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The effect of abortion legalization on child and maternal health in Mexico City

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Abstract: In 2007, Mexico City legalized abortion in the first 12 weeks of pregnancy. By doing so, it became the first and only state in Mexico where abortion on demand is legal. In this paper, I use this natural experiment to estimate the effects of abortion legalization on child and maternal health. I perform Difference-In-Differences estimates using information from all births and deaths occurred between 2002 and 2012. My findings suggest that the change in the abortion legislation in Mexico City reduced the Infant Mortality Rate and the Under 5 Mortality Rate by approximately 2.3 and 2.4 deaths per 1,000 live births, respectively. Moreover, for the Maternal Mortality Rate I find that the estimations range from -5.49 to -6 deaths per 100,000 live births. These results are validated by the use of a more accurate control group generated by the Synthetic Control Method.
To the best of my knowledge, this if the first paper that attempts to examine the effects of abortion legalization in Mexico City on child health.

Key words: Abortion legislation, Mexico, Infant Health, Maternal Health.

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Introduction

The issue of abortion remains a highly controversial topic around the world. In the vast majority of developed countries, abortion on demand is legal whereas in most developing countries it remains illegal and a very polemic subject. To start, many religious and conservative political leaders in these regions oppose to this policy stating that it goes against traditional and cultural values. On the other hand, women's right groups state the importance of this policy in increasing their empowerment and reducing gender inequalities. In addition, researchers have found that decriminalising abortion could improve women's and children's outcomes, specially relating to health. Making abortion legal implies that less women would undergo unsafe abortions which can seriously benefit their health and their productivity. Furthermore, having fewer children could increase the investment made on each child, which has tremendous benefits on children's health.

These advantages are behind a recent international trend of abortion decriminalization which has spread to developing regions with deep catholic influences such as Latin America. In recent decades, countries like Uruguay and Mexico have changed their legislations to decriminalise abortion. The case of Mexico is particularly interesting given that each state has its own abortion legislation. In 2007, voluntary abortion was legalized in the first 12 weeks of pregnancy in Mexico City, making it the only state in the country were women can get abortions on demand.

More than 172,000 women from all over the country have gotten abortions since, although most of them (96%) come from Mexico City and the neighbouring state of Mexico. However, the abortion debate continues in the city where many doctors are conscientious objectors and have refused to perform abortion services. Also, women continue to face great stigma and hostile attitudes in hospitals. Moreover, the Catholic Church remains a strong opponent of the law stating that it threatens the traditional family values of the Mexican society.

This paper aims to estimate the effects that this policy change has had on child and maternal health. I believe this is of particular importance given that children and pregnant women are one of the most vulnerable populations. Not only are they more likely to be poor, malnourished and homeless but they also take a relatively high share of the disease burden associated with emergencies.[1] Moreover, health outcomes in early life have been found to be a good predictor of later life outcomes such as educational level, employment and income given that infant illness can reduce intellectual performance and negatively affect school attendance, among others. Determining the impact of abortion legalization on infant and maternal health is essential to develop more precise policies and to better understand the obstacles that remain in developing countries to reduce infant and maternal mortality.

[1] WHO, World Health Organization (2005)

In particular, I am interested in estimating the impact of abortion legalization in Mexico City on the Infant Mortality Rate, the Under 5 Mortality Rate and the Maternal Mortality Rate.

In order to achieve this I perform a Difference-In-Differences methodology that allows to isolate the changes on the outcomes of interest caused by the policy change. This methodology compares the changes occurred in Mexico City (the treatment group) and the rest of the country (the control group) to estimate the real effect of the policy. However, given that being the capital of the country, Mexico City has very distinctive characteristics that make it hard to compare it to the rest of the country, I use only the cities with more than 100,000 people as the control group. This leaves me with 31 entities instead of 32 since the state of Tlaxcala is composed of small cities.

