction of restrictive laws, although point estimates are in general negative. When instead of the total number cases we examine the total number of inpatient days (Appendix Table A5), we similarly observe a large reduction following Mexico's ILE reform, and no significant impact in the case of regressive reforms.

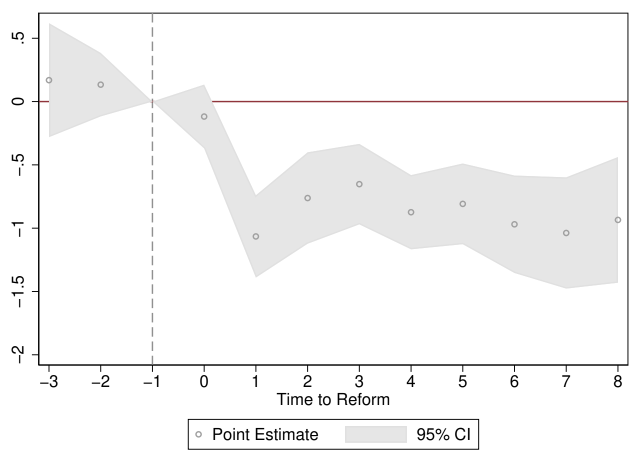
Table 4: Difference-in-Differences Estimates of Legal Reforms on Morbidity

	Abortion Related Morbidity				Haemorrhage Early in Pregnancy			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Post-ILE Reform (DF)	-1.048***	-1.130***	-0.994***	-0.857**	-0.939***	-0.900***	-0.933***	-0.809***
	(0.235)	(0.239)	(0.339)	(0.423)	(0.109)	(0.105)	(0.196)	(0.162)
Post-Regressive Law Change	-0.139	-0.081	-0.256	-0.170	-0.309*	-0.198	-0.334*	-0.175
	(0.322)	(0.350)	(0.291)	(0.338)	(0.181)	(0.140)	(0.177)	(0.125)
Observations	384	384	384	384	384	384	384	384
Mean of Dependent Variable	10.336	10.336	10.336	10.336	2.343	2.343	2.343	2.343
State and Year FEs	Y	Y	Y	Y	Y	Y	Y	Y
Population Weights		Y		Y		Y		Y
Time-Varying Controls			Y	Y			Y	Y

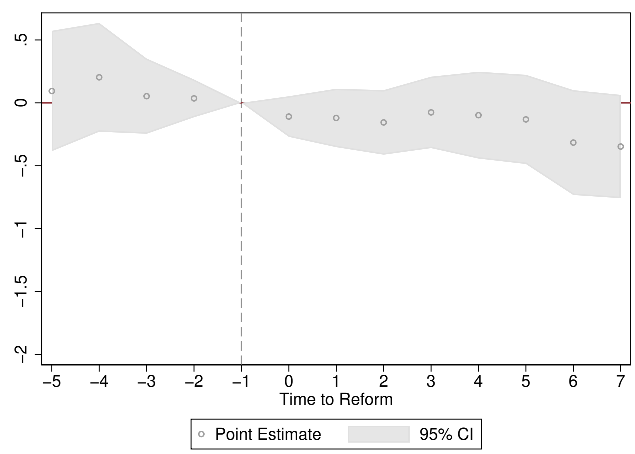
Notes: Each column displays a difference-in-differences regression of the impact of abortion reform on rates of morbidity (inpatient cases). Each morbidity class is measured as cases per 1,000 fertile aged women each year, and average levels in the full set of data are available at the foot of the table. All standard errors are clustered at the level of the state.

We examine the DD estimates in more details in Figures 3 and 4, where the treatment indicator in each of the ILE and Regressive cases is interacted with a full set of lags and leads. Figure 3 examines outcomes for haemorrhage, and Figure 4 examines outcomes for abortion-related morbidity. In both cases, panel A shows the event study for Mexico DF surrounding the ILE reform, and panel B shows the event study for regressive states. In each case, population weights and the full set of time-varying controls are used. In Figure 3 we observe an immediate sharp decline in rates of haemorrhage in Mexico DF following the adoption of ILE. Additionally, we observe little evidence of prevailing differences in treated and untreated states *before* the reform, with the third and second lead being located close to zero. In the case of regressive states (panel B), we observe a similar quite flat profile prior to the reform. Following the reform, while we observe a small reduction in rates of haemorrhage, this reduction is never statistically distinguishable from zero at 95% confidence intervals.

Figure 3: Event Studies for Rates of Haemorrhage Early in Pregnancy



(a) Progressive Abortion Reform (ILE)

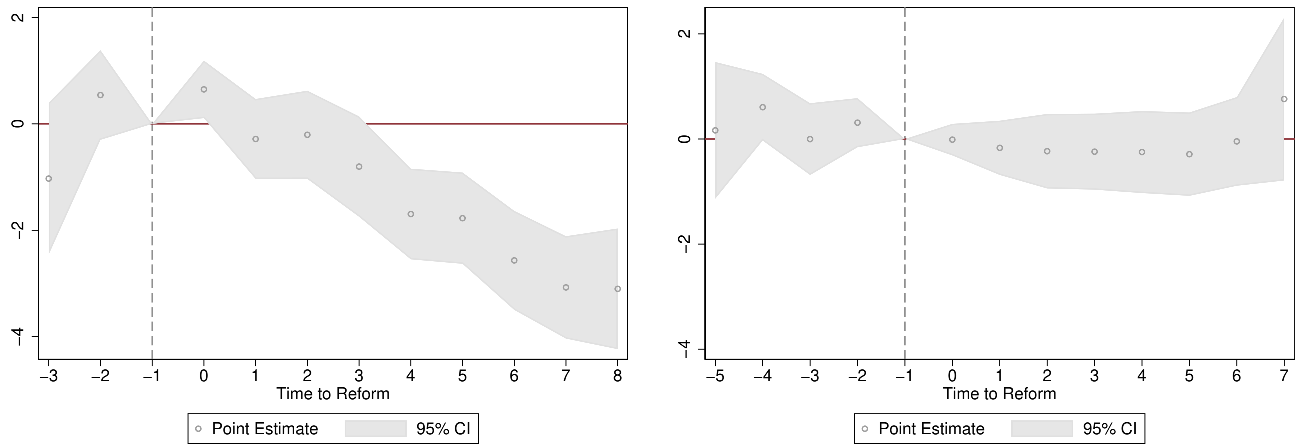


(b) Regressive Abortion Laws (Legislative Tightening)

Notes: Event studies document the evolution of rates of haemorrhage early in pregnancy per 1,000 women surrounding the passage of abortion reforms. Each point estimate refers to the change in rates between treated and non-treated states, compared to their baseline differential (1 year prior to the reform). The left-hand panel shows the difference between Mexico DF and untreated states surrounding the passage of the ILE reform. The right-hand panel shows the difference between regressive policy changers and non-changers around the (time-varying) date that each reform was passed. In each case the 95% confidence intervals are shaded, and are based on wild-bootstrap clustered standard errors.

When considering rates of abortion morbidity, event studies document larger prevailing (pre-reform) differences between DF and untreated states, although with wider confidence intervals. This agrees with simple trends in outcomes documented in Appendix Figure A4, which suggest an increase in morbidity

Figure 4: Event Studies for Rates of Abortion Morbidity



(a) Progressive Abortion Reform (ILE)

(b) Regressive Abortion Laws (Legislative Tightening)

Notes: Refer to notes to Figure 3. Identical event studies are estimated, however now for Abortion related morbidity (ICD codes O02-O08).

due to abortions recorded in Mexico DF in the year 2005 that were not seen in the rest of the country. This drives the negative (but not statistically significant) pre-reform value observed in the third lead of Figure 4a, prior to the steady reduction observed in the post-ILE years. In the case of states which altered legislation in response to ILE, we observe very little evidence of an impact of these reforms on abortion morbidity in 4b. In both the pre- and post-reform period, all estimates are not statistically distinguishable from zero, and are centred around a null impact.

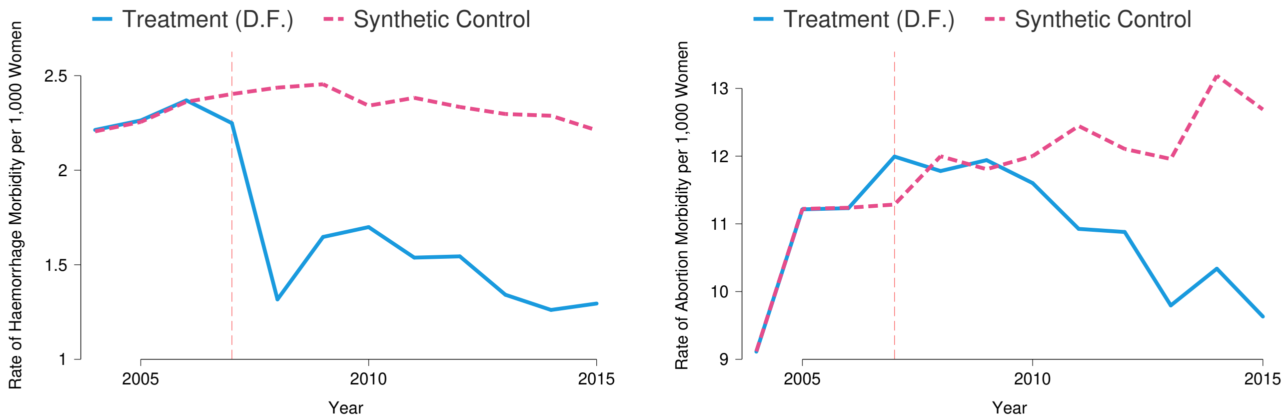
In Figure 5 we present results based on a consistency check comparing rates of haemorrhage early in pregnancy and rates of morbidity for all abortion related causes in Mexico DF and in a synthetic control state. In Panel A we observe an immediate and sharp fall in rates of haemorrhage early in pregnancy, falling from approximately 2.3 cases per 1,000 fertile aged women to approximately 1.3 cases per 1,000 women. This agrees with DD and event study results documented above. Additionally, this supports claims from the medical literature that haemorrhage is one of the major drivers of maternal morbidity and mortality following unsafe abortions (World Health Organization, 2011), as the appearance of a legal and sterile alternative to clandestine abortion resulted in an immediate a 43% reduction in hospitalisations resulting from haemorrhage early in pregnancy. In the sub-set of data for which the month as well as the year of hospitalisation is recorded (those in hospitals administered by the Secretary of Health), we observe that this fall occurs precisely in the month that abortion was legalised, suggesting that changes in haemorrhage morbidity were immediate with the arrival of new legislation (see Appendix Figure A6).

In Panel B of Figure 5 we present trends in rates of morbidity due to abortive causes. In this case we observe a more gradual reduction in morbidity, with a clear difference 4 years post-reform. In longer trends from public hospital data displayed in Appendix Figure A5, descriptive figures do suggest that this was a turning point in Mexico DF, with a peak in 2008, after a steady increase from 2000, and then a steady decline in the total number of cases of hospitalisation up until 2015. In the case of abortion morbidity, it is important to note that the procedure used for abortions realized under the auspices of ILE has changed over time, which may partially explain the delay in observed impacts on morbidity. Initially, the majority of abortions were performed by surgical procedures (manual vacuum aspiration or dilation and curettage) (75%) compared to medical abortions (25%). This gradually changed in subsequent years, with medical abortion procedures reaching 74% in 2011, and the use of dilation and curettage was eliminated entirely (in accordance with WHO recommendations for first-trimester abortions). In addition, the quality of medical abortions performed has also improved, due to the introduction of mifepristone (combined with misoprostol) in 2011 (Becker, 2013).[26] The large rise in medical abortion has both improved the safety of the program and enabled for the high demand for elective abortion to be met.

In Figure 6 we present a visual representation of permutation inference for synthetic control estimates following Abadie et al. (2010). In the left-hand panel, we compare the difference between haemorrhage morbidity in Mexico DF and its synthetic control with placebo differences in each other state in Mexico compared to its own synthetic control. In the first post-reform year, the true estimate exceeds all other placebo iterations, and this largely remains to be true in subsequent years, although from 5 years post-reform a number of more extreme outcomes are observed in certain (generally smaller) states. To calculate an exact permutation p-value, we follow the state and year permutation procedure, generating the null distribution displayed in Appendix Figure A8. A two-tailed test suggests a p-value of 0.09, and a one

[26]The introduction of mifepristone in 2011 allowed for the use of the perceived "gold standard" medical abortion procedure according to the WHO, which is a combination of mifepristone and misoprostol (instead of misoprostol alone). This regimen is more efficient and causes less side-effects (Becker, 2013).

Figure 5: Morbidity Outcomes in Mexico DF and a Synthetic Control Group



(a) Haemorrhage Early in Pregnancy

(b) Abortion Morbidity

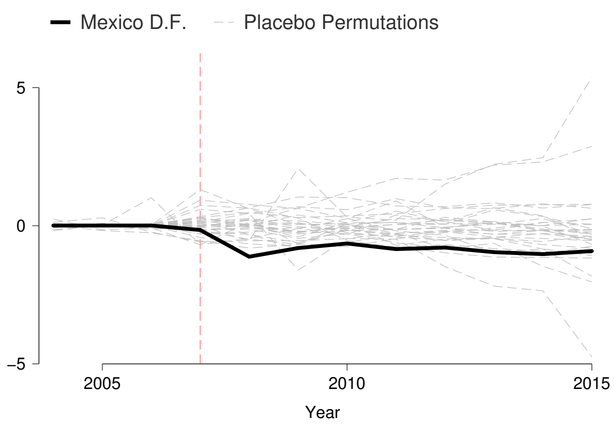
Notes: Left-hand panel displays all morbidity classified as ICD codes O02-O08 (for reasons relating to abortion). Right hand panel displays morbidity for haemorrhage early in pregnancy (prior to week 20 of gestation). In each case synthetic controls are based on a pool of the 30 other states of Mexico (excluding Mexico DF and Mexico State), and are selected based on rates of abortion morbidity in all *pre*-reform years. Morbidity is per 1,000 women aged 15-49 residing in the state.

tailed test suggests a p-value of 0.06, respectively implying that only 9% of placebo outcomes result in an average post-placebo change which is more extreme than the true post-treatment change in D.F, and only 6% of placebos have a larger reduction. In the right-hand panel of Figure 6 we observe similar placebo estimates for abortion related morbidity. In line with the slower-reduction in abortion-related morbidity, we do not observe that the outcome in Mexico DF is more extreme than all placebo outcomes until multiple years post-reform. Only in 2014 and 2015 is the difference more extreme in the true treated state than each placebo iteration. Complete randomization inference similarly suggests that average treatment effects over the whole reform period are less extreme than in the case of haemorrhage. Specifically, two-tailed tests suggest a p-value of 0.19, or 0.087 in the case of one-tailed tests (Appendix Figure A9).

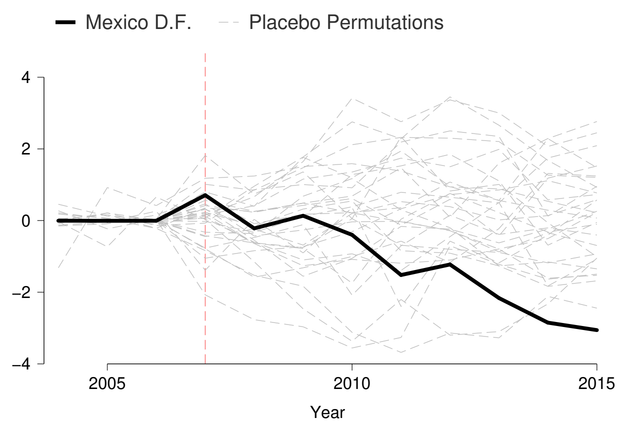
5.3 Maternal Mortality

Moving from maternal morbidity to maternal mortality, we observe a reduction by various orders of magnitude in the frequency of events, in line with the oft-cited metaphor that maternal mortality is the tip of the iceberg, to maternal morbidity's base (see for example Firoz et al. (2013)). In general this makes it

Figure 6: Inference: The Impact of Abortion Reform on Maternal Morbidity



(a) Haemorrhage Early in Pregnancy



(b) Abortion Morbidity

Notes: Inference for synthetic control estimates of the impact of the ILE reform on morbidity based on placebo permutations are displayed. Each panel displays the difference between Mexico DF and its synthetic control (as a thick solid line), and 30 other placebo permutations, where the remaining states are considered as treated in 2006, and their synthetic control is determined based on an identical procedure as for Mexico DF. These are displayed as thin dashed lines.

considerably more difficult to estimate precise impacts on maternal mortality. Given this, and challenges in forming an appropriate counterfactual state for Mexico DF,[27] we focus here on DD and event study estimates, and examine pre-trends in event studies to determine whether impacts appear to be driven by previously existing differences.

