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THE IMPACT OF ABORTION LEGALIZATION ON FERTILITY AND FEMALE EMPOWERMENT: NEW EVIDENCE FROM MEXICO*

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Abstract

We examine the effect of a large-scale, free, elective abortion program implemented in Mexico City in 2007. This reform resulted in a sharp increase in the request and use of early term elective abortions: approximately 90,000 abortions were administered by public health providers in the four years following the reform, versus only 62 in the five years preceding the reform. We document, firstly, that this localised reform resulted in a legislative backlash in 18 other Mexican states which constitutionally altered penal codes to increase sanctions on abortions. We take advantage of this dual policy environment to estimate the effect of progressive and regressive abortion reform on fertility and women's empowerment. Using administrative birth data we find that progressive abortion laws reduce rates of child-bearing, particularly among young women. Additionally, the reform is found to increase women's role in household decision making—an empowerment result in line with economic theory and empirical results from a developed-country setting. We however find little evidence to suggest that the resulting regressive changes to penal codes have had an inverse result over the time-period studied. In turning to mechanisms, evidence from a panel of women suggests that results are directly driven by increased access to abortion, rather than changes in sexual behaviour, contraceptive use or contraceptive knowledge.

Keywords: Fertility, Female Empowerment, Abortion legalization, Mexico

JEL Codes: J13, I15, I18, O15.

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1 Introduction

Despite laws codifying access to abortion dating from as far back as the early 20th century, the issue of abortion legalisation remains a highly controversial social topic. This is especially true in Latin America, where abortion legislation is among the strictest in the world (United Nations, 2014). In spite of strict—and often binding—legislation, Latin America has the highest rates of unsafe abortions in the world, with an estimated 31 abortions per 1,000 fertile-aged women compared to the global rate of 14 per 1,000 women. The high number of unsafe abortions in the Latin American and Caribbean region corresponds to an estimated 4.2 million unsafe induced abortions each year, and accounts for 12% of all maternal deaths in the region (WHO, 2011). In 2015 and 2016 ongoing public debate on abortion legalisation was particularly vociferous, partially in connection with the outbreak of the Zika virus in tropical zones, which is thought to lead to microcephaly among infants (Heymann et al., 2016; Cauchemez et al., 2016).[1]

In this study, we examine the effect of a sharply defined local abortion reform in Mexico City and document the effect of free access to legal and safe abortion services on fertility, sexual behaviour and female empowerment. We combine the state-level variation over time resulting from this natural experiment with high quality vital statistics data on 23 million births. This 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 City. Following the 2007 reform, more than 90,000 women accessed safe legal abortion between 2008 and 2012.

Fertility reform, and abortion reform in particular, has received considerable attention in the economic literature. A large number of studies examining legislative reforms in the United States in the 1970s have documented substantial impacts of these reforms on fertility in the short and long run, as well as on the composition of mothers and children (among others, Angrist and Evans (1996); Bailey (2013); Ananat et al. (2009); Gruber et al. (1999)). Nevertheless, studies of large-scale abortion reforms in developing and emerging economies are less common. Notable exceptions to this are the studies by Pop-Eleches (2010a,b) and Mitrut and Wolff (2010) on abortion reforms in Romania, an upper-middle income country, and Valente (2014)'s study of clinic construction in Nepal, a low income country. The present study adds an additional example of the effects a large-scale abortion reform using high-quality administrative data from

[1] Some groups of lawyers, doctors, activists and UN spokesperson Cecile Pouilly have called on the Supreme Court of Brazil to allow for induced abortions (Watts, 2016).

an emerging economy, and extends the literature on the impact of abortion reforms in a number of ways.

This study adds to the existing literature by firstly, providing evidence on the effect of abortion legalisation absent simultaneous changes in other major contraceptive laws and reforms.[2] Secondly, the paper takes advantage of an idiosyncratic policy environment in which regressive changes in abortion laws in multiple and geographically disperse areas followed a large progressive change, allowing for the separate identification of the effects of both a loosening and tightening of abortion legislation. Thirdly, by combining rich administative data with panel data following women on either side of abortion reforms we are able to test a number of existing hypotheses relating to abortion reforms. We begin by testing whether—as in the existing literature—abortion reforms have immediate and important effects on fertility. Then we test the hypothesis that fertility reform, and abortion reform in particular, will increase female empowerment within the household (Chiappori and Oreffice, 2008). While this has been documented to hold historically in the United States (Oreffice, 2007), no similar evidence exists for an emerging economy, despite considerable interest in women's well-being and empowerment in literature on economic development (Duflo, 2012; Baird et al., 2014).[3] Indeed, earlier influential theoretical work of Akerlof et al. (1996) suggests that under certain circumstances, namely males being less likely to enter marital unions following abortion availability, the direction of a reform's effect on empowerment may even be negative for women.

Abortion laws are determined at the state level in Mexico, where Mexico City (also known as the federal district of Mexico or Mexico D. F.) has its own legislative assembly. The ILE reform provided all women who reside in Mexico City with access to legal and safe abortion procedures, free of charge and for any reason, during the first trimester of pregnancy (Becker, 2013). The law was a radical change from previous legislation in Mexico City, and also compared to the rest of the states of Mexico, where abortion is still banned in all but the extreme circumstances of rape, to save the mother's life, or in cases of severe fetal malformation. Moreover, by legalizing abortion, Mexico City distinguishes itself from nearly all other countries in Latin America and the Caribbean which remain highly restrictive in their policies related to elective abortion

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

[3] A range of work exists showing links between fertility choices, gender preferences, and women's empowerment. For example, (Becker, 1999) demonstrates gender differentials between desired fertility and contraceptive use. More recenct evidence from a randomized controlled trial by Ashraf et al. (2014), shows that when women are able to conceal contraceptive use from their husbands, fertility declines.

(Fraser, 2015).[4] The passing of the ILE reform resulted in a swift backlash, with 18 states following the announcement of the ILE reform by constitutionally modifying their penal codes to increase the harshness of the treatment of suspected abortions. We construct a database recording the precise date for each of these law changes by piecing together dates from published consitutional decrees for each state, resulting in a time and state-varying measure of changes in abortion laws.

By combining state by time variation provided by the ILE reform and the follow-on regressive law changes with rich administrative and panel data, we estimate a difference-in-differences effect of the reform on rates of fertility, and various measures of women's empowerment. We document that the progressive reform resulted in a sharp decline in fertility, particularly among young women, and an increase in measures of women's empowerment. These results are found to hold up to an event-study analysis, state-of-the-art correction for multiple hypothesis testing, and a number of placebo tests. We also document that effects and significance levels are largely unchanged when estimating using an entropy matching technique to form a more comparable quasi-control group for difference-in-difference estimates. The estimated effects on fertility are large, and in line with results documented in the developed-country literature. We estimate that the ILE reform resulted in a 3.7% reduction in fertility among all women, and a 6.9% reduction among adolescents. Moreover, in contrast to Miller and Valente (2016) we do not find evidence to suggest that the effect on fertility can be attributed to changes in contraceptive use, nor do we find links between the abortions and contraceptive knowledge or altered sexual behavior.

Turning to empowerment, we estimate that the abortion reform made women approximately 10% more likely to report being involved in a series of important decisions within her household. No similar results were found for women older than fertile age at the date of the reform, in line with economic theory (Chiappori and Oreffice, 2008). However, we find little evidence to suggest that the reverse was true with regressive abortion reforms. The tightening of laws to increase punitive treatment of abortion was not shown to increase rates of birth, nor decrease rates of women empowerment. We suggest that this may be because regressive constitutional changes had little effect on rates of self-administered abortion, which often occur privately, without any formal medical intervention (Lara et al., 2011).

[4] According to the most recent United Nations figures (United Nations, 2014), Mexico is one of only three countries in the Latin America and Caribbean region (along with Uruguay and Guyana) to be classified as the "Least restrictive" in abortion policy, implying that abortions are permitted for economic or social reasons upon request.

This paper joins a number 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., 2010; Becker, 2013; Mondragón y Kalb et al., 2011), medicine (Madrazo, 2009), and demography (Gutierrez-Vazquez and Parrado, 2015).[5] 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 women's empowerment, as well as fertility declines, may be affected by abortion reform in Mexico. All in all, the paper provides strong evidence that abortion reform in an emerging economy leads to rapid and discernible changes in political behaviour, aggregate fertility rates, and individual empowerment within households.

2 Unintended Pregancies, the Mexican Context and the ILE Reform

Globally, unintended pregnancies lead to approximately 46 million induced abortions each year, accounting for around 50% of the world-wide total (Van Lerberghe et al., 2005). 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.[6] Breathtaking figures suggest that world-wide, unsafe abortions may result in as many as 8 maternal deaths per hour (The Lancet, 2009). 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 regions and groups (WHO, 2011).

[5]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 a limited amount of data is used comparing outcomes between three different years (1990, 2000 and 2010).

[6]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).