Using information on all births and deaths occurred in the country between 2002 and 2012 I am able to calculate the three dependent variables of interest. This information is aggregated and provided by the National Institute of Geography and Statistics (INEGI for its name in Spanish). In addition to including the entity of residence, birth and death records hold important data for our analysis such as age at birth, mother's education and mother's occupation. I use these as the entity level covariates that explain health outcomes.

To control for the socio-economic environment of each entity I use the following variables: GDP per capita, Gini Coefficient, Number of doctors per 1,000 people, Average years of education (population aged 15 and older), Percentage of the population with access to drinking water, Percentage of the population with sewage services and Female participation rate. These variables have been described in the health literature as being important to determine infant and maternal health.

Moreover, I construct a more accurate control group by performing the Synthetic Control Method as a robustness check. This methodology constructs a Synthetic Control Group that most resembles the treatment group (in this case Mexico City) before the legalization of abortion created as a weighted average of all potential control states. The weights for each entity are calculated as to minimize the mean squared prediction error of each dependent variable in Mexico City before the policy change. Then, I apply DID to the control group created under this methodology, and compare the results to the ones found using DID alone.

The present study ads to the existing literature on the effects of abortion on health outcomes in the context of a developing country. To the best of my knowledge, this if the first paper that examines the effects of abortion legalization in Mexico City on child health. So far, researchers have focused on estimating the impact of this policy change on fertility rates and maternal mortality, neglecting the important consequences for child

health that this intervention may have caused. I intent to fill this gap by studying the effects on both the Infant and Under 5 Mortality Rates. Moreover, this is the first study that uses the Synthetic Control Method as a robustness check to estimate the effect that the 2007 abortion reform in Mexico City had on maternal mortality.

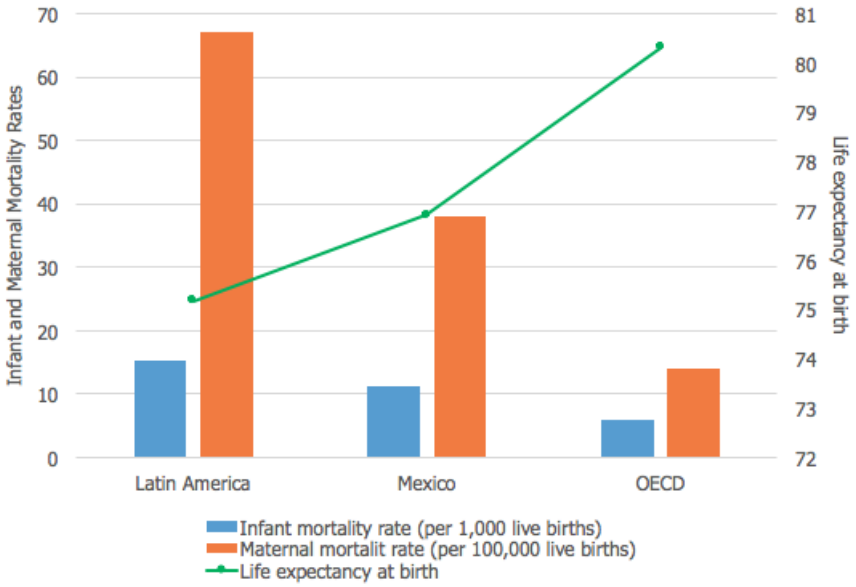
In the first section I will describe both the tendencies in maternal and child health in Mexico as well as the policy change that legalized abortion in Mexico City. In the second section I will discuss the literature review on the mechanisms through which abortion affects child health and the previous studies on the matter. Then, I will explain the Difference-In-Differences methodology implemented in this study as well as the Synthetic Control Method. The fourth section describes the results of this study. Fifthly, I will report the information provided by the robustness checks. I will finish by discussing the findings and summarizing the paper.

1 The context in Mexico

Unsafe abortions play an important role in maternal mortality and remain a health issue, specially in developing countries. According to the WHO (2015), 13% of maternal deaths were attributable to unsafe abortions between 1990 and 2015 worldwide. In addition, unsafe abortions have considerable consequences on women's education, their productivity levels and child health.