In Table 5 we present DD estimates following equation 1 for both all maternal deaths (columns 1-4), and only maternal deaths originating from abortive causes (columns 5-8). When focusing on the ILE reform, we observe mixed evidence pointing in the direction of negative, though often imprecisely estimated, point estimates. Both weighted and unweighted estimates suggest a significant reduction in all maternal deaths following ILE (columns 1 and 2), of approximately 0.6 per 100,000 fertile aged women (versus a mean value of 4 deaths per 100,000 women in Mexico). Note however, that when adding time-varying controls in columns 3 and 4, these estimates are reduced by about one third, and become statistically insignificant at typical levels. Similarly, in the case of abortion related maternal mortality, we observe significant reductions when using weighted or unweighted simple DD models (with point estimates of bet-

[27] In particular, given wider year-to-year variation in rates of abortion in Mexico DF and potential donor states, the Mean Squared Prediction Error in the pre-reform periods in the synthetic control estimate is quite large, and often extremely large when undertaking placebo estimates.

Table 5: Difference-in-Differences Estimates of Legal Reforms on Maternal Mortality

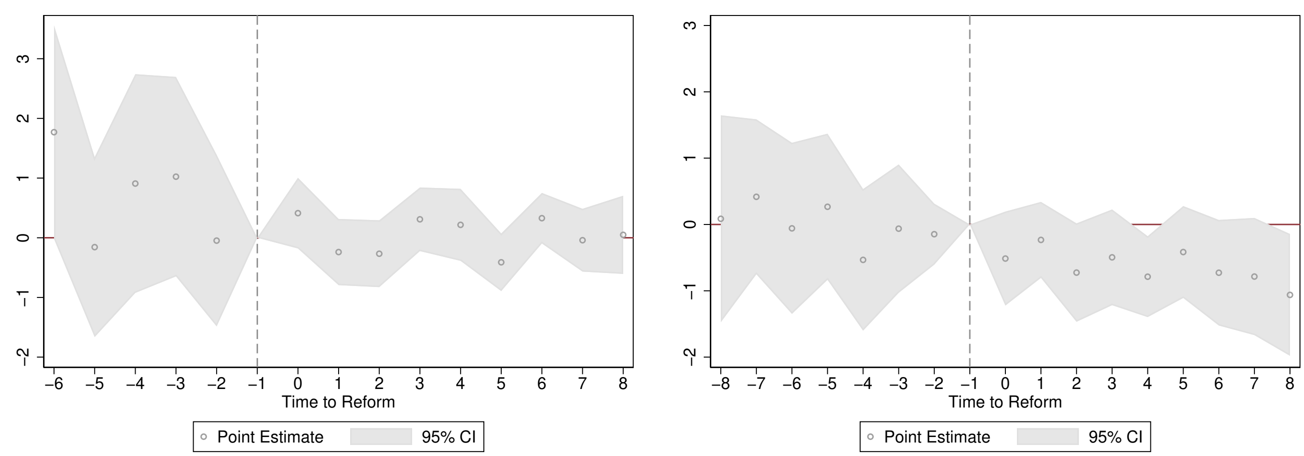
	All Maternal Mortality				Maternal Mortality due to Abortion			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Post-ILE Reform (DF)	-0.663**	-0.669**	-0.414	-0.658	-0.109**	-0.074*	-0.034	-0.038
	(0.273)	(0.317)	(0.590)	(0.585)	(0.050)	(0.044)	(0.077)	(0.071)
Post Regressive Law Change	-0.502	-0.543	-0.478	-0.580	-0.090	-0.036	-0.081	-0.042
	(0.340)	(0.376)	(0.335)	(0.363)	(0.057)	(0.047)	(0.053)	(0.045)
Observations	512	512	512	512	512	512	512	512
Mean of Dependent Variable	4.028	4.028	4.028	4.028	0.276	0.276	0.276	0.276
State and Year FEs	Y	Y	Y	Y	Y	Y	Y	Y
Population Weights		Y		Y		Y		Y
Time-Varying Controls			Y	Y			Y	Y

Notes: Each column displays a difference-in-differences regression of the impact of abortion reform on rates of maternal mortality. Maternal mortality (all causes) and maternal mortality for abortive causes are each measured as total deaths per 100,000 fertile aged women each year, and average levels in the full set of data are available at the foot of the table. All standard errors are clustered at the level of the state.

ween -0.07 to -0.10 per 100,000 fertile aged women), though these become insignificant with the inclusion of time-varying controls.

In the case of regressive reforms we find, across the board, relatively little evidence of any impacts of these reforms on maternal mortality. We do consistently observe negative point estimates of a magnitude approaching that observed in Mexico DF following the ILE reform, however regardless of specifications estimated, we never observe a significant reduction in maternal mortality. We note however that, as discussed, standard errors are quite wide, thus precluding us from concluding that these estimates suggest tightly estimated zero-impacts.

Figure 7: Event Studies for Rates of Maternal Mortality



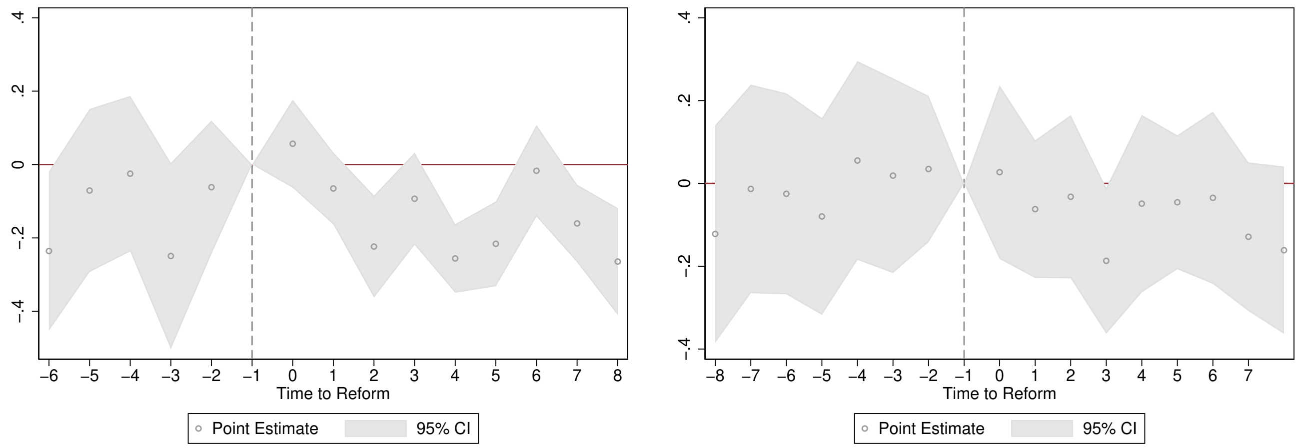
(a) Progressive Abortion Reform (ILE)

(b) Regressive Abortion Laws (Legislative Tightening)

Notes: Event studies examine the impact of abortion reforms on maternal deaths (measured as deaths per 100,000 women of fertile age). Additional notes related to the procedure are provided in Figure 3.

These wide confidence intervals can be observed in event studies presented in Figures 7 (for all maternal mortality) and 8 (for maternal mortality due to abortion). Each event study includes full time-varying controls, and is weighted by the population of fertile aged women. In the case of all mortality, pre-reform point estimates in both progressive and regressive states consistently include zero, and with the exception of 6 periods prior to the passage of reforms in DF are located within 0.1 death per 100,000 women of a zero impact. In the post-reform period, we observe no significant impact in the case of the ILE reform, and in the case of regressive reforms observe two coefficients various years post-reform (four and eight years

Figure 8: Event Studies for Rates of Maternal Mortality due to Abortion



(a) Progressive Abortion Reform (ILE) (b) Regressive Abortion Laws (Legislative Tightening)

Notes: Event studies examine the impact of abortion reforms on maternal deaths (measured as deaths per 100,000 women of fertile age) where maternal deaths are classified as due to abortion (ICD codes O02-O08). Additional notes related to the procedure are provided in Figure 3.

respectively) which point to a reduction in maternal deaths. While this may reflect some disincentive effect flowing from increased sanctions on (illegal) abortion, we note that this is never observed to be significant in mean estimates displayed in DD models.

In the case of maternal mortality due to abortion, once again we observe pre-reform impacts which are not statistically distinguishable from zero. In Figure 8a we observe a divergence in rates of mortality in the post-reform period following the passage of ILE. In the 8 post-reform years, each point estimate is negative, and 6 of 8 are statistically significant at the 95% level. In general, these point estimates cluster around -0.2 deaths per 100,000 live births, which is close to the average level of maternal deaths due to abortion in all of Mexico in the period under study (0.276 deaths per 100,000 fertile-aged women). For comparison, the average level of maternal deaths due to abortion in Mexico DF only, and in the pre-reform period of 2001-2006 is approximately 0.5 deaths per 100,000 fertile-aged women. Figure 8b plots the same event study coefficients and standard errors for rates of maternal deaths due to abortion in states passing regressive abortion reforms. In this case we observe relatively little evidence of a change in maternal deaths. While once again we observe largely negative point estimates, only in one case (three years following passage) does this point estimate significantly differ from zero.

5.4 Understanding impacts of abortions laws

Sensitive Populations Previous studies on abortion laws (see Table 1), suggest that these have a particularly strong effect among sensitive populations such as young and low SES women. We examine heterogeneous effects of abortions laws by age groups. Similar to previous studies described above, we find a particularly strong negative impact on teenage fertility (women aged 15-19) and on fertility among the age groups of 20-24, 25-29 and 30-34 years. When expressed in percentage terms, we observe that rates of birth among teenagers fall by 7.8%. We document DD estimates in Appendix Table A6, and synthetic control estimates for each age group in Appendix Figure A10.

In line with this, we observe a larger drop in morbidity among younger women. Difference-in-difference estimates suggest that the impacts of the reform on abortion morbidity is driven largely by women under the age of 25, and in the case of haemorrhage, while transversal results are observed across age groups, these are largest for those aged between 15 and 34. These results are observed both when considering DD results (Appendix Table A6), as well as in synthetic control analyses (presented in Appendix Figures A11-A12). Given the relatively small number of maternal deaths in quinquennial age groups and corresponding lack of power, we do not estimate reform impacts on maternal mortality by age group.

***De Jure* versus *De Facto* Legal Reforms** In general we find relatively little impact of regressive law changes on resulting fertility, morbidity or mortality. One potential explanation of this is that the although *de jure* changes were made to state constitutions, the *de facto* implementation of laws and penal codes was unchanged. As we document in Appendix Table A7, in many cases, while constitutions were altered—generally to declare that human life begins at conception—this did not always translate in concrete legal changes in the criminal sanctions imposed on women or abortion providers. This has been similarly noted in legal analyses of the reform (Singh et al., 2012b). And even in cases where criminal sanctions were increased, it may be the case that state-level judiciaries do not alter the likelihood of imposing sanctions on abortion.

We examine whether there is evidence of changes in the likelihood of being sentenced to prison for undertaking an abortion, or in the length of prison sentences received, based on the passage of the abortion

Table 6: Difference-in-Differences Estimates of Abortion Reforms on Judicial Outcomes

	Number of Prison Sentences		Length of Prison Sentences	
	(1)	(2)	(3)	(4)
Post-ILE Reform (DF)	-4.111***	-4.233***	2.744	2.689
	(0.245)	(0.339)	(2.386)	(2.066)
Post-Regressive Law Change	-0.673	-1.374**	4.148*	5.226**
	(0.456)	(0.569)	(2.351)	(2.426)
Observations	288	288	176	176
Mean of Dependent Variable	1.819	1.819	3.676	3.676
State and Year FEs	Y	Y	Y	Y
Population Weights		Y		Y

Difference-in-difference models illustrate how abortion reforms correlate with prison sentences handed down by the judiciary, and the length of these prison sentences in years. Total number of sentences and the average length of prison sentences are generated from administrative records captured in Mexico's Judicial Statistics on Penal Matters. This is the universe of judiciary decisions in the country based on the first legal judgement, and so does not include any subsequent appeals. Analysis of the length of prison sentences presented in columns 3 and 4 is conditional on any prison sentences being handed down in each state and year. Prison sentence lengths are calculated from a categorical variable capturing bins of between 6 months and two years, and in each case we record the total years (or fractions of years) based on the midpoint of each bin. Bins are consistently used in the period displayed here. All standard errors are clustered at the level of the state and calculated using a wild bootstrap procedure.

laws examined in this paper. DD results following specification 1 are displayed in Table 6. Here we examine the universe of all custodial sentences handed down by the Mexican judiciary. We observe, firstly, that there is a sharp reduction in the number of prison sentences in Mexico DF following the reform (in line with the legalisation of abortion), and no significant change in sentence length handed down in Mexico DF.[28] Importantly, we observe evidence of a dual impact in regressive states. We observe mixed evidence pointing to a slight reduction in the number of prison sentences handed down, falling by 1.374 cases in weighted regressions (compared with a mean number of sentences per state and year of 1.819). In the case of the length of sentences, we observe a considerable increase, of between 4.1 and 5.3 years, depending on the specification estimated. In the case of weighted estimates, we observe an average increase of 5.3 years (95% confidence interval ranging from 0.5 to 10 years), which is significant, even at the lower end of the 95% confidence interval, when compared with the mean sentence length of 3.7 years. Thus, these results

[28]Note that in Mexico DF, while abortion was legalised by the ILE reform, this was only the case for abortions realised up to 12 weeks of gestation. Thus, in theory, custodial sentences can still be handed down for abortion when not meeting this condition. In practice, a non-zero number of sentences was only observed in Mexico DF in 2011 (refer to Appendix Figure A3 for trends over time).

suggest that while the changes in law did not necessarily always prescribe a change in prison sentences, there is a detectable increase in the length of prison sentences observed in administrative data, conditional on being sentenced to prison. This increase in average sentence length is observed to hold in event study analysis, with significant impacts observed from 1 year post-reform onwards (see Appendix Figure A13).

Leakage to the Private Health System One potential alternative explanation of the observed morbidity results in all public hospitals is that rather than being driven entirely by the abortion reform, they may reflect changes of usage of the health system, with a larger number of women opting to use the private health care system. This explanation cannot explain the impact on fertility and maternal mortality, as these outcomes are based on the complete records of births and deaths in the country. However, it could partially explain the impacts observed on morbidity, as our administrative data records inpatient stays in the public health system (refer to section 3 for additional discussion).

While we can't consistently merge public and private health data at the most dissagregated level of morbidity causes, we *are* able to consider all causes of abortion morbidity in the private health care system.[29] In Appendix Figure A18 we plot rates of abortion related morbidity in the universe of private hospitals (left-hand panel) and the universe of public hospitals (right-hand panel). These descriptive plots suggest that if anything, results in the private system will only strengthen our estimates, as we observe a sharper reduction in abortion related morbidity in private hospitals than we observe in public hospitals. In the case of morbidity due to haemorrhage early in pregnancy, we are unable to observe this as a sole cause in the private health records, but we are able to observe the class in which this cause falls (refer to Appendix Table A2 which provides the description of how public and private records can be matched). Once again, although we are unable to isolate only haemorrhage morbidity, we observe a considerably sharper reduction in morbidity following the reform in the private health system than we observe in the public health system (refer to Appendix Figure A19). In general, these results suggest that focusing only on the public health care system results in a lower bound estimate of the true reform impact on all maternal health.

[29]Note that as documented in Appendix Table A2, this mapping captures all ICD-10 codes O00-O08, while typically abortion morbidity is calculated from codes O02-O08. In Figure A18 we plot comparisons using precisely the same aggregated codes in public and private hospitals.

Reform Spillovers As outlined in section 2.3, the ILE reform was not strictly limited to residents of Mexico DF. Recent evidence from the United States documents a willingness to travel over a significant distance to access abortion providers (Cunningham et al., 2017). In Appendix Table A8 we provide summary figures of the state of precedence of users of abortion services in Mexico DF based on administrative data for 2007-2015. While the majority of users (72.5%) are women from Mexico DF, women residing all throughout Mexico have access to ILE. The largest non-DF population comes from nearby Mexico State (24.2%). In general, users of the ILE reform are clustered in states geographically close to Mexico DF. A descriptive plot is presented in Appendix Figure A14. Residents in Mexico DF have by far the highest rate of abortion, at 5.8 abortions per 1,000 women aged 15-49, followed by Mexico State (at 1 per 1,000), and then two nearby states (Hidalgo and Morelos) with rates of 0.1 per 1,000. Remaining states have rates which are an additional order of magnitude lower than this.