The highest estimated rate of unsafe abortion occurs in the Latin America and Caribbean region. Each year, an estimated 4.2 million unsafe induced abortions are carried out, accounting for 12% of all maternal deaths in the region (WHO, 2011). This region also exhibits some of the world's most conservative laws on abortion (United Nations, 2014). Prior to the legalization of abortion in Mexico City in 2007, and in line with nearly all other countries in the region, Mexico had very strict legal restriction on access to abortion.

Fertility and the Mexican context. Between the years 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)[7], it is estimated that more than half of all pregnancies are unintended. 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 City 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.

Legal restrictions and induced abortions. Prior to the reform in Mexico City, 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

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

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 of strict legal restrictions in Mexico, has been available in pharmacies since 1985 (Lara et al., 2011).[8] 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 is generally not available at pharmacies, leading to considerable risks when self administered (see for example Grimes (2005).)

Due to the high number of unsafe abortions as well as a growing movement for women's reproductive health rights and a coalition of pro-choice NGOs, the legislative assembly of the Federal District of Mexico City 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 City, and Article 14 of the Health Code. These reforms were signed into law the following day, and published in the official Gazette of the Federal District on April 26, 2007 (Ciudad de México, 2007). A broader discussion of the reform's social and legal setting is provided in Kulczycki (2011); Madrazo (2009), Blanco-Mancilla (2011) and Johnson (2013). 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 were made legal in both the public and private health care sectors.

[8] 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).

Implementation of the ILE reform 2007. Immediate implementation was made possible by collaboration between the Ministry of Health of Mexico City, 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., 2012). 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 City, together with Cuba and Uruguay, the most liberal jurisdiction in terms of abortion legislation in the entire Latin American and Caribbean region (Fraser, 2015).

Under the ILE program, women above the age of 18 with residency in Mexico City can access abortion services free of charge at a selected number of public health clinics operated via the Ministry of Health in Mexico City (MOH-DF)[9]. Women with residency outside Mexico City can also access the public provision of abortion through 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 City, 24% were living in the state of Mexico (which shares a border with Mexico City) and 2% were living in other states (Mondragón y Kalb et al., 2011).

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. Information 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

[9]The public health care sector in Mexico is divided at both federal and state level, where the Ministry of Health (MOH) in Mexico City provides abortion procedures at a selected number of MOH-DF hospitals. Other MOH facilities (federally or state funded) are not legally required to provide abortion procedures.

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).

Accessibility and utilization of legally induced abortions. 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 City, women do seek abortion services within the private sector. A descriptive study by Schiavon et al. (2012) suggests that private abortion services are provided at high costs (157–505 US dollars) and that the quality of care is inferior to that in the public sector, given that the less safe and efficient "dilation and curgettage" 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., 2012).

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).[10] 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 (Becker, 2013). As of 2012, approximately 90,000 abortions were carried out at the MOH-DF clinics (Becker, 2013).

Post-April 2007 Policy Environment Almost immediately following Mexico D. F.'s ILE reform, a number of states began a series of counter-legislations to change the respective sections of their penal codes, defining the beginning of human life as occurring at conception. Often, these legal responses directly referenced Mexico D. F.'s ILE reform.[11] 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

[10] Medical abortion procedures constitutes 66 percent of all abortion procedures in the MOH-DF program where Misoprostol was the main regimen until 2011 when Mifepristone was introduced.

[11] 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 D. F. (p. 14) (Gobierno de Nayarit, 2009).

between June 21, 2008 and November 17, 2009. Importantly, these reforms all changed the status of abortion from an act which was penalised according to specific articles of the penal code into a homicide, with considerably more severe sanctions of up to 30 years imprisonment.

In figure 1 we display the geographical distribution of law changes (progressive, regressive or neutral) over the period under study. The only progressive reform refers to Mexico D. F.'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 table 1. To the best of our knowledge, there exists no centralised 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 of this law in our identification strategy.

3 Data

3.1 Birth Records from INEGI

To examine the effects of abortion reforms on fertility, we use vital statistics on all births registered in Mexico for the time period 2002-2011. The data is provided by the National Institute of Statistics and Geography (INEGI for its name in Spanish) and covers 23,151,080 live births among women aged 15-44. 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). Using data from the 2010 census and birth records up until 2009, 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 birth are eventually registered at the national level (Instituto Nacional de Estadística y Geografía, 2012). 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 2002-2014, and then keep all births registered within 3 years of the date of birth[12]. This implies that we only have complete birth registers based on birth years up to (and including) 2011. While these birth registers are not universal, they are recognised as being considerably better than many other registry systems in developing economies. On average, dated estimates suggest that across all developing countries 41% of births are unregisted, and this figure for Latin America alone is 14% (UNICEF, 2005). As we discuss in later sections of this paper, unregistered births will 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).

For our principal analysis, we focus on all births occurring to women aged between 15 and 44 years of age who reside in each of Mexico's 32 states. Data from the birth registers is aggregated by each age group, state, and year, resulting in a total of 9,600 cells (years×states×age). 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.

Summary statistics for birth data (as well as state-specific time-varying controls), are provided in table 2. Rates of birth are presented separately for Mexico D. F. (the principal reform state), states which went on to pass regressive reforms, and states which left un-altered their constitutions. We provide country averages in column 4, which agree with international calculations (The World Bank, 2015). Summary statistics show that rates of birth in Mexico D. F. are lower than rates of birth in the rest of the country, and broadly comparable among regressive and non-regressive reform states. In principal analyses we capture difference in levels among states by state fixed effects, and examine robustness of our results to entropy weighting which matches on pre-reform birth rates.

3.2 Survey Data from the Mexican Family Life Survey (MxFLS)

In order to examine female empowerment and potential mechanisms through which the reform may have affected fertility, we use longitudinal data on household decision-making and con-

[12] 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).

traceptive use and knowledge 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 household decision-making and reproductive health. 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 US (Duke University and Universities of California, Los Angeles). The survey was conducted in three waves during 2002-2003, 2005-2006 and 2009-2012.

The sample used for the analysis of household decision-making consists of a panel of 5,816 unique women living in a household together with their spouse or partner and who completed the household module. The module on household decision-making includes questions on which household members decide on children's health and education, major household spending, labour market participation and contraceptive use, among other things. In Table 3, summary statistics regarding women's participation in household decision-making processes are presented, separated by their region of residence. The averages in participation are presented again separately for Mexico D. F (column 1), states which went on to pass regressive laws (column 2), states which left their constitutions un-altered (column 3) and the averages for the full country (column 4). Panel A displays decision-making for women aged 15-44 (fertile age) and Panel B for women above age 44. We employ this split into fertile and non-fertile age women in a placebo test discussed in section 4. The summary statistics show that women with residency in Mexico City are on average more likely to participate in household decisions compared to women in the rest of the country. A similar pattern can be found across age groups, where women aged 15-44 appear to play more of a role in decisions within the household compared to women above age 44.

Finally, 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. We return to use these data in tests of behaviour following abortion reforms. Summary statistics for reproductive health across regions are provided as an online appendix (table A1) 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 City compared to other states.

3.3 Additional Data Sources

We collect a number of additional (time-varying) controls measured at the level of state and year. This includes the population of women (variation by age, state and year) from the National Population Council of Mexico (CONAPO), socioeconomic variables including illiteracy, schooling, and access to health insurance from the National Institute for Federalism and Municipal Development (INAFED) and the National Education Statistical Information System (SNIE), and data on the municipal-level roll-out of the national health insurance program *Seguro Popular*[13] from the INEGI data bank. Socioeconomic data and measures of *Seguro Popular* coverage vary by state and year. These are merged by year and state to the birth data discussed in section 3.1, and are included as time-varying controls in certain regression specifications.

4 Empirical Strategy

4.1 Estimating Effects on Fertility

The impact of the abortion reform is evaluated by using the sub-national variation in abortion laws, and thus the access to legal and safe abortion procedures, resulting from the ILE reform. Given the temporal- and geographical-variation in availability of free legal abortions, and resulting regressive law changes, we estimate the following difference-in-differences (DiD) specification:

$$\ln(Birth)_{ast} = \beta_0 + \beta_1 \text{ILE}_{s,t-1} + \beta_2 \text{Regressive}_{s,t-1} + \boldsymbol{X}_{st}\boldsymbol{\delta} + \alpha_s + \nu_t + \pi_a + \lambda_s \cdot t + \varepsilon_{ast}. \quad (1)$$

Here the outcome variable of interest is the natural logarithm of the total number of births for women of age a in state s and year t. We are interested in two quasi-treatment variables, each of which are determined by the official residency of the woman. The first, indicated by $\text{ILE}_{s,t-1}$

[13]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. By 2005, two years before the reform, all 32 states had enrolled in the SP program (Knaul et al., 2007).

is a variable that takes the value of one in Mexico City nine months after the ILE reform was adopted in order to compensate for the lag caused by the pregnancy length (assuming 40 weeks of gestation), and zero otherwise.[14] The second dependent variable of interest, $\text{Regressive}_{s,t-1}$ is defined in a similar way, however taking the value of one in those states which passed regressive laws in response to the ILE reform at least 9 months after each law was passed. As discussed in section 2, a non-negligible proportion of all elective abortions were accessed by women with residency in the neighbouring state of Mexico. Thus, to ensure that any potential spillover effects of the reform are not included as part of the quasi-control group, we always separately control for this with a dummy for the post-reform period in Mexico State.