Despite geographic spillovers *in access* consistent with those documented in Cunningham et al. (2017), we do not observe clear evidence of changes in birth or maternal health outcomes in nearby states. In Table 7, we present estimates comparing each of Mexico State, Morelos and Hidalgo (the three states with most considerable abortion usage per population) to their synthetic control state. For comparison we present synthetic control estimates from Mexico DF from Figure 2 (births) and Figure 5 (morbidity). In each case, the synthetic control is chosen from among all remaining states (ie all states except for Mexico DF, Mexico State, Morelos and Hidalgo). Along with estimates, p-values are presented, which quantify the proportion of placebo iterations resulting in more extreme estimates than the difference between the state in interest and its synthetic control. Here, placebos are all permutations of donor states and years. In each of the three non-DF states where the largest proportion of abortions were performed, no significant impact was observed on rates of birth, or maternal morbidity. Point estimates are both considerably smaller in magnitude to those from Mexico DF (the largest is a reduction of 2 births per 1,000 women in the state of Morelos), and p-values all suggest little evidence to reject null hypotheses of no spillover impacts of reforms on these outcomes in this time period.

An alternative model which captures both the impacts of the reform in Mexico DF as well as any reform spillovers to the rest of the country, replaces the ILE variable in equation 1 with the intensity of treatment

Table 7: Synthetic Control Estimates and Inference on Spillover Effects

	Births		Abortion Morbidity		Haemorrhage Morbidity	
	Estimate	p-value	Estimate	p-value	Estimate	p-value
Main Synthetic Control Estimate						
Mexico DF	-6.877	[0.042]	-1.399	[0.190]	-0.906	[0.090]
Synthetic Control Estimate for Spillover States						
Mexico State	0.673	[0.798]	0.333	[0.741]	0.559	[0.200]
Morelos	-2.00	[0.515]	0.749	[0.781]	0.118	[0.470]
Hidalgo	-0.197	[0.953]	-0.679	[0.500]	-0.264	[0.519]

Notes: Each point estimate refers to the average post-treatment difference between each state and its synthetic control, and p-values are calculated using permutation inference described in section 4. A full display of each synthetic control estimate and permutation inference is provided in Appendix Figures A15 (Mexico States), A16 (Morelos) and A17 (Hidalgo).

in each state. This intensity measure is captured as the rate of abortion per 1,000 women (documented in Appendix Table A8) in the post-reform period in each state. If outcomes per 1,000 women are regressed on abortion usage per 1,000 women, this provides a back-of-the-envelope calculation of the elasticity of outcomes with respect to the availability of a legal abortion. For example, if each additional legal abortion results in 1 fewer births, we will estimate a coefficient of -1 in this model, suggesting full pass-through of legalised abortion to birth rates. We estimate models of this type in Appendix Table A9. In general we observe that, using the full data on abortions across Mexico resulting from the ILE reform, impacts per abortion are considerable, suggesting nearly 1 fewer birth per every abortion provided, 0.16 fewer cases of abortion related morbidity, and 0.14 fewer cases of morbidity due to haemorrhage.

Mechanisms: Availability, education, or behavior Along with the law change legalizing access to abortion, the ILE reform included additional components relating to sexual education and disbursement of additional contraceptives in clinics (refer to section 2.3 for a full discussion). In order to examine the channels through which the reform affected fertility: whether it be only access, or a combination of access with behavioral change, we turn to a dataset which allows us to observe (self-reported) behavior more directly. We use the MxFLS data which follows women over time, and has survey rounds both before and after the fertility reforms of interest. To examine the potential effect of the other aspects of the reform (sexual education and alternative contraceptives), we estimate a version of equation 1, however at the level of the individual, which allows for individual-specific fixed-effects given the panel nature of the MxFLS data used.

We examine the effect of abortion reform on all available measures of contraceptive use (whether using any contraceptive or using modern contraceptives), the number of reported sexual partners and whether the respondent reports having knowledge of modern contraceptive methods. We present results of these regressions in Appendix Table A10. In general, we find very little evidence to suggest that the results of the abortion reform flow from an increase in *other* contraceptive knowledge in reform areas, or change in risky sexual behavior as a result of the reform. We find quite close to zero effects for change in contraceptive use and knowledge, and an insignificant reduction in the number of sexual partners reported. In all cases, these results are insignificant at the 10% level. When we replicate these results using a repeated cross-section of women rather than household fixed-effects in a panel setting (see Appendix Table), we reach similar conclusions that the ILE reform does not operate with alternative contraception or information channels, suggesting that the ILE reform's effect is largely due to the sharp increase in utilization of abortion services. Similarly, we do not find that regressive changes in abortion laws cause women to seek additional information or be more likely to use contraceptives, or change sexual behavior as proxied by the number of sexual partners compared to areas which were not subject to a regressive reform.

6 Conclusion

In this paper we examine the impact of abortion law on women's health. We consider a context in which considerable heterogeneity in legislative reform is observed. In Mexico in the late 2000s both a substantial loosening, and a series of tightenings of abortion policies were undertaken at the sub-national level. Using comprehensive vital statistics data on maternal health outcomes, we observe that the appearance of safe legal abortion available in the first trimester of pregnancy in Mexico DF resulted in a sharp drop in maternal morbidity due to haemorrhage, and a slower decline in morbidity due to abortion, perhaps in line with the gradual adoption of recommended abortion techniques by public health clinics. These declines were of substantial importance, suggesting 8,600 fewer inpatient visits in the post-abortion years in Mexico DF. In general, we observe quite weak effects of the tightening of *de facto* sanctions on abortion, even though, as we show, these sanctions did lead to changes in the length of sentences handed down to women.

We document that the impact of Mexico DF's ILE reform on fertility is in line with impacts estimated in other settings, for example the US in the 1970s. Our estimates suggest that fertility declined by approximately 5-6% in the years following the reform. We observe generally weak effects of regressive reforms on fertility, though note that in the case of Mexico, these state-level reforms may have *reduced* fertility by around 1-2%. Importantly, when examining the impacts of abortion reforms on rates of maternal death, our estimates are considerably noisier than those for maternal morbidity. This is of importance given that a range of papers examining the impact of abortion on women's health limit analyses to maternal death, given a paucity of high-quality health records. Our results suggest that this focus on "the tip of the iceberg" may lead to less convincing results than when focusing on maternal morbidity. While focusing on surviving child birth should be an absolute minimum when designing public policies to protect maternal and women's health, maternal morbidity is of considerable importance when quantifying life-time well-being, and avoiding a considerable health burden leading to chronic conditions.

The results of this paper are becoming relevant once again as a number of countries revisit abortion legislation and attempt to make considerable changes in constitutions and penal codes. Among others, legislative reforms have been undertaken or attempted in Ireland, Argentina and Chile in 2017-2018 focusing on legalising abortion in certain circumstance, and increasing restrictions have been enacted or proposed in Poland and a number of US states. This paper documents that these policies are likely to have a considerable impact on women's health and well-being.

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Appendices

Appendix Figures and Tables

Table A1: Constitutional Changes Following Mexico DF's ILE Reforms

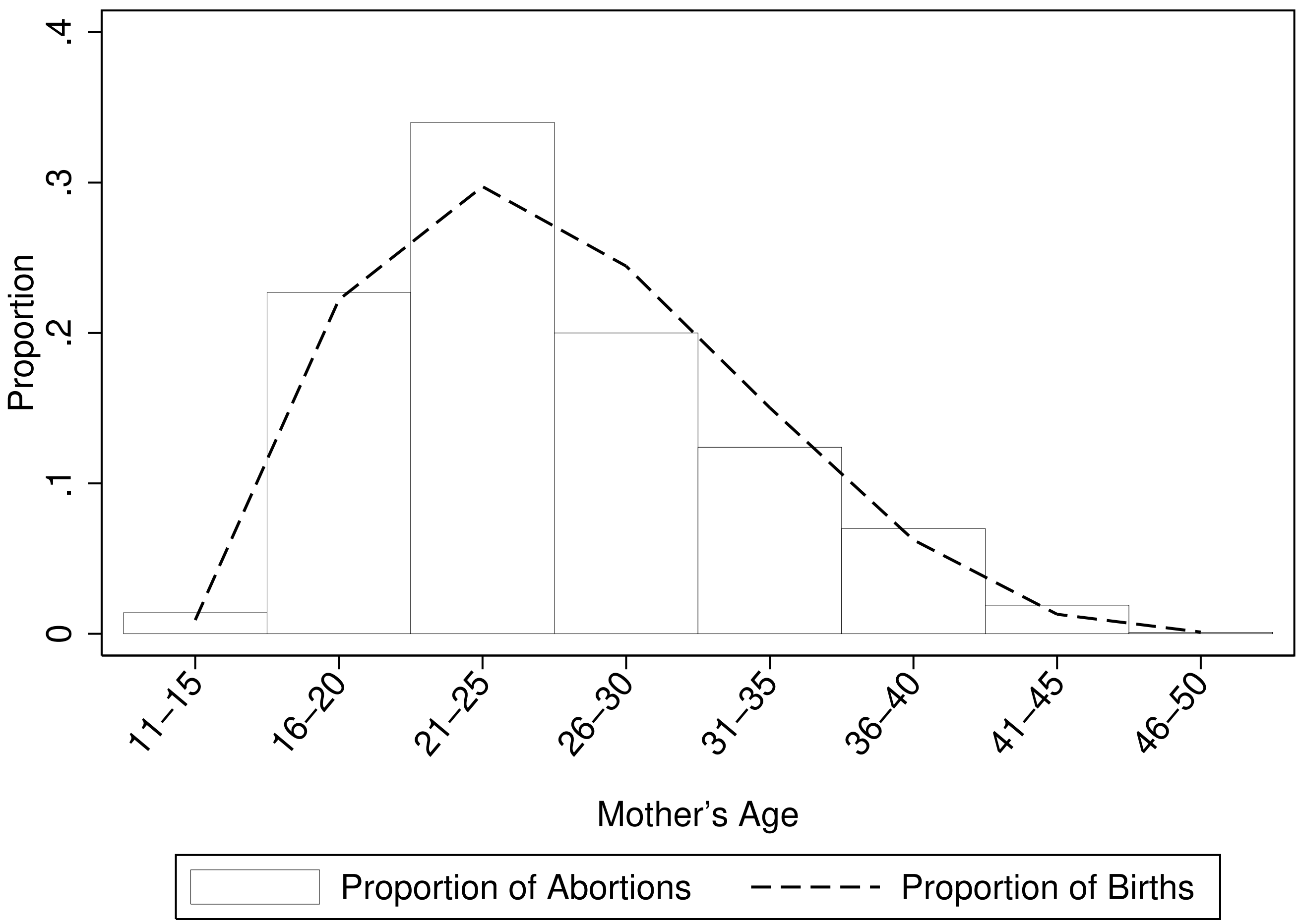
State	**Reform Date**	**Constitutional Decree**	**Article in Question**
Baja California	Dec 26, 2008	Decree 175	7
Chiapas	Jan 20, 2009	Decree 139	178
Chihuahua	Jun 21, 2008	Decree 231-08	143
Colima	Nov 25, 2009	Decree 296	187
Durango	May 31, 2009	Decree 273	350
Guanajuato	May 26, 2009	Dictamen 836	158
Jalisco	Jul 02, 2009	Decree 22361	228
Morelos	Dec 11, 2008	Decree 1153	115
Nayarit	Jun 06, 2009	Decree 50	335
Oaxaca	Sep 11, 2009	Decree 1383	312
Puebla	Jun 03, 2009	SPI-ISS-27-09*	136
Querétaro	Sep 18, 2009	P. O. 68‡	339
Quintana Roo	May 15, 2009	Decree 158	92
San Luis Potosí	Sep 02, 2009	Decree 833	128
Sonora	Apr 06, 2009	Law 174	265
Tamaulipas	Dec 23, 2009	Decree LX-1850	356
Yucatán	Aug 07, 2009	Decree 219	389
Veracruz	Nov 17, 2009	G. L. 155‡	150

Notes: All states which formally altered their constitutions following Mexico DF's ILE reform are indicated above. Constitutional decree refers to the law composed to alter the state constitution, and article in question refers to the article altered in the constitution or penal code which was altered by the decree. Dates, decrees and articles are collated by the authors from various state government sources. The official document approving each decree and its associated date is available in a zipped folder on the authors' websites.

* Decrees or official newspapers for the State of Puebla could not be located by the authors. The date and article in question is suggested by Gamboa Montejano and Valdés Robledo (2014).

‡ P. O. refers to the official newspaper where laws are published in Querétaro, and G. L. refers to the same newspaper in Veracruz. The law was published without number (pp. 9857-9859) in P. O. 68 and in G. L. 155 (pp 2-5) in Querétaro and Veracruz respectively.

Figure A1: Proportion of births and abortion in MOH-DF clinics



Notes: Proportion of births by age are generated from administrative data provided by INEGI. Proportion of abortions by age are compiled from summary data released by the Ministry of Health of Mexico DF.

Figure A2: Geographical Distribution of State Law Changes (post August-2007)

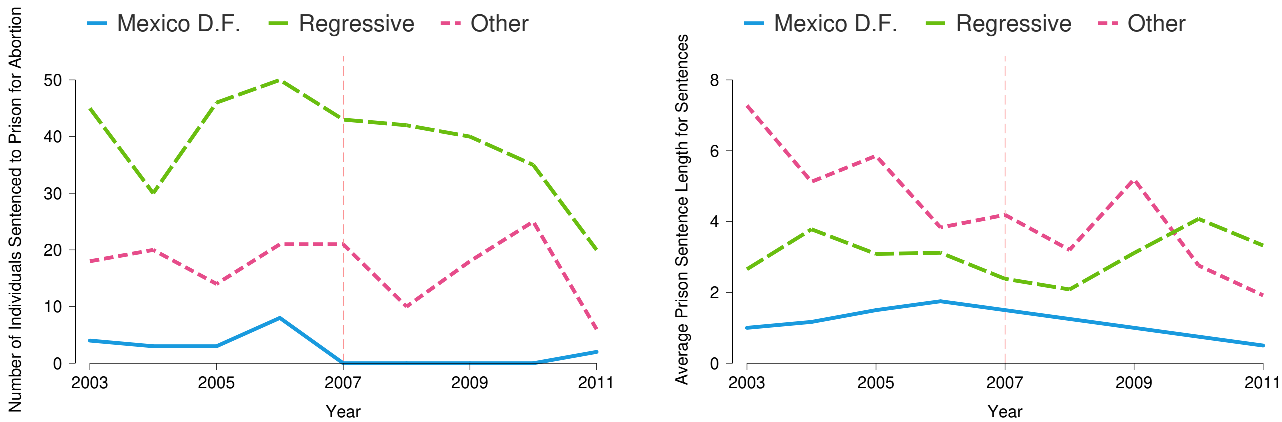
Notes: The August 2007 ILE reform occurred in Mexico DF (yellow). Resulting (regressive) reforms in other states are indicated in red, with states highlighted in blue indicating that no law change occurred between 2007 and 2016.

Table A2: Maternal Morbidity in Mexico

ICD-10 Code	Private Code	Name	Cases	Percent
O00	236	Ectopic pregnancy	187,315	0.534
O01	236	Hydatidiform mole	30,190	0.086
O02	236	Other abnormal products of conception	650,198	1.852
O03	234	Spontaneous abortion	335,081	0.954
O04	235	Medical abortion	7,268	0.021
O05	236	Other abortion	53,928	0.154
O06	236	Unspecified abortion	2,153,004	6.133
O07	236	Failed attempted abortion	996	0.003
O08	236	Complications following abortion and ectopic/molar pregnancy	12,047	0.034
O10	237	Complications due to Pre-Existing Hypertension	81,301	0.232
O11	237	Pre-existing hypertensive disorder with superimposed proteinuria	2,504	0.007
O12	237	Gestational oedema and proteinuria without hypertension	967	0.003
O13	237	Gestational hypertension without significant proteinuria	592,387	1.687
O14	237	Severe pre-eclampsia	666,635	1.899
O15	237	Eclampsia	49,263	0.140
O16	237	Unspecified maternal hypertension	145,099	0.413
O20	242	Haemorrhage in early pregnancy	677,757	1.931
O21	242	Excessive vomiting in pregnancy	60,311	0.172
O22	242	Venous complications in pregnancy	7,322	0.021
O23	242	Infections of genitourinary tract in pregnancy	792,372	2.257
O24	242	Diabetes mellitus in pregnancy	252,069	0.718
O25	242	Malnutrition in pregnancy	956	0.003
O26	242	Maternal care for other conditions predominantly related to pregnancy	86,511	0.246
O28	242	Abnormal findings on antenatal screening of mother	1,354	0.004
O29	242	Complications of anaesthesia during pregnancy	1,104	0.003
O30	239	Multiple gestation	116,853	0.333
O31	239	Complications specific to multiple gestation	4,178	0.012
O32	239	Maternal care for known or suspected malpresentation of fetus	377,630	1.076
O33	239	Maternal care for known or suspected disproportion	1,237,260	3.524
O34	239	Maternal care for known or suspected abnormality of pelvic organs	1,483,859	4.227
O35	239	Maternal care for known or suspected fetal abnormality and damage	16,046	0.046
O36	239	Maternal care for other known or suspected fetal problems	737,348	2.100
O40	239	Polyhydramnios	33,782	0.096
O41	239	Other disorders of amniotic fluid and membranes	694,761	1.979
O42	239	Premature rupture of membranes	1,079,039	3.074
O43	239	Placental disorders	12,270	0.035
O44	238	Placenta praevia	98,225	0.280

O45	238	Premature separation of placenta (abruptio placentae)	54,260	0.155
O46	238	Antepartum haemorrhage, not elsewhere classified	8,770	0.025
O47	239	False labour	1,214,865	3.461
O48	239	Prolonged pregnancy	85,304	0.243
O60	242	Preterm delivery	436,889	1.244
O61	242	Failed induction of labour	74,634	0.213
O62	242	Abnormalities of forces of labour	235,129	0.670
O63	242	Long labour	263,861	0.752
O64	240	Obstructed labour due to malposition and malpresentation of fetus	255,257	0.727
O65	240	Obstructed labour due to maternal pelvic abnormality	478,134	1.362
O66	240	Other obstructed labour	134,555	0.383
O67	242	Labour and delivery complicated by intrapartum haemorrhage	9,832	0.028
O68	242	Labour and delivery complicated by fetal stress (distress)	761,623	2.169
O69	242	Labour and delivery complicated by umbilical cord complications	133,400	0.380
O70	242	Perineal laceration during delivery	82,045	0.234
O71	242	Other obstetric trauma	22,141	0.063
O72	241	Postpartum haemorrhage	91,844	0.262
O73	242	Retained placenta and membranes, without haemorrhage	51,166	0.146
O74	242	Complications of anaesthesia during labour and delivery	4,832	0.014
O75	242	Other complications of labour and delivery	167,982	0.478
O80	243	Single spontaneous delivery	14,383,652	40.972
O81	242	Single delivery by forceps and vacuum extractor	57,556	0.164
O82	242	Single delivery by caesarean section	2,465,467	7.023
O83	242	Other assisted single delivery	98,323	0.280
O84	242	Multiple delivery	46,596	0.133
O85	244	Puerperal sepsis	25,599	0.073
O86	244	Other puerperal infections	35,657	0.102
O87	244	Venous complications in the puerperium	2,418	0.007
O88	244	Obstetric embolism	1,147	0.003
O89	244	Complications of anaesthesia during the puerperium	8,855	0.025
O90	244	Complications of the puerperium, not elsewhere classified	76,866	0.219
O91	244	Infections of breast associated with childbirth	7,497	0.021
O92	244	Other disorders of breast and lactation associated with childbirth	791	0.002
O94	244	Sequelae of complication of pregnancy, childbirth and the puerperium	1,809	0.005
O95	244	Obstetric death of unspecified cause	38	0.000
O96	244	Death from obstetric cause >42 days but < 1 year after delivery	10	0.000
O97	244	Death from sequelae of direct obstetric causes	10	0.000
O98	244	Maternal infectious and parasitic diseases	97,048	0.276
O99	244	Other maternal diseases complicating pregnancy, birth and the puerperium	491,279	1.399
		TOTAL	35,106,332	100.000

Figure A3: *De Jure* Sentencing of Abortion: Trends by State Type



(a) Number of Individuals Sentenced to Prison

(b) Average Length of Prison Sentences (Years)

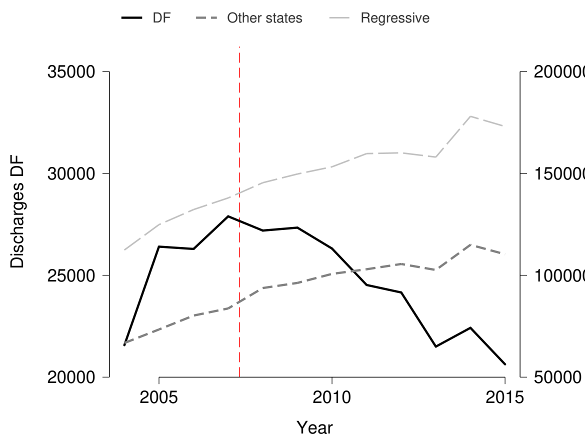
Notes: Total number of sentences and the average length of prison sentences are generated from administrative records captured in Mexico's Judicial Statistics on Penal Matters. This is the universe of judiciary decisions in the country based on the first legal judgement, and so does not include any subsequent appeals. Prison sentence lengths are calculated from a categorical variable capturing bins of between 6 months and two years, and in each case we record the total years (or fractions of years) based on the midpoint of each bin. Bins are consistently used in the period displayed here. Regressive states refer to any states tightening abortion laws in the period under study.

Table A3: Summary Statistics, MxFLS data on women aged 15-44

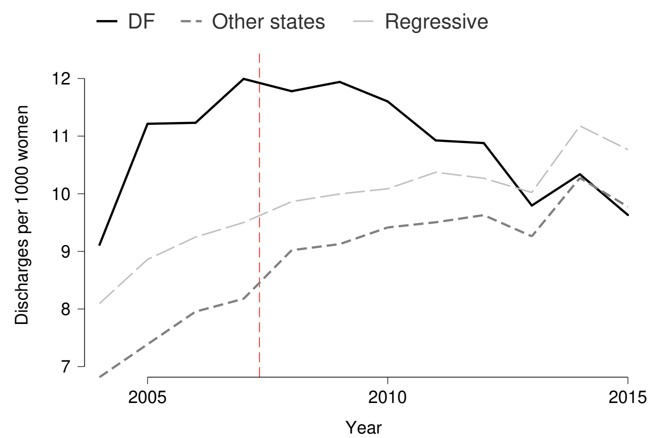
	(1) **Mexico City**	(2) **Regressive States**	(3) **Rest of Mexico**	(4) **Full Country**
Contraception knowledge	0.991	0.997	1.000	0.998
	(0.094)	(0.051)	(0.011)	(0.044)
Use modern method	0.676	0.589	0.578	0.590
	(0.469)	(0.492)	(0.494)	(0.492)
Use any method	0.686	0.638	0.617	0.632
	(0.465)	(0.481)	(0.486)	(0.482)
Age marriage	20.535	19.603	19.643	19.668
	(3.891)	(3.825)	(3.827)	(3.834)
Age first sex	18.807	18.957	18.998	18.965
	(3.676)	(3.593)	(3.541)	(3.577)
Number of sex partners	1.762	1.339	1.354	1.367
	(1.545)	(1.088)	(1.037)	(1.101)
Observations	187	5081	3526	8794

Notes: Data on household decision making and sexual behavior is obtained from the Mexican Family Life Survey (MxFLS), which was conducted in 2002-2003, 2005-2006 and 2009-2012. The sample consits of women aged 15-44 who were interviewed in all three rounds, and hence form the panel data sample. Panel A presents summary statistics from household decision making module and Panel B from the reproductive health module. Mean values are displayed with standard deviations in parentheses. Regressive states are those which ever had a regressive law change posterior to 2008.

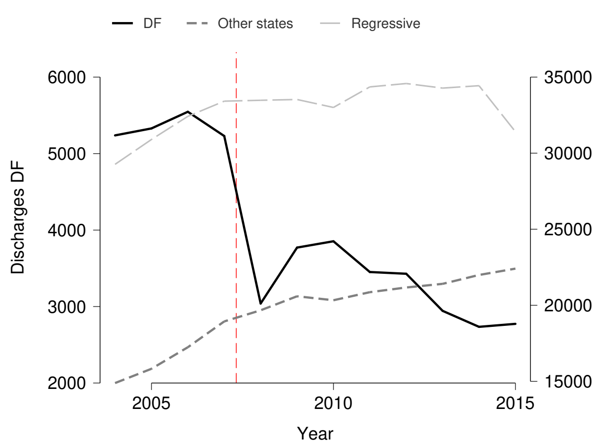
Figure A4: Raw Trends in Total Cases and Rates of Specific Maternal Morbidities



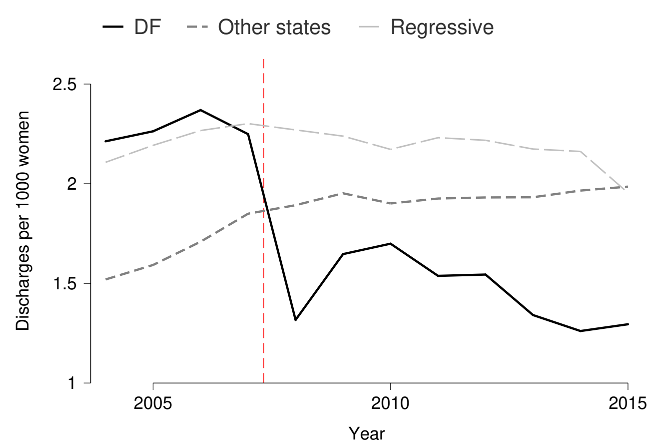
(a) Abortion Morbidity (Total)



(b) Abortion Morbidity (per 1000 women)



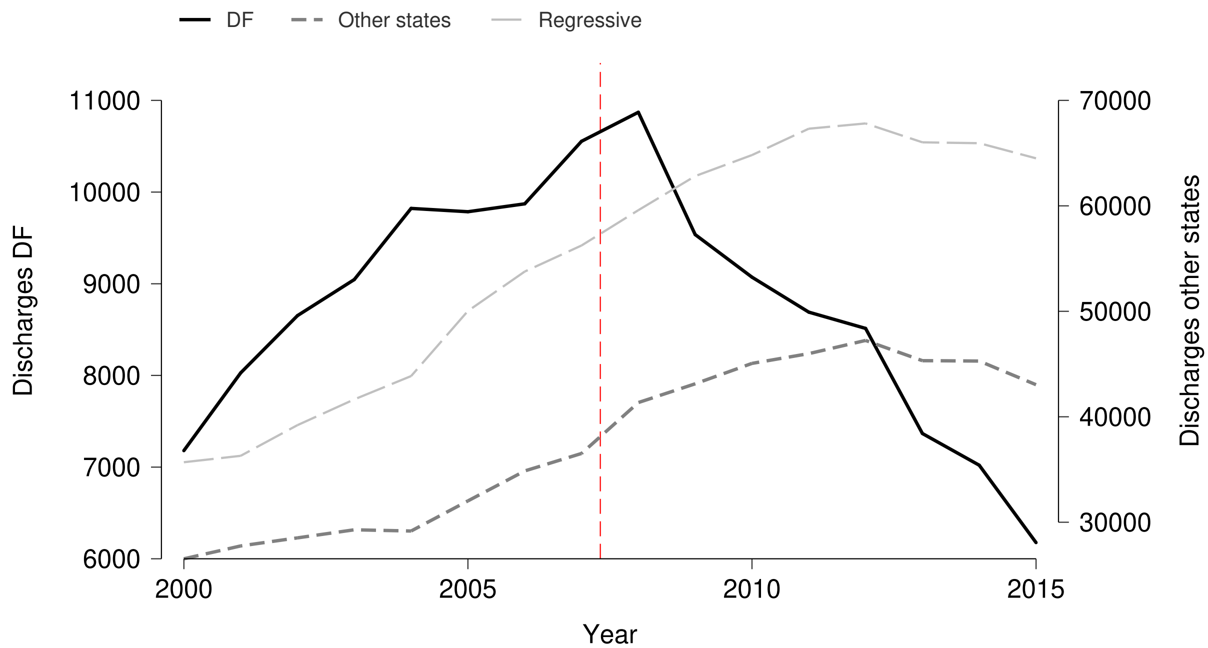
(c) Haemorrhage Early in Pregnancy (Total)



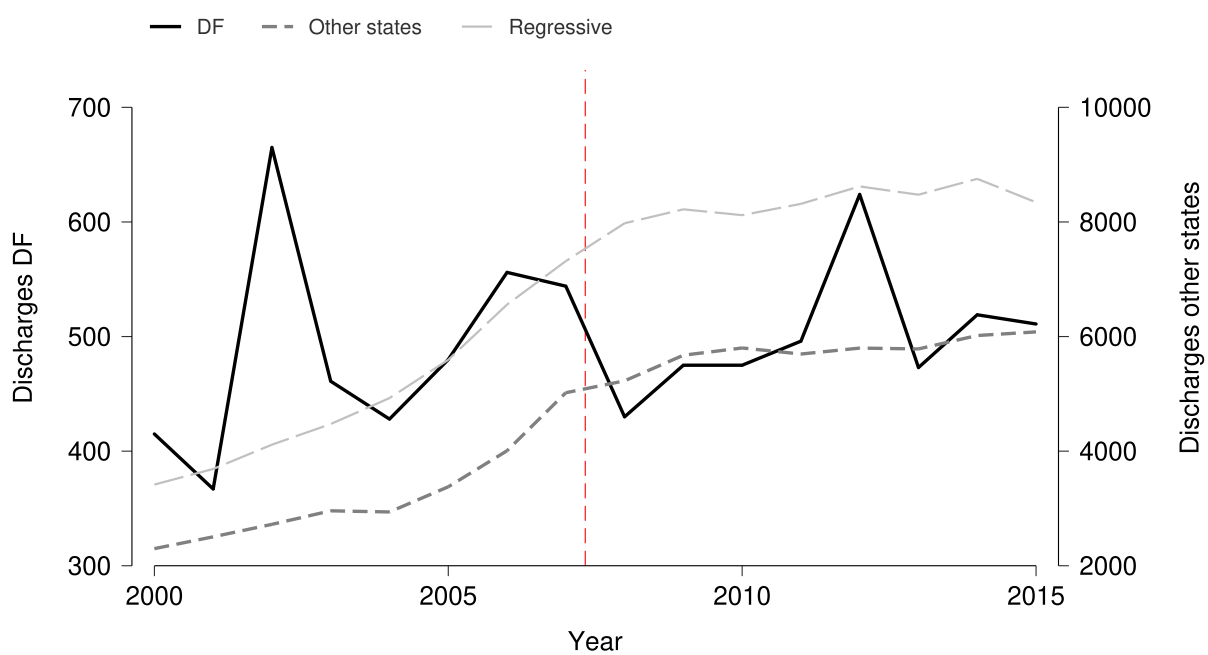
(d) Haemorrhage Early in Pregnancy (per 1000 women)

Notes: Figures present the total number of discharges due to abortion related morbidity (panels a and b), and haemorrhage early in pregnancy (panels c and d). Left-hand panels document total cases, with the total number for Mexico DF plotted on the left-hand y-axis, and the total number for all other states plotted on the right-hand y-axis. Right hand panels document the same values per 1,000 women of fertile age. Each trend is based on data from the universe of discharge records from the public health system.