The difficulty in evaluating effects of these new laws lies in the fact that legislative changes are often endogenously determined. That is, abortion legalization is likely to be correlated with observed and unobserved characteristics of Mexico City and, similarly for the regressive reform states. Even though the distribution of treatment is non-random, the inclusion of state (α_s), year (ν_t) and age (π_a) fixed effects allows us to estimate the impact of the reform in a DiD setting. Under the parallel-trends assumption that in the absence of the reform treated and untreated states would have followed similar trends over time, DiD gives the causal impact of the reform on outcome variables. We examine the veracity of this assumption in following sections including estimating a full event study for the effect of the ILE reform. In certain specifications, we include a set of state-level time-varying controls $\boldsymbol{X}_{st}$, and also allow for differential linear time trends in each state over time, captured by the $\lambda_s \cdot t$ term. The idiosyncratic error term ε_{ast} is clustered at the state level in order to allow for autocorrelation of unobserved shocks within states over time[15], and age by state by year cells are weighted by the state population (see for example Dell (2015) for a discussion based on a similar structure).

In our main specifications, births are measured as the log number of total births occurring in each cell. While births can be measured in a number of ways, including counts, gross fertility rate and total fertility rate (which we report in the online appendix), we prefer the natural

[14]We choose the most conservative definition of the post-treatment period starting in January 2008 and onwards for our baseline specification.

[15]This is the generally accepted method in a DiD model (Bertrand et al., 2004). However, there is a potential inconsistency in the standard error caused by serial correlation when the time period is long and numbers of groups (i.e. states) are small (Bertrand et al., 2004). A likely outcome in these circumstances is underestimated standard errors leading to falsely significant DiD estimates. This raises concern, since the number of clusters in our case are 32, which is slightly below commonly accepted "rule of thumb" thresholds for consistent estimation of standard errors (Angrist and Pischke, 2009; Cameron and Miller, 2015). One suggested way of dealing with this problem is to use wild bootstrapped standard errors (Bertrand et al., 2004; Cameron and Miller, 2015), and as such, we also examine our main specifications using wild bootstrapped standard errors and show that these results are consistent with our baseline results.

logarithm of the number of births for a number of reasons. Firstly, we lack micro-data registers of population in each year and are constrained to demographic projections based on the census, quinquennial surveys, migration, births and deaths (Consejo Nacional de Población, 2012). Secondly, we estimate regressions with log births using OLS. Without the log normalisation of births, regression residuals are not normally distributed, and predicted values are at times negative. Taking the log transformation allows us to resolve these issues in our case.

In equation 1, all states which were not affected by either the ILE reform or resulting regressive changes are considered as part of the quasi-control group. Given the considerable heterogeneity across the country, both within and between urban and rural districts, this may result in a quasi-control group which is considerably different from the quasi-treatment groups. While our difference-in-difference study will pick up any difference in levels, nevertheless we may be concerned that heterogeneity between groups drives the results, rather than the reform itself. In order to temper these concerns, we provide additional estimates of equation 1, however this time using entropy balancing to determine an optimal quasi-control group. Entropy-balancing, from Hainmueller (2012), is a technique designed to optimise covariate balance between two groups. This technique, increasingly used in economic applications (for example Stanton and Thomas (2016)) matches the moments between samples of desired covariates. In order to apply this to our DiD methodology we calculate entropy weights matching only on *pre*-reform birth rates of births between states. As well as documenting graphical effects of the reform under entropy matching, we can then replicate our findings from equation 1 with the optimal weights, to examine whether our earlier effects are driven by a non-ideal control group.

4.2 Estimating Effects on Individual and Household Behaviour

After documenting the effect of various reforms on fertility outcomes at a state level, we then go on to estimate their effect on individual behaviours collated from the MxFLS data. Given that the MxFLS follows women and families over time, this allows for the construction of a panel overlapping the full sets of reforms on each side. When turning to behavioural outcomes, this leads to the following specification:

$$Behaviour_{ist} = \alpha_0 + \alpha_1 \text{ILE}_{st-1} + \alpha_2 \text{Regressive}_{st-1} + \mu_i + \phi_t + \boldsymbol{X}_{it}\boldsymbol{\delta} + \eta_{ist} \quad (2)$$

As before, ILE and Regressive are dummy variables indicating whether the woman i in question was exposed to either type of reform in the previous period. Once again these are measured at the level of state of residence (which is where the woman is interviewed in her household). Our outcome of interest in this case is *Behaviour*, which measures a series of behaviours of interest, both in terms of empowerment within the household, and reported sexual behaviour. Given the panel data setting and three rounds of data, we control for household-specific fixed effects (μ_i), and survey wave fixed effects (ϕ_t). Our coefficients of interest are thus the effect of having been exposed to the reform, *conditional* on all observable and unobservable household-specific invariant factors which are absorbed in the fixed effect.

For our tests described in equation 2, there are various *Behaviour* indicators which were (ex-ante) defined as outcomes of interest. This implies running multiple regressions on our treatment indicators, leading to a well known problem of testing multiple hypotheses with a single reform. If we were to naively estimate multiple regressions and examine the test statistic relating to α_1 and α_2 at a fixed significance level in each one, we would be at risk of incorrectly over-rejecting null hypotheses after the first test. In order to account for this, we efficiently (both statistically and computationally) fix the level of the family wise error rate (FWER) of these tests. We follow a step-wise testing algorithm proposed by Romano and Wolf (2005a,b), which updates the proposed multiple hypothesis testing algorithms of Bonferroni (1935) and Holm (1979). Fixing the FWER instead of a significance level of each individual hypothesis means that we will no longer be propense to overcommit type I errors. A full discussion of the Romano-Wolf step-down technique and the resulting p-values is provided in appendix B.

The hypotheses of interest tested in equation 2 relate to well-known (theoretical) results suggesting that empowerment of fertile-aged women will respond to changes in birth control technologies (Chiappori and Oreffice, 2008). In order to allay concerns that any results may represent a general change of empowerment of all women, and identification concerns that empowerment may be the cause, rather than the result, of the reform, we propose two placebo tests. The first placebo test consists of re-estimating equation 2, however in place of using fertile aged women, estimate the effects on women who are no longer of fertile age, and hence no longer benefit from any additional bargaining power gained on the marriage market. The second test is an identification test, and consists of estimating the same model using only pre-reform waves of the MxFLS. Given that we have two waves of pre-reform data, we can re-estimate equation 2, where in place of the actual reform dates, we use placebo dates between the first and second survey round which were entirely before the actual reforms took place. In each case, the ILE and Regressive variables are defined for the same states, however in the second pre-treatment period. If any changes in empowerment do actually flow from the reform, we should see that these placebo reforms have no effect on empowerment, suggesting that parallel trends between treated and non-treated areas existed before implementation. As is the case with the main specifications, in all cases where multiple hypotheses are tested, we efficiently correct for over-rejection fixing the FWER using the Romano-Wolf procedure.

5 Results

5.1 Fertility

Table 4 presents results of the DiD model described in equation 1. The first three columns display the pooled effect of the reforms on women of all ages, while columns 4-6 present the same specifications for teenage women only (ages 15-19). These results suggest, firstly, that the legalisation of abortion in Mexico D. F. caused a large and statistically significant reduction in rates of births, both for all women, and for teenaged women. The estimated coefficient on ILE Reform for all women fluctuates between a reduction of births by 2.2% ($p < 0.05$) to a reduction by as much as (a marginally significant) 3.7% when including state-specific linear trends and time-varying controls.[16] When considering only the effect of passing the ILE reform on teenage motherhood, we find larger effects, of a magnitude comparable to international evidence (Bailey, 2006; Guldi, 2008; Ananat and Hungerman, 2012; Valente, 2014). The baseline (uncontrolled) DiD effect is estimated as 5.2% reduction in rates of teen pregnancy, with estimates as high as a 6.8% reduction when accounting for time-varying controls and allowing for state-specific linear trends. The magnitude and direction of this effect is virtually identical to that found by Pop-Eleches (2010a) following the lifting of abortion restrictions in Romania.

The estimates corresponding to the effect of constitutionally *tightening* policies relating to abortion appear to be largely of the reverse direction, however never at a statistically significant level. When considering the effect of "Regressive Law Changes" in table 4 we see that these are associated with small positive coefficients for all women (ranging from a 0.1 to a 1% increase in rates of birth), though always imprecisely estimated. For teenage women the evidence is once

[16] Percentage change in births based in coefficients in the log model are interpreted as $\exp(\hat{\beta}_1) - 1$. The coefficients can be approximately interpreted as the proportional reduction in rates of birth, but when we refer to them in the text we will always perform the exponential transformation to refer to exact changes.

again imprecise, suggesting that if anything, the effect of regressive laws are too small to be statistically indistinguishable from zero.

Our principal specification uses population-weighted cells by age, state and year, so results are interpreted as the effect on births per woman. In appendix table A2 we see that the negative effect of the ILE reform on fertility is largely unchanged when considering unweighted results which give equal weight to age by state cells. Similarly, we find that when replicating this specification using cluster-robust wild bootstrapping, estimates are largely unchanged: the effect of the ILE reform is found to be negative and statistically distinguishable from zero, while we can never reject the null that the resulting regressive policy changes have had any significant effect of birth rates for all women, or young women. When examining results by age we see that results are largely driven by younger and older women (refer to appendix table A4), and are substantively similar when instead of using log(births) as the outcome variable of interest, we use the birth rate based on an estimated population in the denominator (refer to appendix table A5).

5.2 Validity of Difference-in-Differences Strategy

The validity of the previous results rely fundamentally on the validity of a parallel-trends assumption for the DiD specification. We examine this assumption formally in figure 2 with the plotting of an event study examining the effect of the ILE reform on rates of birth. In this plot we fully interact a dummy of residing in Mexico D. F. with the years preceding and posterior to the reform. The coefficients on these variables then allow us to compare changes in levels of births in D. F. compared with changes in levels in the rest of the country, with respects to an arbitrary base year.[17] We follow the general convention of omitting the year that the reform was implemented as the omitted base category, as the effect on fertility should begin in the first post-reform year. The rest of the specification follows equation 1 precisely including the use of time-varying controls, fixed effects, and clustered standard errors.

If the estimated reduction in fertility from table 4 is indeed due to the effect of the reform rather than capturing prevailing differences in trends between quasi-treatment and quasi-control areas, we should see that differences in trends emerge only *after* the implementation of the

[17]Crude trends of numbers of births in Mexico D. F. and the rest of the country are displayed in appendix figure A3.

reform. We see precisely this pattern in figure 2, where we display the event study for women of all ages (a similar result holds when considering only adolescent fertility, and is displayed in appendix figure A2). In the 5 pre-reform periods, there is no statistically significant differences between quasi-treatment and quasi-control compared to the prevailing difference in the year when the reform was implemented. However, a sharp reduction in fertility appears in Mexico D. F. in the first post-reform year, leveling off at approximately -5% in the following 3 years. This provides support of the parallel trend assumption, as any confounding factors which could explain the reform's effect on fertility must have emerged over exactly the same time-period of the reform, rather than as pre-existing differential trends. The magnitude of the dynamic effects also matches up quite well with actual usage figures of abortions in public health clinics, which reached a plateau two years after the reform's implementation.

5.3 Using Entropy Balancing to Examine Estimate Validity

The results described in sections 5.1 and 5.2 provide convincing evidence that the ILE reform produced a significant reduction in rates of birth, especially among younger women. However, in the analysis up to this point, the reform area (Mexico D. F.) was compared to all untreated areas of the country, regardless of differential state-level characteristics. Given the heterogeneity between (and within) Mexican states, we examine the robustness of these findings to a potentially more comparable quasi-control group. In order to do so, we use an entropy weighting procedure described by Hainmueller (2012). This allows us to match states based on pre-reform rates of fertility, and examine how these pre-matched states evolve once the reform has been implemented.[18]

In figure 3 we observe that entropy matching provides an appropriate pre-trend balance between Mexico D. F. and the matched rest-of-Mexico sample. Graphically, we observe that even when demanding that states are matched on pre-trends and levels of fertility, rates of birth in Mexico D. F. decline faster and by a greater amount after the reform than in the matched but untreated states. Similar results are presented by age-group in appendix figure A4, and we observe that (up to the age of 35 at least), a similar dynamic is observed.

[18]The logic of entropy weighting shares certain characteristics with the synthetic control method for differences-in-differences of Abadie et al. (2010). However, entropy weighting does not rely on a convex hull assumption assumption within states over time, meaning that even if Mexico D. F. has higher rates of fertility over the period under study, we can apply entropy matching using pre-reform birth rates. For this reason, we prefer entropy matching over synthetic control methods.

We examine these results in a regression framework in table 5. In these specifications we use the weights estimated from the entropy matching process to replicate specification 1. We find, reassuringly, that results are qualitatively similar. For all women the effect of the reform is estimated to vary from -2.3% (baseline DiD) to -3.1% (including controls and state-specific linear trends), though when including state-specific trends the result is no longer estimated with sufficient precision to reject a null hypothesis of a zero effect. When turning to teenage births, however, we are able to reject a null of no effect for both the baseline and the trend with control model. In this case, our estimated effects are slightly smaller than when we use the full-Mexico quasi control group, though the results still suggest a quantitatively considerable effect, varying from a 4.2 to 5.1% reduction in teen births.

5.4 Mechanism: Availability, Education, or Behaviour

Along with the law change legalising access to abortion, the ILE reform included additional components relating to sexual education and disbursement of additional contraceptives in clinics (refer to section 2 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 behavioural change, we turn to a dataset which allows us to observe (self-reported) behaviour 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 equation 2, which allows for individual specific fixed-effects given the panel data 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. In this case, as we are regressing mutliple outcome measures on an identical series of reform variables, as discussed above it is well-known that classical tests will lead to over-rejection of null hypotheses of a zero effect of the reform (Bonferroni, 1935; Holm, 1979). To correct for a higher likelihood of committing type I errors, we estimate p-values using Romano and Wolf (2005a,b)'s step down method. This penalises p-values to account for multiple hypothesis testing, and does so in an efficient way which allows for arbitrary correlations between outcome variables. In appendix B we provide a full discussion of our implementation of this multiple hypothesis testing method.

We present results of these regressions in table 6. 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 behaviour 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 insiginifcant at the 10% level when using both traditional and Romano-Wolf corrected p-values, though as expected, p-values are lower when failing to account for multiple testing. When we replicate these results using a repeated cross-section of women rather than household fixed-effects in a panel setting, 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 (see appendix table A6 for the cross-sectional replication). 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 behaviour as proxied by the number of sexual partners compared to areas which were not subject to a regressive reform. Overall, like the case of the fertility results described in previous subsections, these results suggest that regressive reforms themselves are not sufficient to result in easily percebtible changes in fertility behaviour.

5.5 Female Empowerment

Table 7 presents results of the reform's effect on women's reported empowerment within the household. Here we once again estimate specification 2 using MxFLS panel data. Table 7 suggests that, as in developed countries (Oreffice, 2007), so in an emerging economy setting (progressive) abortion reform increases women's bargaining power within the household. In column 6 of this table we present a panel-data regression of an aggregate empowerment index on reform indicators. This aggregate indicator, a sum of all ex-ante defined measures of women's empowerment in the household variables, takes a more positive value when women report having a greater role in decisions relating to their behaviours, or investments in their children. Following the ILE reform in Mexico D. F. the average value of this index for women was found to increase by substantially more than that for women in other parts of the country (we discuss two placebo tests relating to these results in the following paragraphs). The effect size is significant: on average, the sum of all empowerment variables increased by 10% of its baseline value when comparing between reform and non-reform areas. However, we find very little evidence to suggest that the regressive changes in abortion laws was sufficient to harm women *when considering intra-household outcomes only.* The estimated effect on the aggregate index was found to be positive, small, and statistically indistinguishable from zero following regressive law changes.

In additional columns of table 7 we examine each item of the index separately, where in each case a higher value for the variable indicates that the woman is more likely to take part in the respective decision in her household. As before, given that multiple hypotheses are tested, p-values are corrected using Romano and Wolf (2005a,b)'s stepdown procedure. With one exception, we see that for all outcomes considered, the reform's effect is to increase empowerment compared to non-reform areas. However, among the five elements, the largest and most statistically significant effect is found on women reporting to be more likely to participate in decisions regarding investments in their children. The coefficient on taking part in a child's educational decisions is found to be statistically significant, even when correcting for multiple testing. Remaining variables, while signed in a way which suggests increasing empowerment, are not statistically significant based on Romano-Wolf p-values.

These results, while suggestive, may capture many other underlying changes in empowerment across districts within Mexico which are unrelated to fertility reform. We provide an additional test of whether these results may flow from the fertility reform using a placebo group in which we estimate the same specification, however this time comparing women *above* fertile age in reform and non-reform areas. This type of test follows discussion in Chiappori and Oreffice (2008); Oreffice (2007), who argue that empowerment effects should be observed among fertile aged couples, but not older couples (for example, see p. 114 in Chiappori and Oreffice (2008)). In table 8 we present results of the effect of the reform on women who are no longer of fertile age. As in the empirical work of Oreffice (2007), we find no evidence to suggest that the reform increases empowerment among women who are aged 45 or above. Indeed, among the aggregate index and all elements of the index, both for the ILE reform and regressive reform states, only one significant effect was found, and it was a significant *negative* effect on participation in large expenditures. These placebo tests lead credence to the interpretation that abortion reform increases empowerment among women of fertile age as, if anything, empowerment was weakly decreasing in Mexico D. F. among women over the ages of 45.