Figure A5: Longer Trends in Specific Morbidities using Secretary of Health Hospitals Only



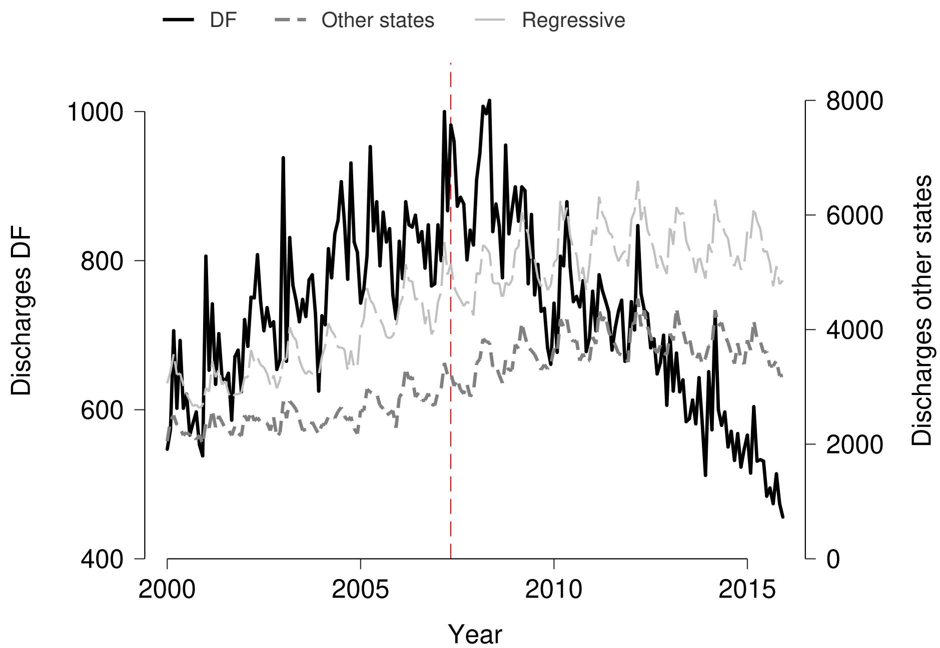
(a) Abortion Morbidity (Total)



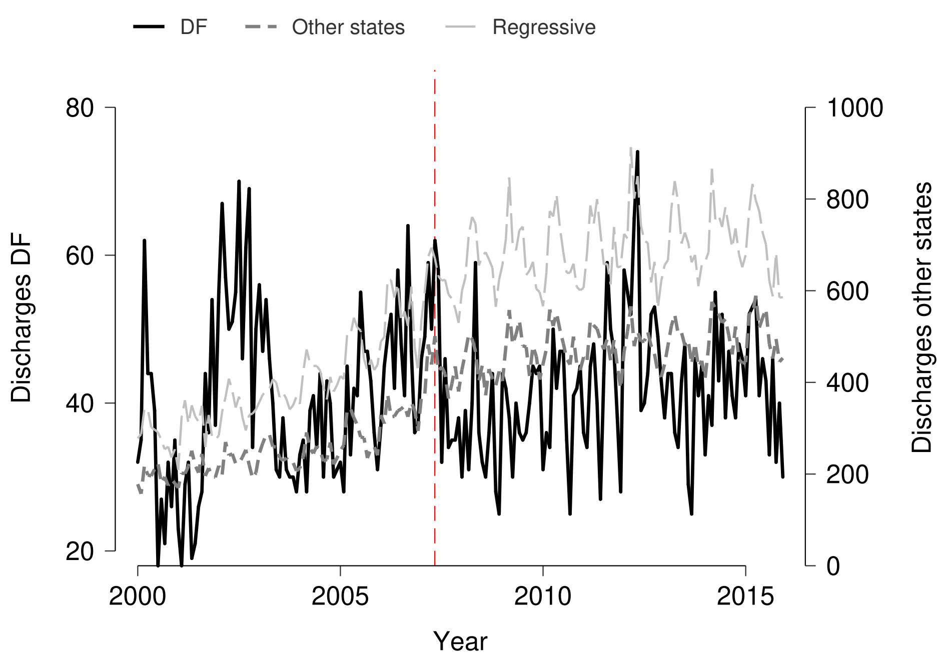
(b) Haemorrhage Early in Pregnancy (Total)

Notes: Figures present the total number of discharges due to abortion related morbidity (panel A), and haemorrhage early in pregnancy (panel B). Each trend is based on data from hospitals administered from the Secretariat of Health only (available from 2000 onwards). Data in Figure 2 is based on the universe of the public health system, and also includes hospitals administered by Social Security Institutes.

Figure A6: Monthly Trends in Specific Morbidities using Secretary of Health Hospitals Only



(a) Abortion Morbidity (Total)



(b) Haemorrhage Early in Pregnancy (Total)

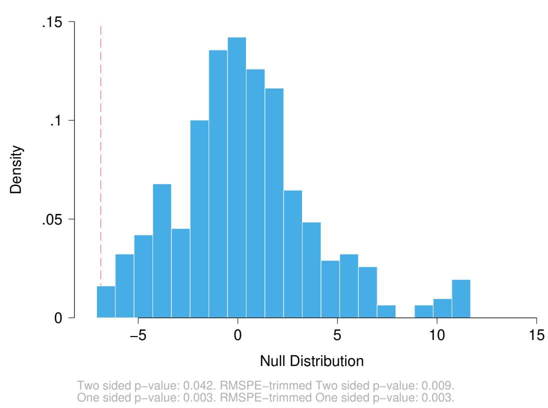
Notes: Plots replicate those in Appendix Figure A5, however now displaying monthly averages. Monthly averages can only be plotted for data from hospitals administered by the Secretariat of Health. The dotted vertical line is plotted in April of 2007, the date of passage of the abortion reform, and wide-scale rollout of available abortions.

Table A4: Summary Statistics on Time-Varying Controls

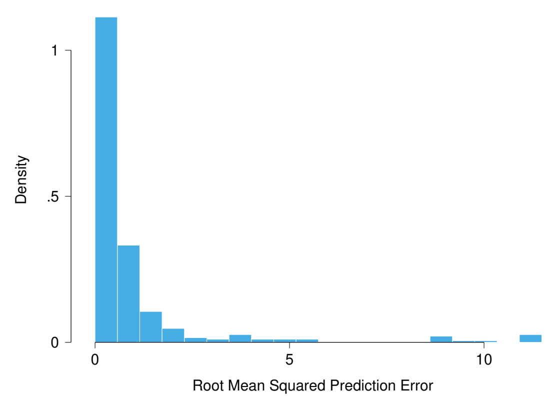
Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Percent of State Living Below Poverty Line	512	46.81	14.58	17.58	83.85
Percent of State Residents with Access to Health Institutions	512	48.88	14.07	20.66	90.69
Average Schooling of Adult Population	512	8.43	0.99	5.71	11.05
Percent of Women of Working Age Economically Active	512	37.05	2.85	26.66	44.69
Average Salary of Full Time Workers	512	5037.28	1089.12	1957.12	8022.83
Proportion of Municipalities with Seguro Popular Coverage	512	0.78	0.38	0.00	1.00

Each observation is a state×year cell. Mexico is composed of 32 States. The number of observations represents 32 states and years 2001-2016. State poverty is provided by the National Council for the Evaluation of Social Development Policy (CONEVAL). The proportion of residents with access to health institutions is provided by the Mexican Secretary of Health. Years of schooling are compiled from the National Educational Information System (SNIP). The proportion of economically active women and average salaries by state are calculated from the trimestral National Occupation and Employment Survey (ENOE) provided by INEGI. Seguro Popular coverage is calculated from municipal rollout data, and records the proportion of each municipalities in the state having access. Prior to 2002 this value is always 0, and after 2007 this value is always 1.

Figure A7: Complete Randomization Inference for Synthetic Control: Fertility Rates



(a) Null Distribution based on Randomization Inference



(b) RMSPE from Placebo Synthetic Controls

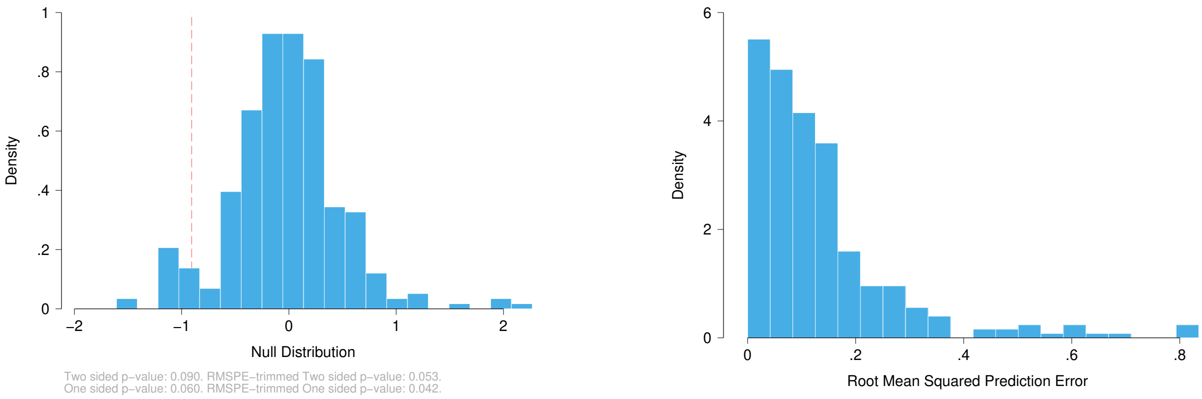
Notes: Left-hand panel plots the null distribution of average synthetic control placebo estimates $\hat{\alpha}^*$, and the actual estimate as the vertical dashed line. The actual estimate in this case is $\hat{\alpha} = -6.877$. Each placebo estimate is generated from a synthetic control permutation where the placebo-treatment state is one of the 30 non-ILE states, and the treatment year is one of the years from 2002-2012. Full permutations for each state and year combination are generated. The right-hand panel plots the RMSPE associated with each synthetic control procedure. When considering trimmed p-values, we trim the sample at RMSPE<5 to avoid cases where the synthetic control does not re-create pre-reform averages. Untrimmed p-values are based on the full set of permutations.

Table A5: Difference-in-Differences Estimates of Legal Reforms on Morbidity using Inpatient Days

	Abortion Related Morbidity				Haemorrhage Early in Pregnancy			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Post-ILE Reform (DF)	-1.513***	-1.356***	-0.878**	-0.727	-1.916***	-1.935***	-1.230***	-1.730***
	(0.364)	(0.378)	(0.377)	(0.498)	(0.220)	(0.232)	(0.203)	(0.220)
Post Regressive Law Change	-0.577	0.029	1.169	1.370	-0.327	-0.202	0.256	0.170
	(0.495)	(0.562)	(0.834)	(0.813)	(0.343)	(0.297)	(0.294)	(0.298)
Observations	384	384	384	384	384	384	384	384
Mean of Dependent Var	14.387	14.387	14.387	14.387	4.792	4.792	4.792	4.792
State and Year FEs	Y	Y	Y	Y	Y	Y	Y	Y
Population Weights		Y		Y		Y		Y
Time Varying Controls			Y	Y			Y	Y

Notes: Specifications replicate those in Table 4, however now instead of estimating the impact of the reforms on the number of inpatient cases, we estimate impacts on the total number of inpatient days corresponding to these cases. Additional notes are available in Table 4.

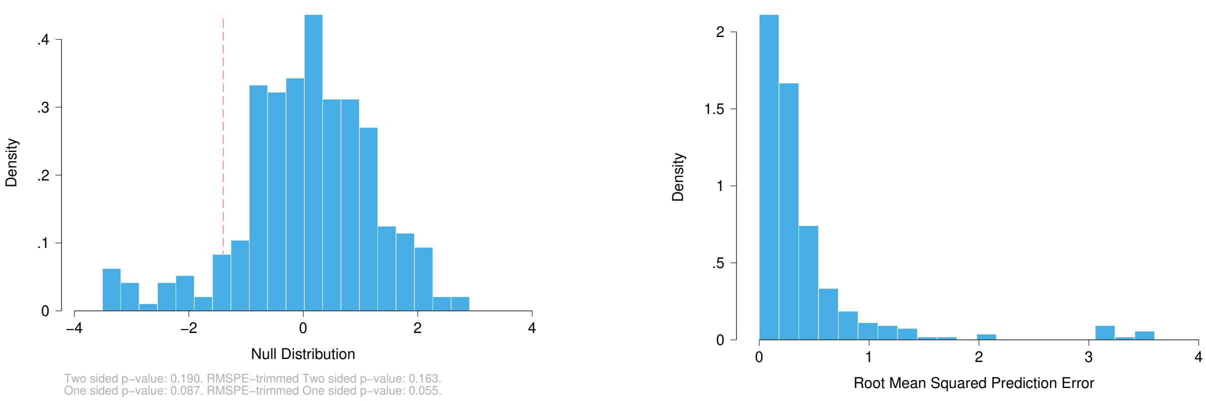
Figure A8: Complete Randomization Inference for Synthetic Control: Haemorrhage Morbidity



(a) Null Distribution based on Randomization Inference (b) RMSPE from Placebo Synthetic Controls

Notes: Left-hand panel plots the null distribution of average synthetic control placebo estimates $\hat{\alpha}^*$, and the actual estimate as the vertical dashed line. The actual estimate in this case is $\hat{\alpha} = -0.906$. Each placebo estimate is generated from a synthetic control permutation where the placebo-treatment state is one of the 30 non-ILE states, and the treatment year is one of the years from 2005-2014. Full permutations for each state and year combination are generated. The right-hand panel plots the RMSPE associated with each synthetic control procedure. When considering trimmed p-values, we trim the sample at RMSPE<0.4 to avoid cases where the synthetic control does not re-create pre-reform averages. Untrimmed p-values are based on the full set of permutations.

Figure A9: Complete Randomization Inference for Synthetic Control: Abortion Related Morbidity



(a) Null Distribution based on Randomization Inference (b) RMSPE from Placebo Synthetic Controls

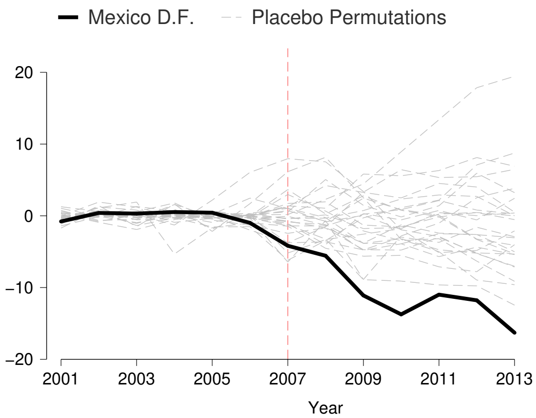
Notes: Refer to notes to Appendix Figure A8. An identical procedure is followed, however now using abortion related morbidity as the outcome instead of haemorrhage early in pregnancy. The actual estimate in this case is $\hat{\alpha} = -1.399$. The RMSPE trimming constant in this case is set at 2 when trimmed p-values are displayed.

Table A6: Difference-in-Differences Estimates of Impact of Legal Reforms by Age

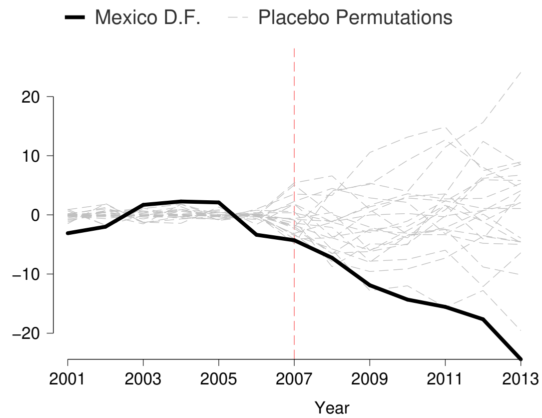
	15-19 (1)	20-24 (2)	25-29 (3)	30-34 (4)	35-39 (5)	40-44 (6)
Panel A: Birth Rates						
Post-ILE Reform (DF)	-5.002***	-3.363*	-5.813***	-9.567***	1.055	3.179***
	(1.132)	(1.820)	(1.407)	(1.611)	(1.442)	(0.843)
Post-Regressive Law Change	-1.418	-1.998	-0.774	-0.811	-1.191	-0.796
	(2.033)	(2.517)	(2.059)	(2.128)	(2.048)	(1.204)
Observations	512	512	512	512	512	512
Mean of Dependent Var	64.028	114.113	102.399	72.469	37.264	10.811
Panel B: Abortion Morbidity						
Post-ILE Reform (DF)	-1.083***	-0.408	0.331	-0.435	-0.149	-0.002
	(0.337)	(0.385)	(0.251)	(0.282)	(0.241)	(0.122)
Post-Regressive Law Change	-0.465	-0.155	-0.168	-0.285	-0.140	-0.125
	(0.391)	(0.406)	(0.358)	(0.313)	(0.244)	(0.123)
Observations	512	512	512	512	512	512
Mean of Dependent Var	7.886	11.044	10.980	7.030	5.062	2.294
Panel C: Haemorrhage Morbidity						
Post-ILE Reform (DF)	-0.734***	-1.409***	-1.373***	-0.896***	-0.390***	-0.091***
	(0.150)	(0.263)	(0.138)	(0.169)	(0.097)	(0.025)
Post-Regressive Law Change	-0.268*	-0.495*	-0.350	-0.309	-0.154	-0.053
	(0.157)	(0.287)	(0.217)	(0.189)	(0.108)	(0.032)
Observations	512	512	512	512	512	512
Mean of Dependent Var	1.297	2.480	3.151	1.853	0.992	0.266

Notes: Each panel displays DD models for a single outcome, with a separate model estimated for each age group listed in column headers. In each case, full time-varying controls are included and population weights are used based on the population of women of the relevant age group in each state. Each outcome is displayed as occurrences per 1,000 women of this age. Additional notes regarding estimation details are provided in Tables 3 and 4.