Finally, we may be concerned that rather than being a result of the reform, women's empowerment may have been (part of) the cause of the reform. If this is the case, rather than our results indicating that contraceptive reform increased empowerment in Mexico D. F. we would be capturing causality that runs in the opposite direction. Fortunately, given our panel-data setting with two pre-reform periods, we can test this formally to see if empowerment changes emerge pre- or post-reform. The logic of this test is similar to typical tests of Granger (1969) causality. In table 9 we estimate a placebo specification where we remove the third round of survey data, and define the reform variables as if any reforms occurring between the second and third survey wave had occurred between waves 1 and 2 of the survey. In this case, any significant estimated effects of the reforms will indicate a pre-existing difference in trends among reform and non-reform states, rather than a direct effect of the reform itself. Once again, we find little—or no—evidence to suggest that this was the case. Among both the empowerment index and the elements of the index, no statistically significant effects are found (when appropriately adjusting for multiple hypothesis testing).

6 Conclusion

The passing of the ILE reform in Mexico D. F. provided an unprecedented case among Latin American countries, and joined very few large scale reforms of abortion in developing and emerging countries world-wide. Given continual social and economic discussion of the tightening and loosening of abortion policy in many contexts, the passing of this reform allows for an important examination of the broad scope of potential effects.

In this paper we document that, firstly, the passing of the ILE reform lead to immediate changes in policy which affected women even in states considerably separated from Mexico D. F. We generate a database of regressive law changes relating to abortion which precisely capture these *policy* changes, and allow for us to capture both the effects of the ILE reform, and resulting legislative changes on a state-by-state basis. Secondly, we show that as documented extensively in the USA and in a number of lower and middle income countries, the legalisation of abortion does lead to a reduction in fertility, and that this reduction is particulary noteworthy for younger women. Had the abortion law not been passed in Mexico D. F., we estimate that fertility would have been approximately 7% higher among adolescents, which is equivalent to 4 additional births per 1,000 15-19 year olds. For means of comparison, in the 14 years from 2000 to 2014, the adolescent fertility rate in the whole country has fallen from approximately 80 per 1,000 teens to 63.5 per 1,000, or a reduction of 15.5 births per 1,000 women (The World

Bank, 2015). We document that this effect appears to be driven by access to legal abortion, and find little evidence to suggest that it leads to large changes in sexual behaviour, contraceptive knowledge, or contraceptive use. Finally, we document that in the context of Mexico, large-scale abortion reform brings with it increases in women's empowerment within the household, finding that empowerment changes accrue to fertile aged women rather than older women, as proposed in formal economic models of fertility reform (Chiappori and Oreffice, 2008; Oreffice, 2007).

All in all, this paper provides additional evidence of the potential scope of legalised abortion, even in a late-adopting setting. Although many countries, particularly in the developed world, do allow access to legal abortion, the lessons from this case are relevant to many countries in the developing world which currently do not allow abortion in any circumstance, or only under a very limited set of conditions. At present, approximately 25% of the world's population lives in a place where abortion is not legal, suggesting that future reforms could be responsible for (further) demographic transition, empowerment, and the additional benefits that accrue from women playing a larger role in household decisions.

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Figures and Tables

Table 1: 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 consitution, 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 1: Geographical Distribution of State Law Changes (post August-2007)

Notes: The August 2007 ELA reform occurred in Mexico D.F. (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 2: State and Maternal Characteristics (Birth Data)

	(1) Mexico City	(2) Regressive States	(3) Rest of Mexico	(4) Full Country
ILE Reform	0.400	0.000	0.000	0.013
	(0.491)	(0.000)	(0.000)	(0.111)
Regressive Law Change	0.000	0.226	0.000	0.134
	(0.000)	(0.418)	(0.000)	(0.341)
Illiteracy	2.415	7.435	8.900	7.828
	(0.259)	(3.992)	(5.543)	(4.735)
People aged 6-14 with no schooling	2.954	5.122	5.504	5.197
	(0.152)	(1.188)	(2.086)	(1.632)
No Health Coverage	39.228	39.072	43.958	40.909
	(4.357)	(12.970)	(17.128)	(14.698)
Seguro Popular	0.625	0.746	0.742	0.741
	(0.463)	(0.370)	(0.363)	(0.371)
Birth Rate (All)	64.738	88.246	87.745	86.025
	(33.552)	(47.809)	(48.068)	(47.305)
Birth Rate 15-19	56.500	76.481	78.216	75.673
	(30.215)	(40.534)	(40.562)	(40.251)
Birth Rate 20-24	99.412	141.671	141.880	138.321
	(2.676)	(15.313)	(12.711)	(17.952)
Birth Rate 25-29	92.580	127.298	127.876	124.484
	(6.178)	(16.968)	(13.572)	(18.012)
Birth Rate 30-34	76.904	90.752	90.447	89.373
	(10.155)	(18.504)	(17.557)	(17.979)
Birth Rate 35-39	40.845	47.316	45.461	46.002
	(11.689)	(15.433)	(14.488)	(14.879)
Birth Rate 40-44	9.295	14.296	12.326	13.060
	(5.507)	(8.803)	(7.810)	(8.307)
States × Year	300	5700	3600	9600
Total Births	1,505,790	12,729,949	8,921,380	23,157,119

NOTES Data on fertility and maternal characteristics is obtained from INEGI and covers all births among women aged 15-44 during the time period 2002-2011. Data on state level education and health care is obtained from the National Institute for Federalism and Municipal Development and the National Education Statistical Information System (respectively) for the same period. Mean values are displayed, with standard deviations below in parentheses. Regressive states are those which ever had a regressive law change posterior to 2008, and so regressive law change is the proportion of all years in these states which follow a law change. Similarly, ILE Reform refers to the proportion of years in Mexico D.F. which follow the implementation of the ILE Reform

Table 3: Summary Statistics, Household Decision Making, MxFLS

	(1) Mexico City	(2) Regressive States	(3) Rest of Mexico	(4) Full Country
Elements and index				
	Panel A: Women aged 15-44			
Child Education	0.929	0.898	0.882	0.893
	(0.258)	(0.303)	(0.323)	(0.309)
Child Health	0.895	0.903	0.880	0.894
	(0.307)	(0.297)	(0.325)	(0.308)
Expenditures	0.723	0.681	0.667	0.678
	(0.449)	(0.466)	(0.471)	(0.467)
Work	0.892	0.779	0.761	0.778
	(0.311)	(0.415)	(0.427)	(0.416)
Contraception	0.863	0.833	0.854	0.842
	(0.345)	(0.373)	(0.354)	(0.365)
Index	4.302	4.094	4.044	4.085
	(0.945)	(1.081)	(1.111)	(1.088)
Observations	172	4769	3234	8175
	Panel B: Women above age 44			
Child Education	0.442	0.464	0.475	0.466
	(0.499)	(0.499)	(0.499)	(0.499)
Child Health	0.503	0.496	0.492	0.495
	(0.502)	(0.500)	(0.500)	(0.500)
Expenditures	0.726	0.675	0.674	0.678
	(0.448)	(0.469)	(0.469)	(0.467)
Work	0.885	0.818	0.797	0.816
	(0.321)	(0.386)	(0.402)	(0.388)
Contraception	0.400	0.362	0.408	0.380
	(0.492)	(0.481)	(0.492)	(0.485)
Index	2.956	2.814	2.846	2.834
	(1.366)	(1.409)	(1.425)	(1.411)
Observations	112	3690	2178	5980

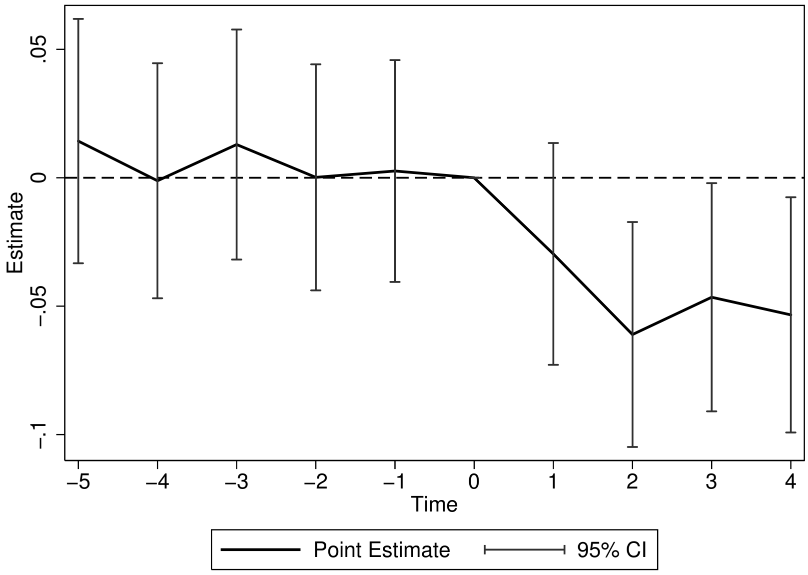
NOTES Data on household decision making and sexual behavior is obtained from the Mexican Family Life Survey (MxFLS), which was conducted in 2002-2003, 2005-2006 and 2009-2012. In panel A, summary statistics of household decision making for women aged 15-44 are presented and for women above age 44 in panel B. Mean values are displayed with standard deviations in parentheses. Regressive states are those which ever had a regressive law change posterior to 2008.

Table 4: The Effect of the ELA Reform and Resulting Law Changes on log(Births)

	All Women			Teen-aged Women		
	(1)	(2)	(3)	(4)	(5)	(6)
	ln(Birth)	ln(Birth)	ln(Birth)	ln(Birth)	ln(Birth)	ln(Birth)
ILE Reform	-0.022**	-0.028	-0.038*	-0.053***	-0.058**	-0.070**
	[0.010]	[0.019]	[0.020]	[0.016]	[0.029]	[0.029]
Regressive Law Change	0.001	0.004	0.010	-0.007	0.001	0.013
	[0.006]	[0.008]	[0.009]	[0.009]	[0.011]	[0.012]
Constant	5.537***	0.080	-7.458	5.443***	-12.660	-31.098
	[0.016]	[12.536]	[19.697]	[0.021]	[16.900]	[26.589]
Observations	9600	9600	9600	1600	1600	1600
State and Year FEs	Y	Y	Y	Y	Y	Y
State Linear Trends		Y	Y		Y	Y
Time-Varying Controls			Y			Y

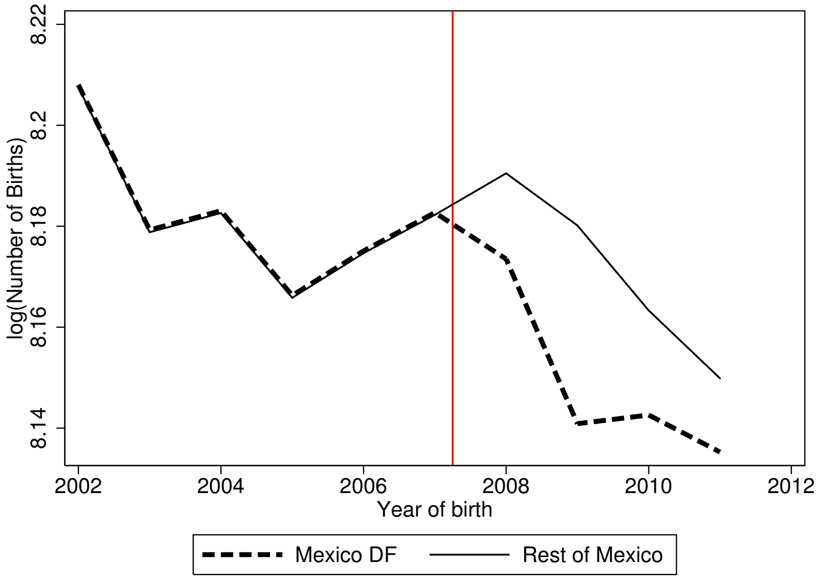
Difference-in-difference estimates of the reform on rates of births are displayed. Standard errors clustered by state are presented in parentheses. All regressions are weighted by population of women of the relevant age group in each state and year. ***p-value<0.01, **p-value<0.05, *p-value<0.01.

Figure 2: Event Study Estimates of ILE Reform



Notes: Event study estimates and confidence intervals interact the presence of legalised abortion with lags and leads. Each lag/lead is a yearly estimate, and year 0 (2007) is the omitted base year.

Figure 3: Births using Entropy Weights Based on Pre-Reform



Notes: Trends in log(Births) for Mexico D.F. and an aggregate trend for the rest of Mexico are displayed. The aggregate trend is calculated using entropy weighting (Hainmueller, 2012). Weights are constructed based on *pre*-reform birth rates between treated and non-treated areas. The vertical red line displays the date of the law change.

Table 5: The Effect of the ELA Reform and Resulting Law Changes on log(Births) (Entropy Weighting)

	All Women			Teen-aged Women		
	(1)	(2)	(3)	(4)	(5)	(6)
	ln(Birth)	ln(Birth)	ln(Birth)	ln(Birth)	ln(Birth)	ln(Birth)
ILE Reform	-0.024*	-0.024	-0.032	-0.044***	-0.043	-0.052**
	[0.013]	[0.023]	[0.024]	[0.015]	[0.027]	[0.023]
Regressive Law Change	0.002	0.000	0.009	-0.018*	-0.008	0.010
	[0.009]	[0.012]	[0.011]	[0.010]	[0.014]	[0.014]
Constant	5.277***	-3.530	-19.594	5.342***	-20.413**	-43.749*
	[0.036]	[6.193]	[17.869]	[0.029]	[10.064]	[25.561]
Observations	9600	9600	9600	1600	1600	1600
State and Year FEs	Y	Y	Y	Y	Y	Y
State Linear Trends		Y	Y		Y	Y
Time-Varying Controls			Y			Y

Specifications replicate those in table 1, however now using entropy re-weighting to balance pre-reform trends in births as described in Hainmueller (2012). Standard errors clustered by state are presented in parentheses. ***p-value<0.01, **p-value<0.05, *p-value<0.01.

Table 6: 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)
	[0.693]	[0.933]	[0.993]	[0.993]
Regressive Law Change	-0.009	0.041	0.014	0.267
	(0.304)	(0.492)	(0.814)	(0.064)
	[0.600]	[0.760]	[0.833]	[0.220]
Observations	10007	10007	10007	10007
R-Squared	0.889	0.568	0.558	0.531
Mean of Dep Var	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, house-hold fixed effects, year fixed effects and time-varying controls. In order to correct for Family Wise Error Rates from multiple hypothesis testing, we calculate Romano and Wolf (2005a) p-values, using their Stepdown methods. Romano-Wolf p-values are presented in square brackets, and traditional (uncorrected) p-values are presented in round brackets. Significance stars refer to significance at 10% (*), 5% (**) or 1% (***) levels, and are based on Romano-Wolf p-values.

Table 7: The Effect of the Abortion Reform on Women's Empowerment in the Household

	Individual Elements					Index
	(1) Child Educ	(2) Child Health	(3) Expenditure	(4) Work	(5) Contracep	(6)
ILE Reform	0.139**	0.076	0.194	-0.001	0.066	0.474**
	(0.012)	(0.346)	(0.059)	(0.994)	(0.369)	(0.028)
	[0.047]	[0.740]	[0.213]	[0.993]	[0.587]	
Regressive Law Change	-0.071	-0.008	0.138	0.050	-0.039	0.071
	(0.128)	(0.809)	(0.022)	(0.355)	(0.503)	(0.619)
	[0.407]	[0.787]	[0.100]	[0.720]	[0.747]	
Observations	8175	8175	8175	8175	8175	8175
R-Squared	0.604	0.571	0.520	0.570	0.536	0.593
Mean of Dep Var	0.874	0.873	0.678	0.770	0.850	4.044

Each column presents a seperate regression of an empowerment variable or the empowerment index including household fixed effects, year fixed effects and time-varying controls. In order to correct for Family Wise Error Rates from multiple hypothesis testing, we calculate Romano and Wolf (2005a) p-values, using their Stepdown methods. Romano-Wolf p-values are presented in square brackets, and traditional (uncorrected) p-values are presented in round brackets. Significance stars refer to significance at 10% (*), 5% (**) or 1% (***) levels, and are based on Romano-Wolf p-values.

Table 8: Placebo Test of the Effect of the Reform on Women's Empowerment (Women Aged 45+)

	Individual Elements					Index
	(1) Child Educ	(2) Child Health	(3) Expenditure	(4) Work	(5) Contracep	(6)
ILE Reform	0.053	-0.024	-0.334**	-0.057	0.083	-0.279
	(0.611)	(0.837)	(0.007)	(0.616)	(0.562)	(0.337)
	[0.953]	[0.847]	[0.027]	[0.827]	[0.960]	
Regressive Law Change	-0.098	-0.041	-0.171	0.013	0.118	-0.179
	(0.194)	(0.578)	(0.140)	(0.885)	(0.268)	(0.465)
	[0.533]	[0.820]	[0.500]	[0.900]	[0.547]	
Observations	5980	5980	5980	5980	5980	5980
R-Squared	0.674	0.683	0.540	0.529	0.607	0.676
Mean of Dep Var	0.463	0.497	0.668	0.791	0.380	2.799

For full notes refer to table 7. Regression results presented here are estimated as in table 7, however now the sample consists of married women *above* fertile age (45 years and above).