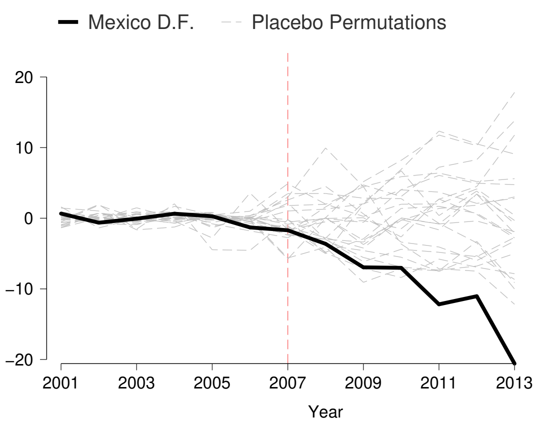
Figure A10: Synthetic Control Estimates of ILE's Impact on Fertility by Age



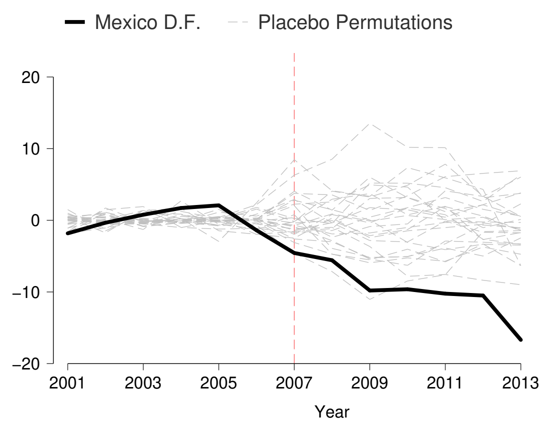
(a) 15-19 Year-olds



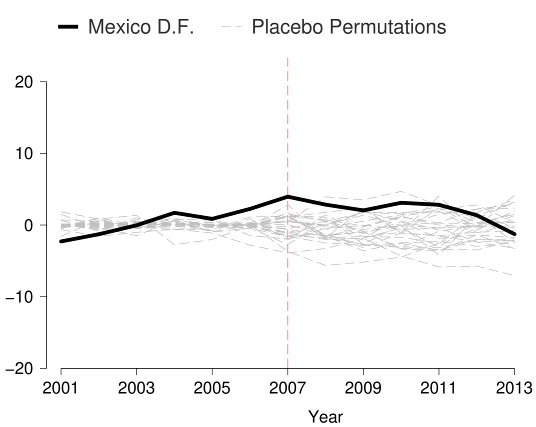
(b) 20-24 Year-olds



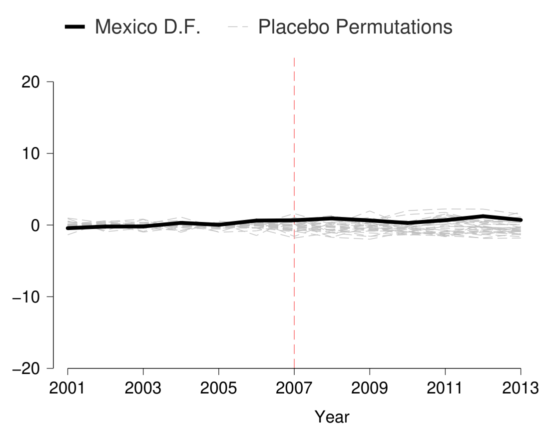
(c) 25-29 Year-olds



(d) 30-34 Year-olds



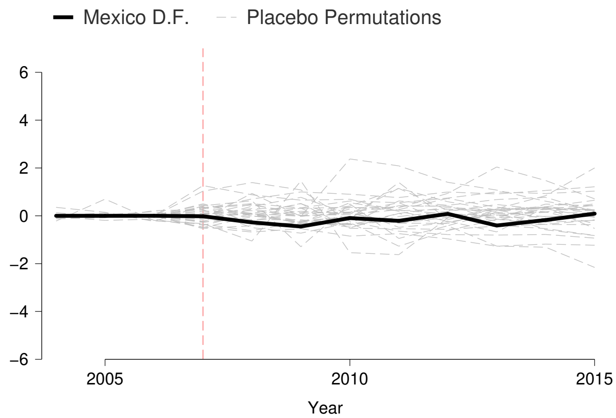
(e) 35-39 Year-olds



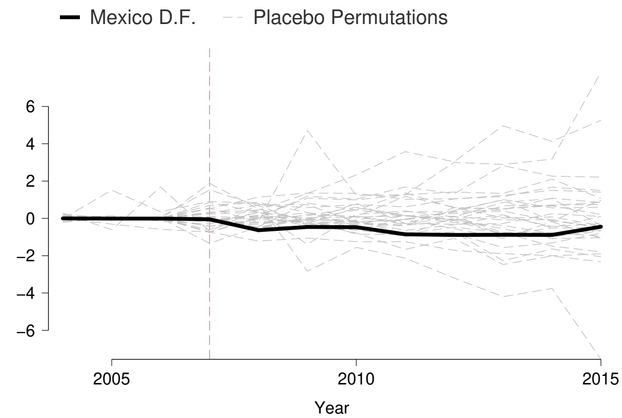
(f) 40-44 Year-olds

Notes: Synthetic control estimates and inference of the impact of the ILE reform on fertility rates by age groups. Each panel replicates Figure 2b however only for the subgroup of women aged in the range noted in panel captions.

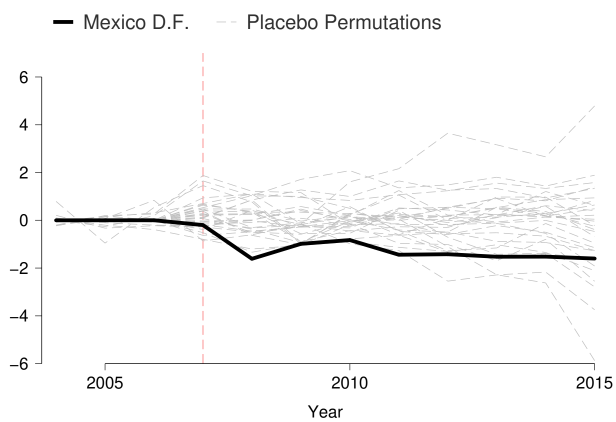
Figure A11: Synthetic Control Estimates of ILE's Impact on Haemorrhage Morbidity by Age



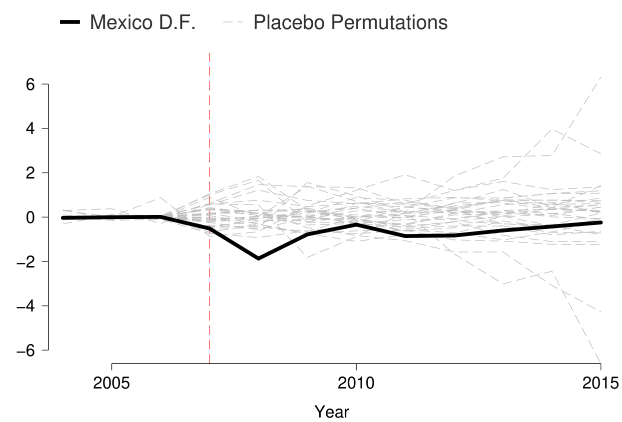
(a) 15-19 Year-olds



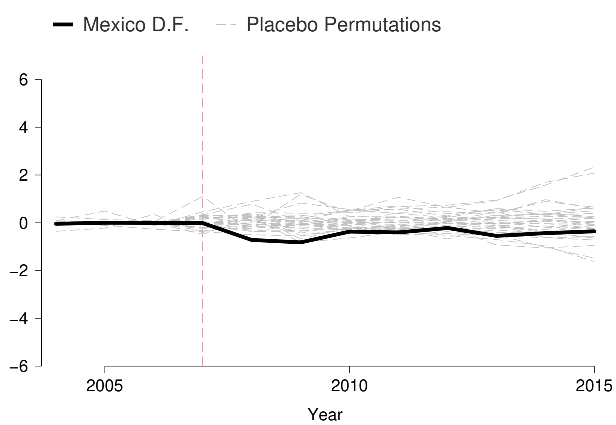
(b) 20-24 Year-olds



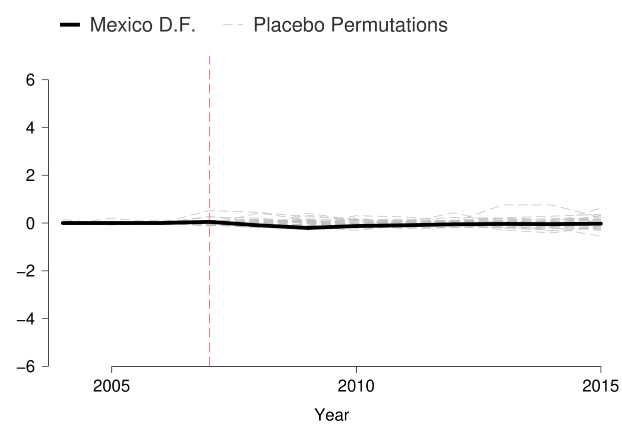
(c) 25-29 Year-olds



(d) 30-34 Year-olds



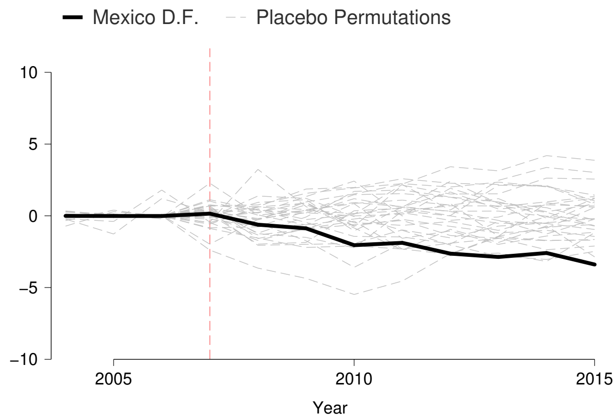
(e) 35-39 Year-olds



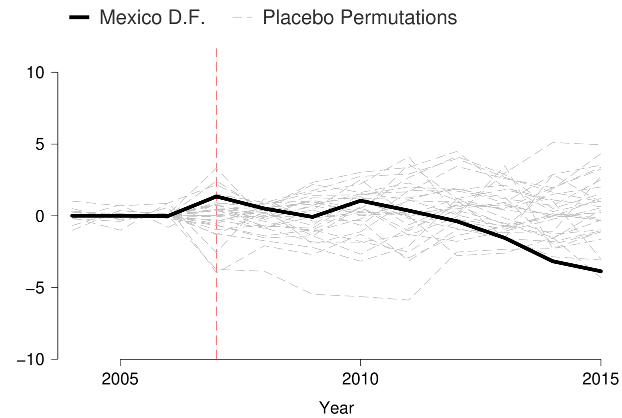
(f) 40-44 Year-olds

Notes: Synthetic control estimates and inference of the impact of the ILE reform on rates of morbidity due to abortion by age groups. Each panel replicates Figure 6a however only for the subgroup of women aged in the range noted in panel captions.

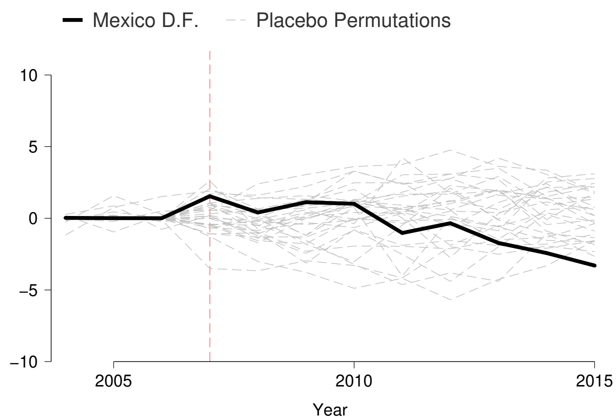
Figure A12: Synthetic Control Estimates of ILE's Impact on Abortion Morbidity by Age



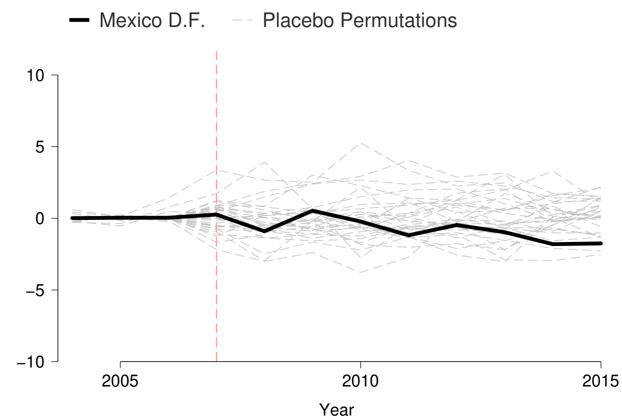
(a) 15-19 Year-olds



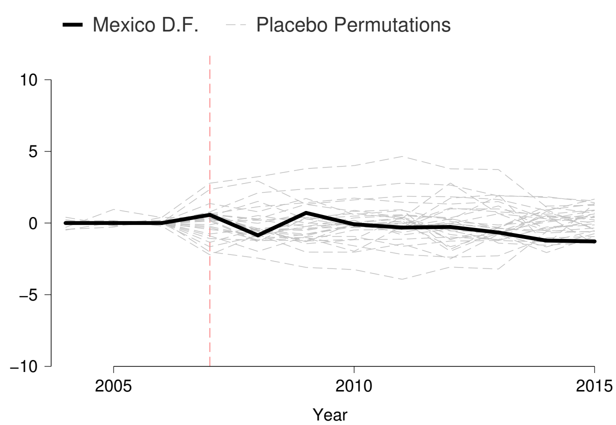
(b) 20-24 Year-olds



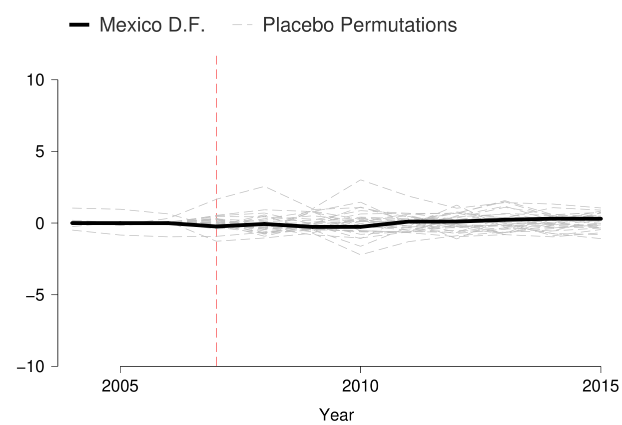
(c) 25-29 Year-olds



(d) 30-34 Year-olds



(e) 35-39 Year-olds



(f) 40-44 Year-olds

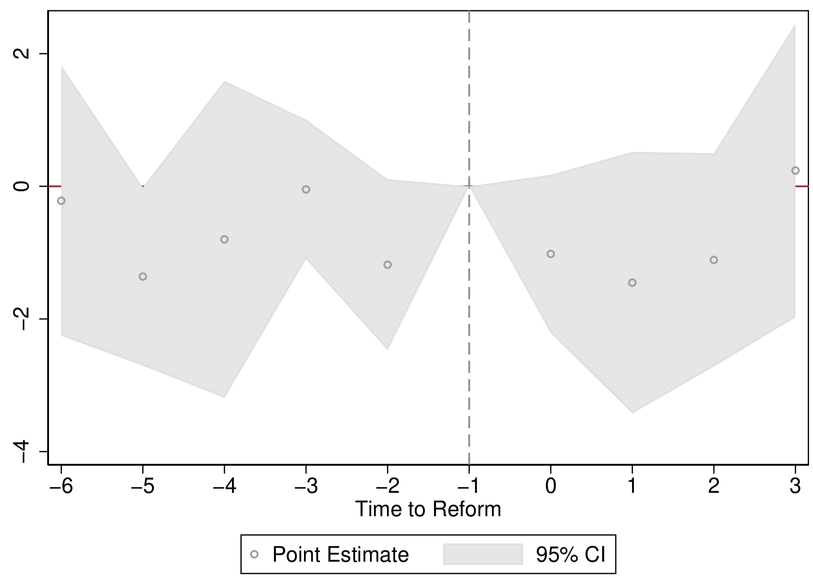
Notes: Synthetic control estimates and inference of the impact of the ILE reform on rates of morbidity due to abortion by age groups. Each panel replicates Figure 6b however only for the subgroup of women aged in the range noted in panel captions.

Table A7: Changes in Penal Codes Surrounding Abortion Laws

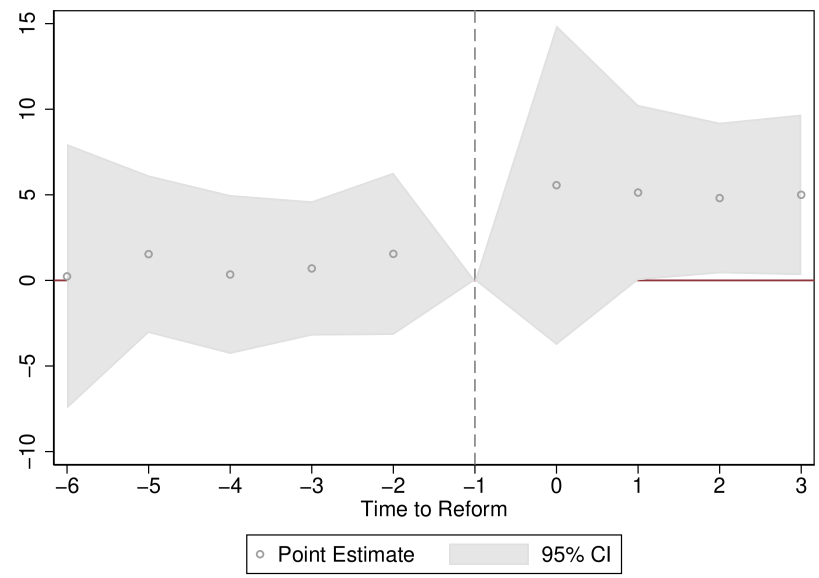
State	Pre-Reform Sanction	Post-Reform Sanction	Additional Changes
Chiapas	1-3 years prison	1 to 3 years prison	Added detail to the penal code, increased sentences for "collaborators"
Chihuahua	3 months to 5 years prison	6 months to 3 years prison	Added detail to the penal code, increased sentences for "collaborators"
Colima	1-3 years prison and fine	1-3 years prison and fine	No changes to penal code (only state constitution)
Durango	1-3 years prison	1-3 years prison and fine	Increased sentences for "collaborators"
Guanajuato	6 months to 3 years prison and fine	6 months to 3 years prison and fine	Increased sentences for "collaborators"
Jalisco	4 months to 1 year prison	4 months to 1 year prison	Added possibility of psychological treatment in commutation of prison
Mexico DF	1-3 years prison	3-6 months prison or community work	Added possibility of community work in commutation of prison
Morelos	1-5 years prison	1-5 years prison and fine	Added possibility of psychological treatment in commutation of prison
Nayarit	1-3 years prison and fine	1-3 years prison and fine	No changes to penal code (only state constitution)
Oaxaca	6 months to 2 years prison	6 months to 2 years prison	No changes to penal code (only state constitution)
Queretaro	1-3 years prison	1-3 years prison	No changes to penal code (only state constitution)
Quintana Roo	6 months to 2 years prison	6 months to 2 years prison	No changes to penal code (only state constitution)
San Luís de Potosí	1-3 years prison and fine	1-3 years prison and fine	Monetary amount of fine altered
Sonora	1-6 years prison and fine	1-6 years prison and fine	No changes to penal code (only state constitution)
Tamaulipas	1-5 years prison	1-5 years prison	Added possibility of psychological treatment in commutation of prison
Yucatan	1-5 years prison	1-5 years prison	Changed sanctions in certain specified circumstances

All details are collated from a side-by-side reading of penal codes prior to and posterior to the reform. In cases where no changes were made in the penal codes, this implies that changes were only made in the State Constitutions, which were altered to recognise life as beginning at conception.

Figure A13: *De Jure* Sentencing of Abortion: Event Studies for Regressive Law Changes



(a) Number of Individuals Sentenced to Prison



(b) Average Length of Prison Sentence

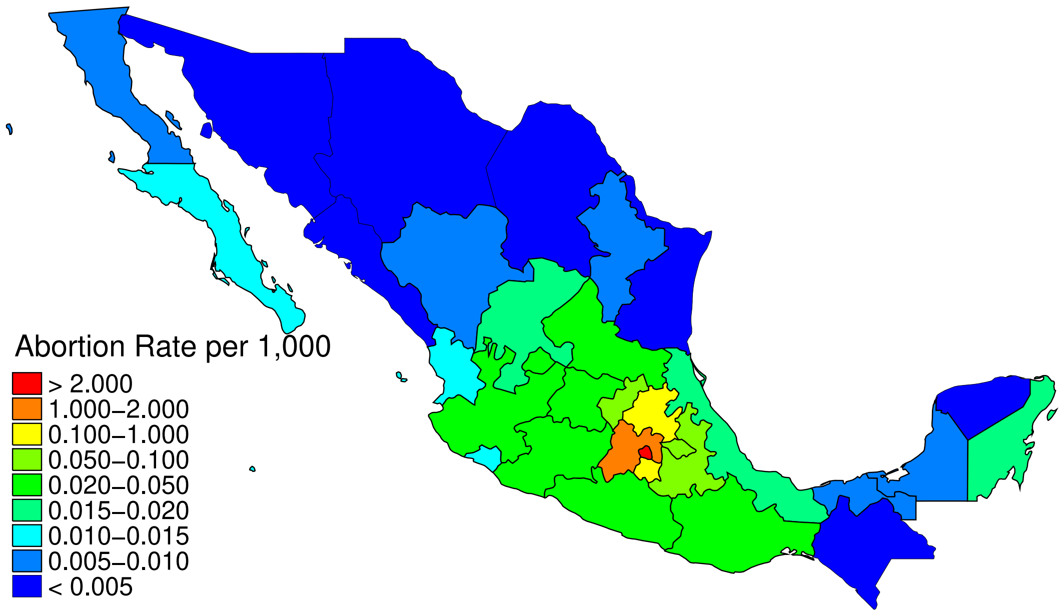
Notes: Event studies document the evolution or criminal outcomes surrounding the passage of regressive abortion laws in Mexican States. Total number of sentences and the average length of prison sentences are generated from administrative records captured in Mexico's Judicial Statistics on Penal Matters. This is the universe of judiciary decisions in the country based on the first legal judgement, and so does not include any subsequent appeals. Prison sentence lengths are calculated from a categorical variable capturing bins of between 6 months and two years, and in each case we record the total years (or fractions of years) based on the midpoint of each bin. Bins are consistently used in the period displayed here. In each case the 95% confidence intervals are shaded, and are based on wild-bootstrap clustered standard errors.

Table A8: State of Residence of Users of ILE: 2007-2015

State	Number of Patients	Rate per 1,000 women
Aguascalientes	87	0.036
Baja California	40	0.006
Baja California Sur	19	0.014
Campeche	11	0.006
Chiapas	34	0.003
Chihuahua	31	0.004
Coahuila	28	0.005
Colima	19	0.014
Mexico D.F.	104,048	5.833
Durango	21	0.006
Guanajuato	268	0.023
Guerrero	161	0.025
Hidalgo	637	0.118
Jalisco	334	0.023
Mexico State	34,703	1.084
Michoacán	309	0.035
Morelos	464	0.128
Nayarit	27	0.012
Nuevo León	66	0.007
Oaxaca	230	0.031
Puebla	807	0.068
Querétaro	329	0.085
Quintana Roo	58	0.020
San Luis Potosí	108	0.021
Sinaloa	19	0.003
Sonora	28	0.005
Tabasco	32	0.007
Tamaulipas	30	0.004
Tlaxcala	188	0.078
Veracruz	267	0.018
Yucatán	18	0.005
Zacatecas	52	0.018
Non-Mexican Residents	52	—
Unknown	250	—
Total	143,550	0.628

Notes: The quantity of abortions are provided from administrative data compiled as the Information System for Legal Interruption of Pregnancy from Mexico City's Secretary of Health, and are for the years 2007-2015. Rates per women refer to the number of abortions per 1,000 women aged 15-49.

Figure A14: Geographic Variation in Usage of Mexico DF's ILE Program to Access Abortion



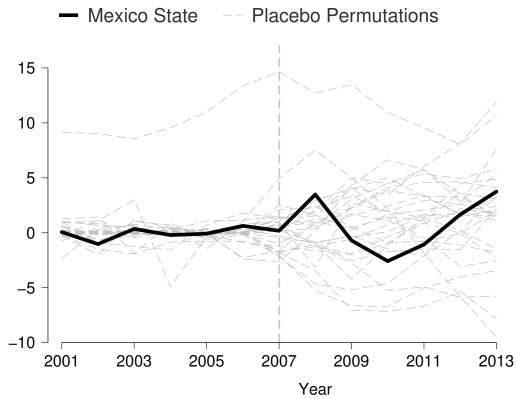
Notes: Each state is shaded according to the rate of abortions per 1,000 women provided under the auspices of the ILE reform. All rates are calculated based on administrative records of state of residence. Refer to Table A8 for the precise number and rate in each state.

Table A9: DD Estimates of the Impact of ILE Usage Intensity on Birth Rates and Health

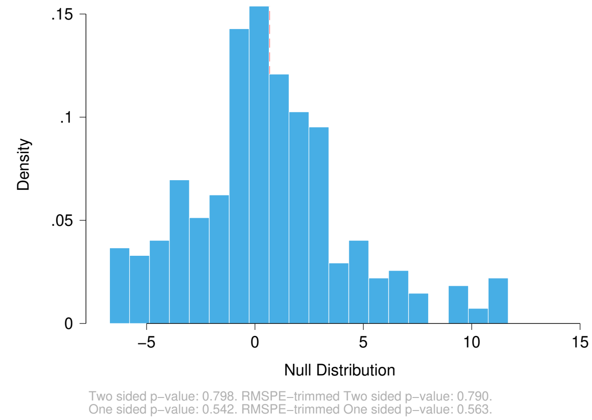
		Morbidity		Mortality	
	Births (1)	Abortion (2)	Haemorrhage (3)	Maternal (4)	Abortive (5)
Abortions per 1,000 Women	-0.939***	-0.156**	-0.142***	-0.001	-0.000
	(0.225)	(0.051)	(0.026)	(0.001)	(0.000)
Post-Regressive Law Change	-2.498	-0.246	-0.202	-0.006	-0.001
	(1.377)	(0.331)	(0.118)	(0.003)	(0.000)
Observations	416	384	384	512	512
Mean of Dependent Variable	87.643	10.336	2.343	0.040	0.003

Notes: DD estimates replicate specification 1, however the ILE program is measured as the number of abortions accessed per 1,000 women in each state in the post-reform period. Post-Regressive Law Change is measured as a binary variable, so does not capture intensity, and is not interpreted in the same way as abortions per 1,000 women. Each outcome is measured per 1,000 women in the state and year, and are identical to the outcomes in Tables 3, 4 and 5 in the paper. Each specification includes full time-varying controls, weights by state population, and standard errors are clustered using a wild bootstrap. For additional details, refer to Notes to Table 3.

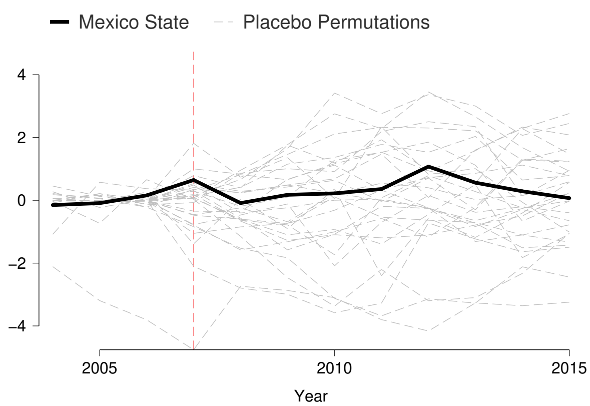
Figure A15: Synthetic Control Estimates for Spillovers: Mexico State



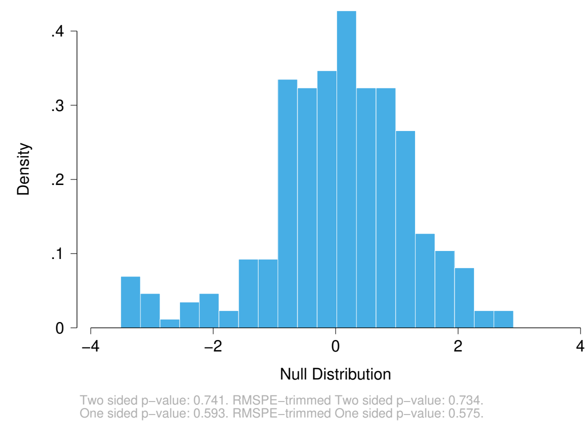
(a) Birth Rates: Inference by State



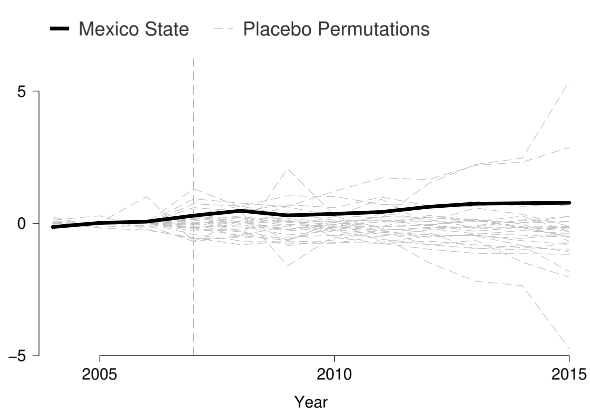
(b) Birth Rates: Inference by State and Time



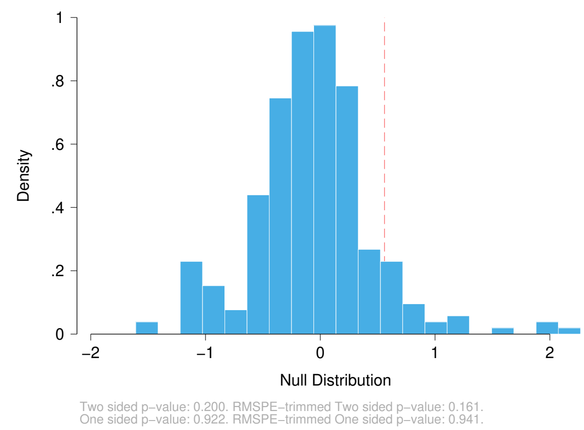
(c) Abortion Morbidity: Inference by State



(d) Abortion Morbidity: Inference by State and Time



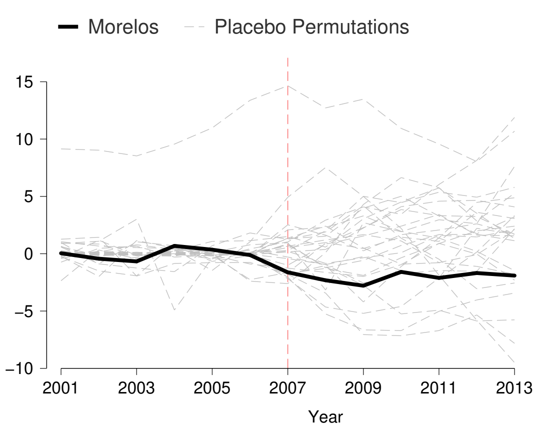
(e) Haemorrhage Morbidity: Inference by State



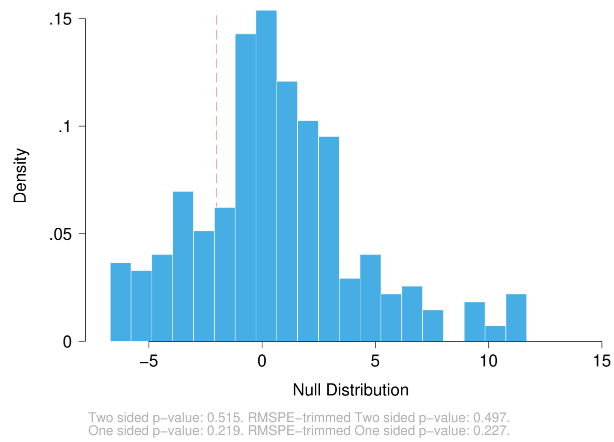
(f) Haemorrhage Morbidity: Inference by State, Time

Notes: Left-hand panels present plots of the difference between outcomes in Mexico State and similar differences between placebo states and their synthetic controls. Right hand plots compare average post-treatment differences between Mexico State and its synthetic control with a null distribution constructed permuting treatment over each donor state and time period. Panels (a) and (b) are for birth rates, (c) and (d) for abortion morbidity, and (e) and (f) for haemorrhage morbidity.