Table 9: Identification Test of the Effect of the Reform on Women's Empowerment (Pre-Reform)

	Individual Elements					Index
	(1) Child Educ	(2) Child Health	(3) Expenditure	(4) Work	(5) Contracep	(6)
ILE Reform	-0.043	0.095	0.255	-0.299	-0.006	0.002
	(0.815)	(0.547)	(0.028)	(0.050)	(0.972)	(0.996)
	[0.973]	[0.907]	[0.153]	[0.180]	[0.960]	
Regressive Law Change	-0.008	0.016	0.077	-0.076	-0.112	-0.103
	(0.887)	(0.774)	(0.180)	(0.117)	(0.057)	(0.493)
	[0.900]	[0.940]	[0.473]	[0.387]	[0.267]	
Observations	3538	3538	3538	3538	3538	3538
R-Squared	0.768	0.783	0.708	0.676	0.722	0.768
Mean of Dep Var	0.507	0.546	0.668	0.782	0.381	2.883

For full notes refer to table 7. This placebo test uses only the two pre-reform rounds, and defines as a placebo treatment group residents of Mexico D.F. in round two. A similar defintion is used to create the placebo Regressive Law Change group based on residents of regressive states, prior to the implementation of the reform.

A Appendix Tables and Figures

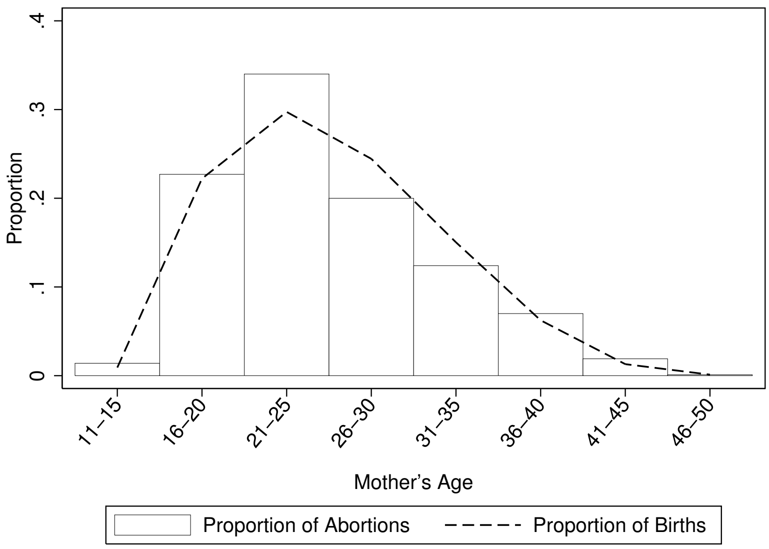
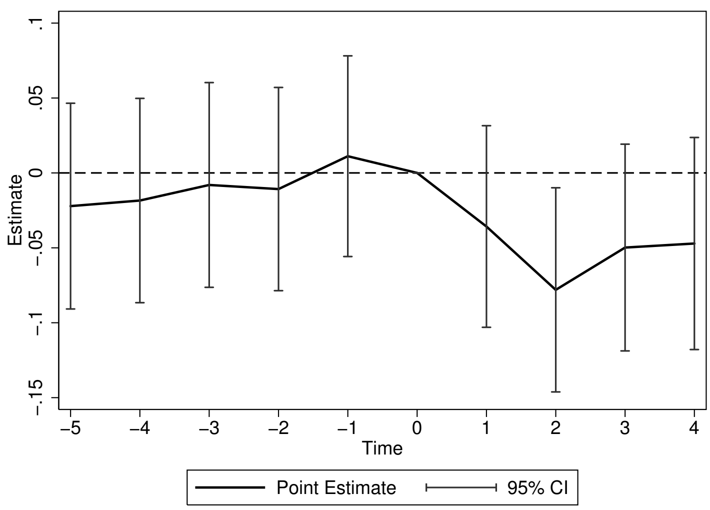


Figure A1: Birth and Abortion Descriptives: Mexico

Notes to figure: Total births are plotted between 2002 and 2011. Abortions are plotted from the date of reform (April 26, 2007) until 2011. The total quantity of births is 23.2 million (all of Mexico), and total abortions are 69,861 (Mexico City only). Births are calculated from administrative data (INEGI) and abortions from administrative data (Secretary of Health, Mexico DF).

Figure A2: Event Study Estimates of ILE Reform (15-19 Year-olds)



Notes: Event study estimates and confidence intervals interact the presence of legalised abortion with lags and leads. Each lag/lead is a yearly estimate, and year 0 (2007) is the omitted base year.

Table A1: Summary Statistics, Reproductive health, MxFLS

	(1) Mexico City	(2) Regressive States	(3) Rest of Mexico	(4) Full Country
	Women aged 15-44			
Knowledge of contraceptives	0.993	0.996	1.000	0.997
	(0.084)	(0.061)	(0.011)	(0.051)
Use modern method	0.653	0.565	0.565	0.570
	(0.477)	(0.496)	(0.496)	(0.495)
Use any method	0.661	0.610	0.602	0.610
	(0.474)	(0.488)	(0.489)	(0.488)
Number of sex partners	1.767	1.392	1.453	1.437
	(1.474)	(1.225)	(1.335)	(1.286)
Observations	226	5758	4023	10007

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. . Mean values are displayed with standard deviations in parentheses. Regressive states are those which ever had a regressive law change posterior to 2008.

Table A2: Unweighed Estimates of the Effect of Reforms on log(Births)

	All Women			Teen-aged Women		
	(1) ln(Birth)	(2) ln(Birth)	(3) ln(Birth)	(4) ln(Birth)	(5) ln(Birth)	(6) ln(Birth)
ILE Reform	-0.034*	-0.029	-0.038	-0.062***	-0.054	-0.067
	[0.018]	[0.033]	[0.034]	[0.024]	[0.043]	[0.043]
Regressive Law Change	-0.012*	-0.008	-0.004	-0.021**	-0.020*	-0.010
	[0.007]	[0.009]	[0.009]	[0.009]	[0.011]	[0.011]
Constant	5.603***	-1.954	-14.568	5.458***	-12.332	-44.087**
	[0.013]	[8.298]	[17.004]	[0.014]	[10.628]	[21.644]
Observations	9600	9600	9600	1600	1600	1600
State and Year FEs	Y	Y	Y	Y	Y	Y
State Linear Trends		Y	Y		Y	Y
Time-Varying Controls			Y			Y

Regressions replicate table 4, however using unweighted age by state by year cell. ***p-value<0.01, **p-value<0.05, *p-value<0.01.

Table A3: Replicating Fertility Results with Wild Cluster Bootstrapping

	All Women			Teen-aged Women		
	(1) ln(Birth)	(2) ln(Birth)	(3) ln(Birth)	(4) ln(Birth)	(5) ln(Birth)	(6) ln(Birth)
ILE Reform	-0.034‡‡	-0.029‡‡	-0.038‡‡	-0.062‡‡	-0.054‡‡	-0.067‡‡
	[-0.061,-0.012]	[-0.039,-0.021]	[-0.051,-0.028]	[-0.087,-0.037]	[-0.065,-0.042]	[-0.082,-0.054]
Regressive Law Change	-0.012	-0.008	-0.004	-0.021	-0.020	-0.010
	[-0.047,0.018]	[-0.024,0.007]	[-0.016,0.009]	[-0.058,0.016]	[-0.049,0.007]	[-0.033,0.014]
Observations	9600	9600	9600	1600	1600	1600
State and Year FEs	Y	Y	Y	Y	Y	Y
State Linear Trends		Y	Y		Y	Y
Time-Varying Controls			Y			Y

Results replicate unweighted difference-in-difference estimates of the effect of reforms on rates of birth, however now using wild bootstrapped standard errors in place of analytical standard errors clustered at the level of the state. Point estimates are presented, along with 95% confidence intervals of these estimates in parentheses. ‡‡ Significant at the 95% level.

Table A4: The Effect of Abortion Reform on log(Births) by Age

	(1) Ages 15-19	(2) Ages 20-24	(3) Ages 25-29	(4) Ages 30-34	(5) Ages 35-39	(6) Ages 40-44
ILE Reform	-0.070**	-0.013	0.011	-0.062***	-0.047*	-0.036
	[0.029]	[0.012]	[0.013]	[0.016]	[0.024]	[0.041]
Regressive Law Change	0.013	0.009*	0.011*	0.023***	-0.002	0.004
	[0.012]	[0.005]	[0.006]	[0.007]	[0.011]	[0.019]
Constant	-31.098	19.381*	-6.635	10.290	-8.623	-37.297
	[26.589]	[11.712]	[13.172]	[16.744]	[25.512]	[43.923]
Observations	1600	1600	1600	1600	1600	1600

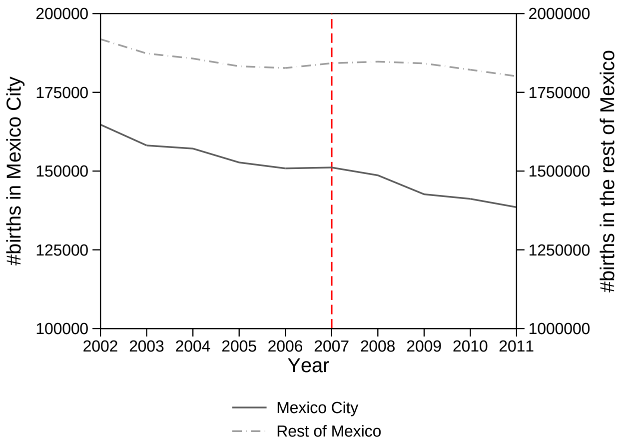
All specifications include age, state and year fixed effects state-specific linear trends, and time varying controls (ie, the specification in column (3) and (6) of table 4.) Standard errors clustered by state are presented in parentheses. All regressions are weighted by population of women of the relevant age group in each state and year. ***p-value<0.01, **p-value<0.05, *p-value<0.01.

Table A5: Replication Results Using Birth Rates instead of log(Birhts)

	(1) Ages 15-19	(2) Ages 20-24	(3) Ages 25-29	(4) Ages 30-34	(5) Ages 35-39	(6) Ages 40-44	(7) All Ages
ILE Reform	-3.942*	-2.380	0.375	-3.975***	-2.525**	-0.220	-2.334*
	[2.132]	[1.723]	[1.558]	[1.371]	[0.988]	[0.624]	[1.252]
Regressive Law Change	0.912	1.479**	1.004	1.666***	0.176	0.077	0.936*
	[0.858]	[0.728]	[0.683]	[0.613]	[0.446]	[0.286]	[0.544]
Observations	1600	1600	1600	1600	1600	1600	9600

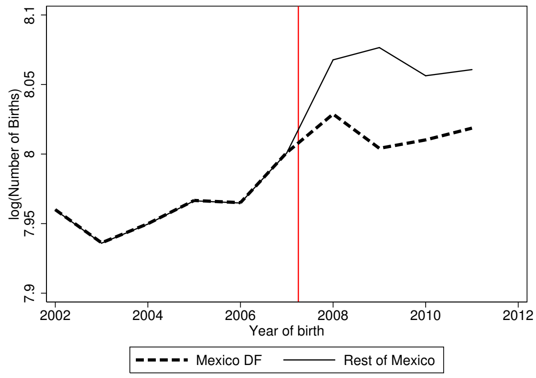
Regressions results using rates of birth are displayed. All specifications include age, state and year fixed effects, state-specific linear trends, and time varying controls (ie,the specification in column (3) and (6) of table 4.) Standard errors clustered by state are presented in parentheses. All regressions are weighted by population of women of the relevant age group in each state and year. ***p-value<0.01, **p-value<0.05, *p-value<0.01.

Figure A3: Crude Birth Trends: Mexico D. F. and Rest of Mexico

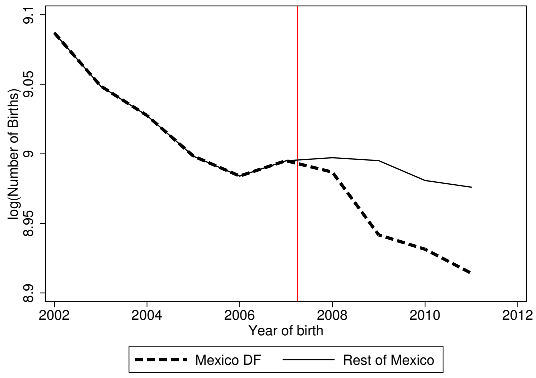


Notes to figure A3: Total births in each state are calculated from INEGI microdata registers based on state of residence of the mother.

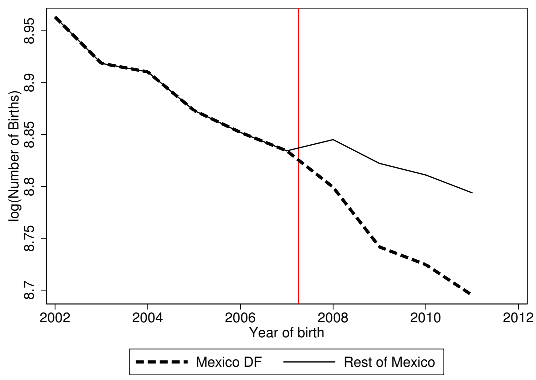
Figure A4: Age-Specific Entropy-Weighted Trends in Births



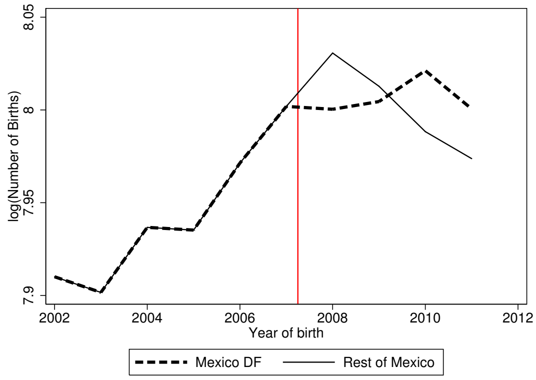
(a) 15-18 Year-olds



(b) 19-24 Year-olds



(c) 25-34 Year-olds



(d) 35-39 Year-olds

Notes: Refer to notes to figure 3. Entropy weights are calculated use pre-reform birth trends for the age group in each particular figure only.

Table A6: 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)
	[0.967]	[0.773]	[0.873]	[0.693]
Regressive Law Change	-0.002	0.093**	0.065	0.150
	(0.815)	(0.008)	(0.065)	(0.106)
	[0.873]	[0.020]	[0.233]	[0.213]
Observations	10007	10007	10007	10007
R-Squared	0.037	0.027	0.029	0.033
Mean of Dep Var	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. In order to correct for Family Wise Error Rates from multiple hypothesis testing, we calculate Romano and Wolf (2005a) p-values, using their Stepdown methods. Romano-Wolf p-values are presented in square brackets, and traditional (uncorrected) p-values are presented in round brackets. Significance stars refer to significance at 10% (*), 5% (**) or 1% (***) levels, and are based on Romano-Wolf p-values.

B Correction for FWER Using Romano and Wolf's Stepdown Procedure

We are interested in testing K hypotheses regarding the effect of the reforms on particular indicators. As we are running multiple hypothesis tests, the probability of falsely rejecting a null given that it is true is high. If we set the accepted type I error rate for each individual hypothesis as α, the likelihood of rejecting at least one hypothesis incorrectly would be equal to $1 - (1 - \alpha)^K$ (assuming independent hypotheses). For a type I error rate of $\alpha = 0.05$ per individual hypothesis and $K = 5$ hypotheses, the likelihood of falsely rejecting at least 1 null is thus equal to $\alpha_K = 0.226$.

In order to proceed with testing we thus aim to fix the Family Wise Error Rate (FWER), rather than the probability of type I errors for each hypothesis individually. This FWER is the probability of making at least one type I error in the family of K hypotheses, and we would like to fix this value at $\alpha_K = 0.05$. The classical multiple hypothesis correction of Bonferroni (1935) suggests simply adjusting a constant correction to inflate all p-values associated with each of the K tests, however as is well-known, this testing procedure is overly conservative, resulting in low power (Romano and Wolf, 2005b). A more powerful series of tests which both fix the FWER and have greater power are step-down methods, first proposed by Holm (1979). We follow a step-wise testing procedure which is more powerful in terms of type II errors than classical multiple hypothesis testing procedures given that it accounts for dependence between hypothesis tests. This stepdown procedure from Romano and Wolf (2005a), is being increasingly used in empirical economics, see for example Savelyev and Tan (2015).

We implement the "Studentized StepM Method" described in Romano and Wolf (2005b) (p. 1252). Specifically, we proceed following the steps below, where the computationally intensive steps 1 and 2 need only be estimated once.

1. Estimate the K models associated with each of the K hypotheses and calculate the t-statistics associated with each hypothesis as $t_k = (\widehat{\beta}_k - \beta_k^0)/se(\widehat{\beta}_k)$. Rank the absolute value of the t_k-statistics, and take the highest t-statistic to indicate the variable of interest for testing

2. Estimate $B = 150$ bootstrap replications of each of the K models, storing the t-statistic associated with each of the K tests for each of the B trials, resulting in $t_{k,b}$ t-statistics. Also calculate the (bootstrap) standard error for each variable using the distribution of parameters across each of the B bootstrap samples for a particular k.

3. For the variable of interest for testing, form the null distribution of t-statistics by taking the maximum t-statistic for each of the B bootstrap replications among all of the potential donor variables. The null distribution is defined as $t_k^{null} = |(\max(t) - \overline{\max(t)})/se(\widehat{\beta}_k)|$

4. Calculate the Romano Wolf p-value by comparing t_k from step one with t_k^{null} from step 3. Store this p-value as the p-value corresponding to this variable.

5. Remove this variable from the list of variables to test, and remove the bootstrap replications associated with this variable from the pool of t-values for the null distribution. The variable with the next highest t-statistic from 1 now becomes the variable of interest for testing, and the donor variables consist of this and the remaining variables to be tested. If there remain variables to test, return to step 3. Otherwise, end.