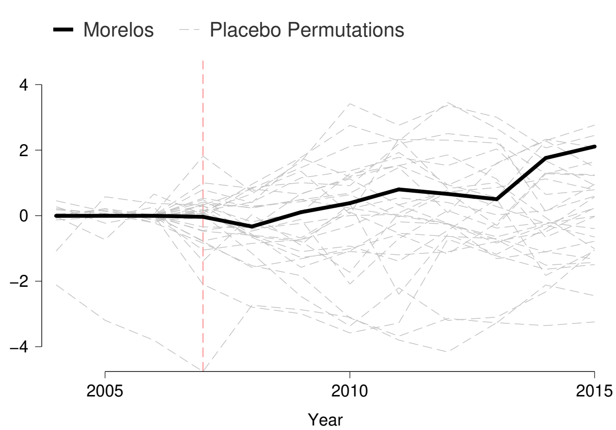
Figure A16: Synthetic Control Estimates for Spillovers: Morelos



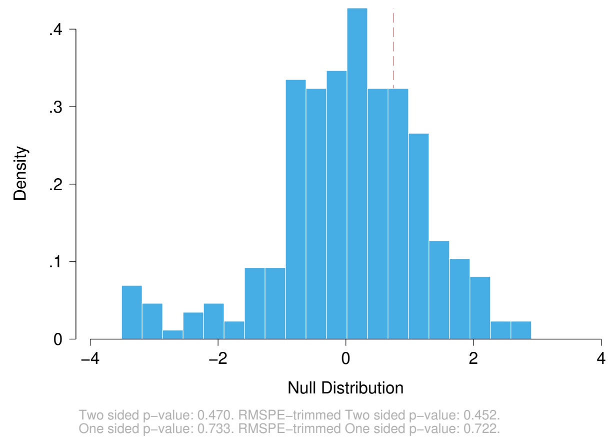
(a) Birth Rates: Inference by State



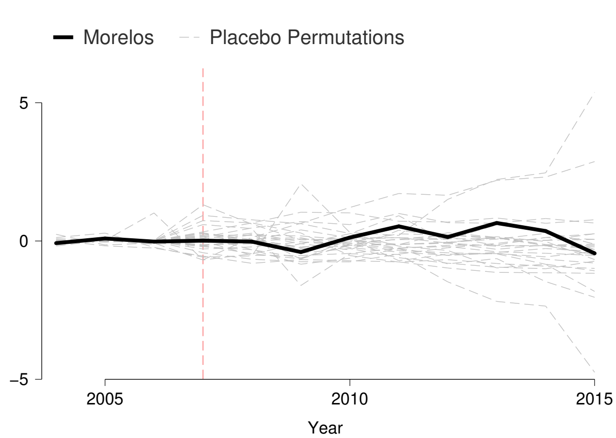
(b) Birth Rates: Inference by State and Time



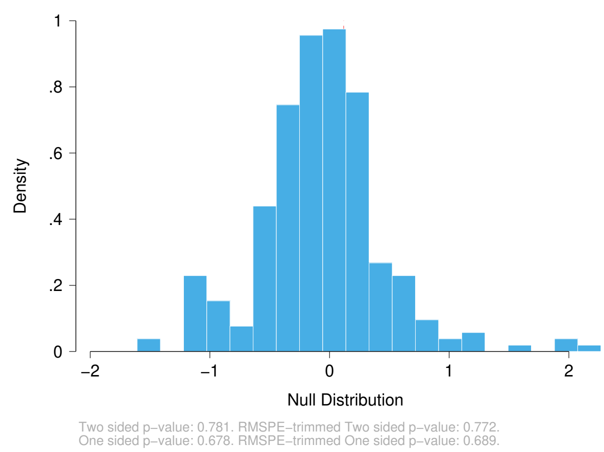
(c) Abortion Morbidity: Inference by State



(d) Abortion Morbidity: Inference by State and Time



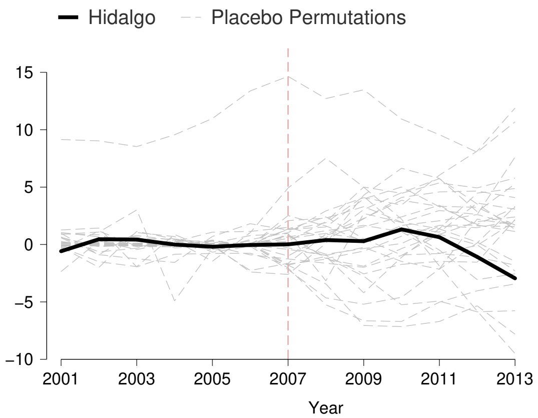
(e) Haemorrhage Morbidity: Inference by State



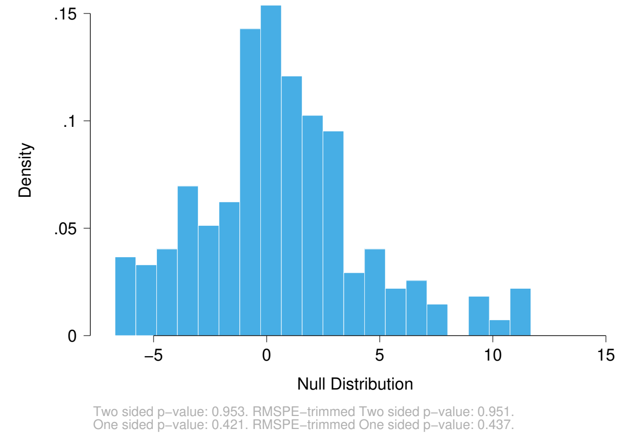
(f) Haemorrhage Morbidity: Inference by State, Time

Notes: Refer to notes to Appendix Figure A15. All details are identical, however now results are displayed for the state of Morelos.

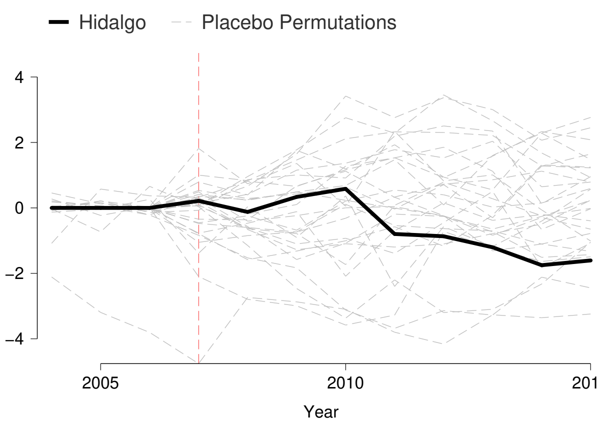
Figure A17: Synthetic Control Estimates for Spillovers: Hidalgo



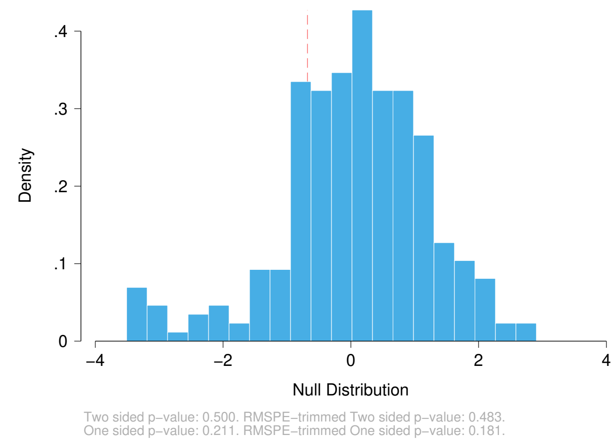
(a) Birth Rates: Inference by State



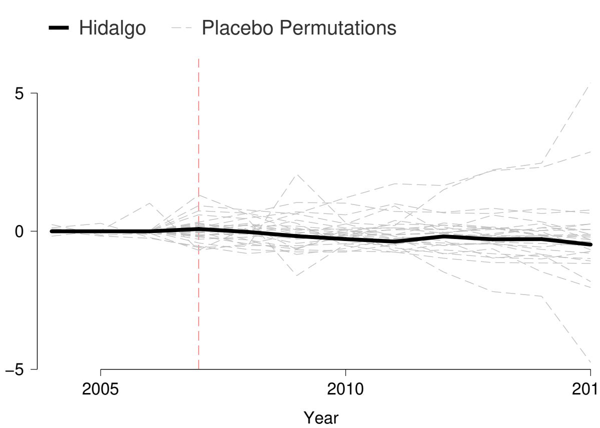
(b) Birth Rates: Inference by State and Time



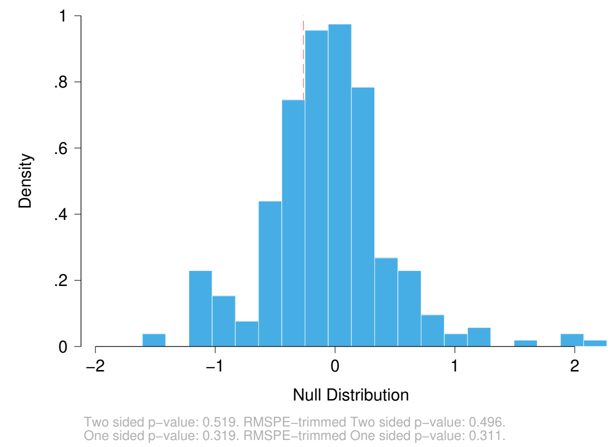
(c) Abortion Morbidity: Inference by State



(d) Abortion Morbidity: Inference by State and Time



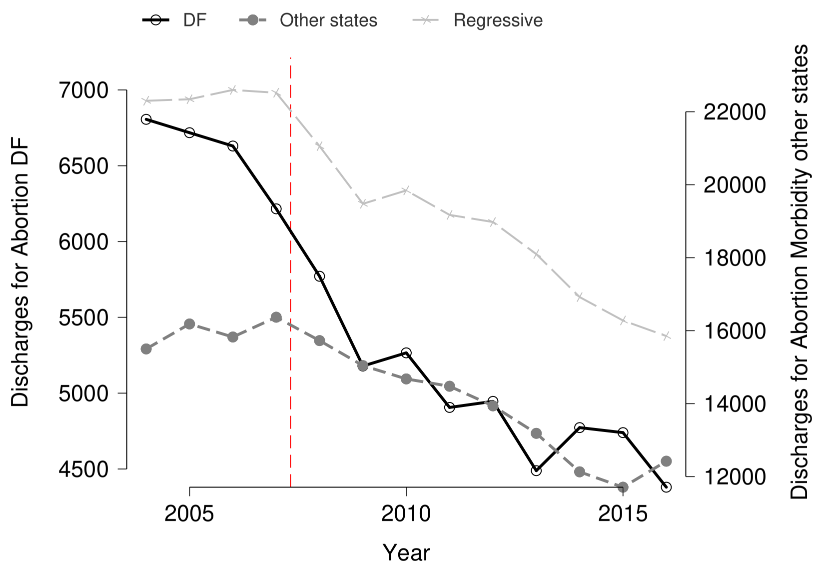
(e) Haemorrhage Morbidity: Inference by State



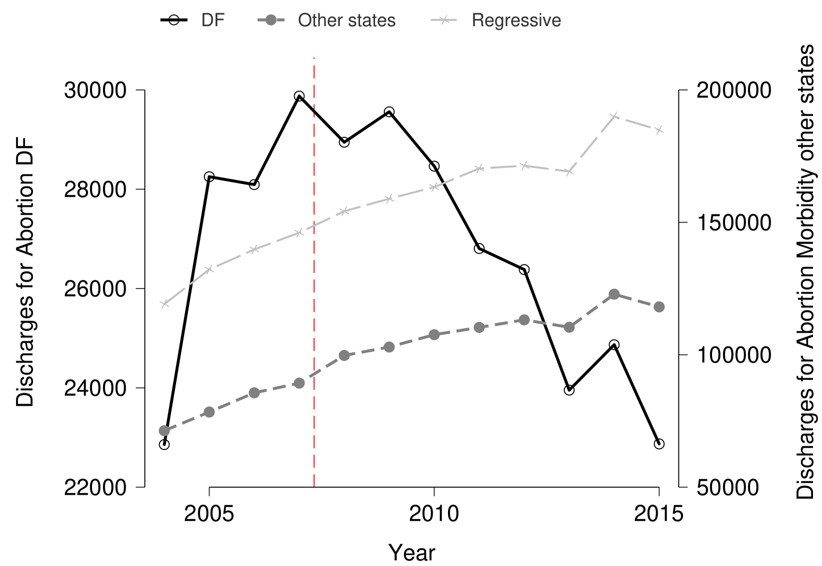
(f) Haemorrhage Morbidity: Inference by State, Time

Notes: Refer to notes to Appendix Figure A15. All details are identical, however now results are displayed for the state of Hidalgo.

Figure A18: Trends in Public and Private Health System Morbidity: Abortion-Related



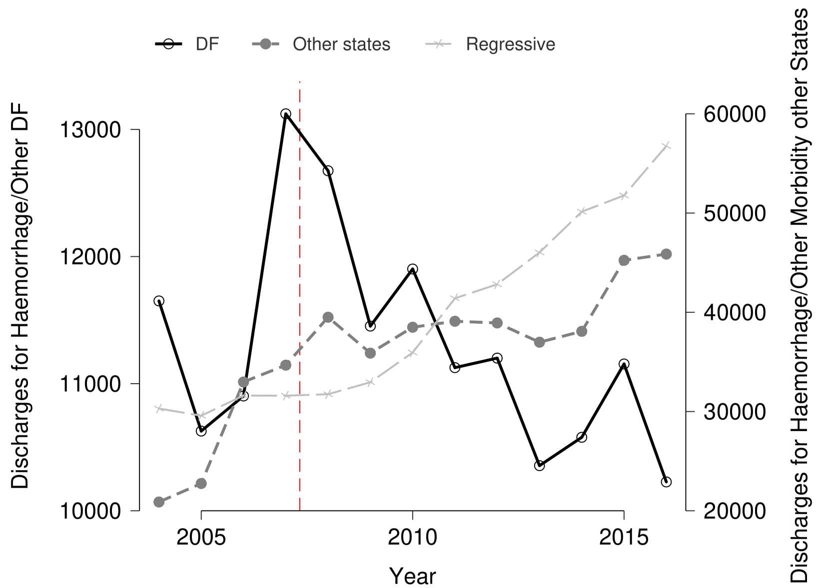
(a) Quantity of Hospital Visits in the Private Sector



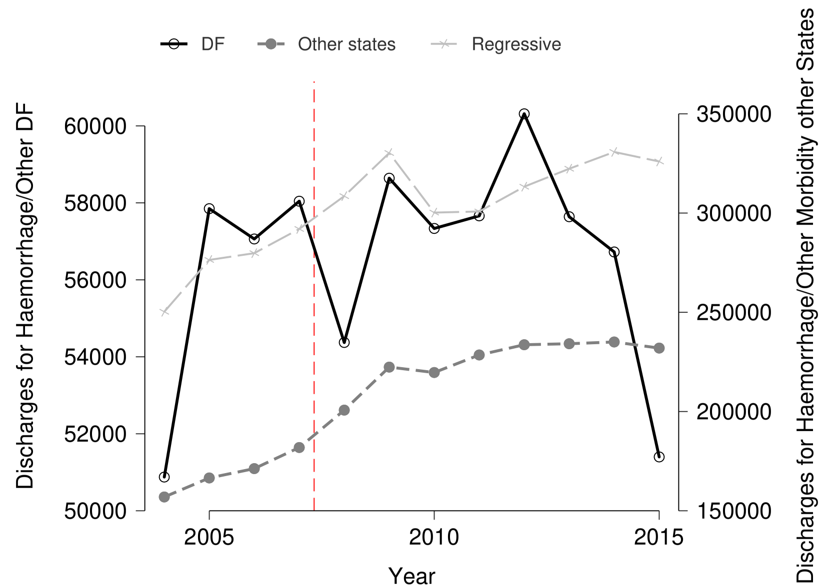
(b) Quantity of Hospital Visits in the Public Sector

Notes: Left-hand panel plots all abortion morbidity according to the universe of private health records. Microdata on these records are available by request from INEGI. Right-hand panel plots all abortion morbidity coded using the same codes as in private records based on the universe of public hospital records. A description of how these codes are merged between the public and private system is available in Appendix Table A2.

Figure A19: Trends in Public and Private Health System Morbidity: Other Maternal Causes (including Haemorrhage)



(a) Quantity of Hospital Visits in the Private Sector



(b) Quantity of Hospital Visits in the Public Sector

Notes: Left-hand panel plots all “Other Maternal Causes” (including haemorrhage early in pregnancy) according to the universe of private health records. Microdata on these records are available by request from INEGI. Right-hand panel plots all “Other Maternal Causes” coded using the same codes as in private records based on the universe of public hospital records. A description of how these codes are merged between the public and private system is available in Appendix Table A2.

Table A10: The Effect of the Abortion Reform on Reported Sexual Behaviour (Panel Specification)

	(1) Modern Contracep Knowledge	(2) Any Contraception	(3) Modern Contraception	(4) Num of Sex Partners
ILE Reform	0.002	-0.012	-0.013	-0.111
	(0.276)	(0.914)	(0.901)	(0.776)
Regressive Law Change	-0.009	0.041	0.014	0.267
	(0.304)	(0.492)	(0.814)	(0.064)
Observations	10007	10007	10007	10007
R-Squared	0.889	0.568	0.558	0.531
Mean of Dependent Variable	0.999	0.569	0.610	1.418

Each column presents a seperate regression of a contraceptive or sexual behaviour variable on abortion reform measures, household fixed effects, year fixed effects and time-varying controls. p-values are presented below coefficients in parentheses.

Table A11: The Effect of the Abortion Reform on Reported Sexual Behaviour (Repeated Cross-Section Specification)

	(1) Modern Contracep Knowledge	(2) Any Contraception	(3) Modern Contraception	(4) Num of Sex Partners
ILE Reform	-0.011	-0.050	-0.057	-0.111
	(0.513)	(0.579)	(0.520)	(0.675)
Regressive Law Change	-0.002	0.093	0.065	0.150
	(0.815)	(0.008)	(0.065)	(0.106)
Observations	10007	10007	10007	10007
R-Squared	0.037	0.027	0.029	0.033
Mean of Dependent Variable	0.999	0.569	0.610	1.418

Each column presents a seperate regression of a contraceptive or sexual behaviour variable on abortion reform measures, year fixed effects and time-varying controls. p-values are presented below coefficients in parentheses.