The relevance maternal and child health play for the development of countries is highlighted by the importance given to life expectancy in the Human Development Index (HDI). Figure 1 shows the life expectancy at birth for Latin America, Mexico and the OECD. Also, this figure shows the Maternal and Infant Mortality Rates for these regions. Even though Mexico has relatively low rates of Maternal Mortality and Infant Mortality compared to the region, it remains at the rear of the OECD countries in terms of maternal and infant health issues. This is why is important to understand the determinants of Maternal and Infant mortality rates and the impact that legalising abortion has had on these indicators in Mexico City.

Figure 1: Health Indicators for Mexico, Latin America and OECD: 2015



Elaborated by the author using data from the World Bank

According to the World Bank, Mexico is the tenth most populous country in the world with approximately 130 million inhabitants (2015). The country is divided in 32 federal entities of which 31 are federal states and one is the federal district of Mexico (commonly known as Mexico City or Federal District). Mexico City alone holds 7% of the country's population (approximately 9 million) and its metropolitan area, which is considerably larger, has approximately 21 million people.[2] These numbers makes it the most populous metropolitan area in Latin America.

Child and maternal health remain an important health issue for the country given that, as mentioned earlier, the levels for both Maternal and Infant Mortality Rates are high compared to the OECD average. Moreover, the decriminalization of abortion in Mexico City make the country an interesting case study. Schiavon et al. (2012) undertake a retrospective analysis to understand the impact of unsafe abortions in maternal deaths in Mexico between 1990 and 2008. Using official data on mortality and morbidity related to maternal causes (reported by the National Institute of Statistics and Geography), the authors find that approximately 7.7% maternal deaths were related to abortion in this period. Moreover, the risk of having unsafe abortions is highest among poor women, with low levels of education and also among women belonging to indigenous groups.

More importantly, when abortion is performed in sanitary conditions, with trained health care providers and proper equipment, it carries little or no risk (with one fatality out of 100,000 procedures). This implies that decriminalizing abortion might have a significant impact in reducing maternal mortality in the country.

[2]INEGI, Instituto Nacional de Estadística y Geografía (2015)

1.1 Abortion legislation in Mexico

Abortion legislation in Mexico is complicated. To start, each state has its own penal code which means abortion laws are determined at a state level and differ across the country. Before 2007, abortion was illegal except under specific circumstances -such as rape-. To undergo legal abortions, women needed to obtain court orders and deal with physicians who often refused to perform the procedure.

This, however, did not prevent Mexican women from getting illegal (and many times unsafe) abortions. According to the Guttmacher Institute (2008), approximately 875,000 induced abortions were performed in Mexico in 2006 and the country's abortion rate was 33 abortions per 1,000 women aged 15-44, which is slightly higher than the Latin American average of 31 abortions per 1,000. There was a considerable difference in abortion rates across the country, with Mexico City and the Northern region with the highest rates and the Southern with the lowest. This could be explained by the fact that the South is significantly poorer and the population is less educated than in the rest of the country. On this subject, Bankole et al. (1999) find that in 15 of 23 countries studied, most of the abortions were obtained by women who had at least secondary education. Moreover, in the case of Romania, Pop-Eleches (2006) finds that urban, educated women working in good jobs were more likely to have abortions prior to the ban on abortion by communist dictator Nicolae Ceausescu. The results of these studies could partly explain why the Southern region in Mexico has with a lower abortion rate than the rest of the country.

However, in April 2007, the Legislative Assembly of the Federal District decriminalized elective abortion in the first 12 weeks of pregnancy. Additionally, the General Health Law was reformed to oblige the Secretary of Health of Mexico City to provide free abortions services in public health facilities to women living in the city. Residents from other federal states can receive this service on a (low) sliding fee scale. This reform made Mexico City the first and only area of Mexico where voluntary abortion for the first three months of pregnancy became legal and provided in a safe environment.[3] The reform was immediately implemented and abortion services were made available in public and private clinics since April 2007.

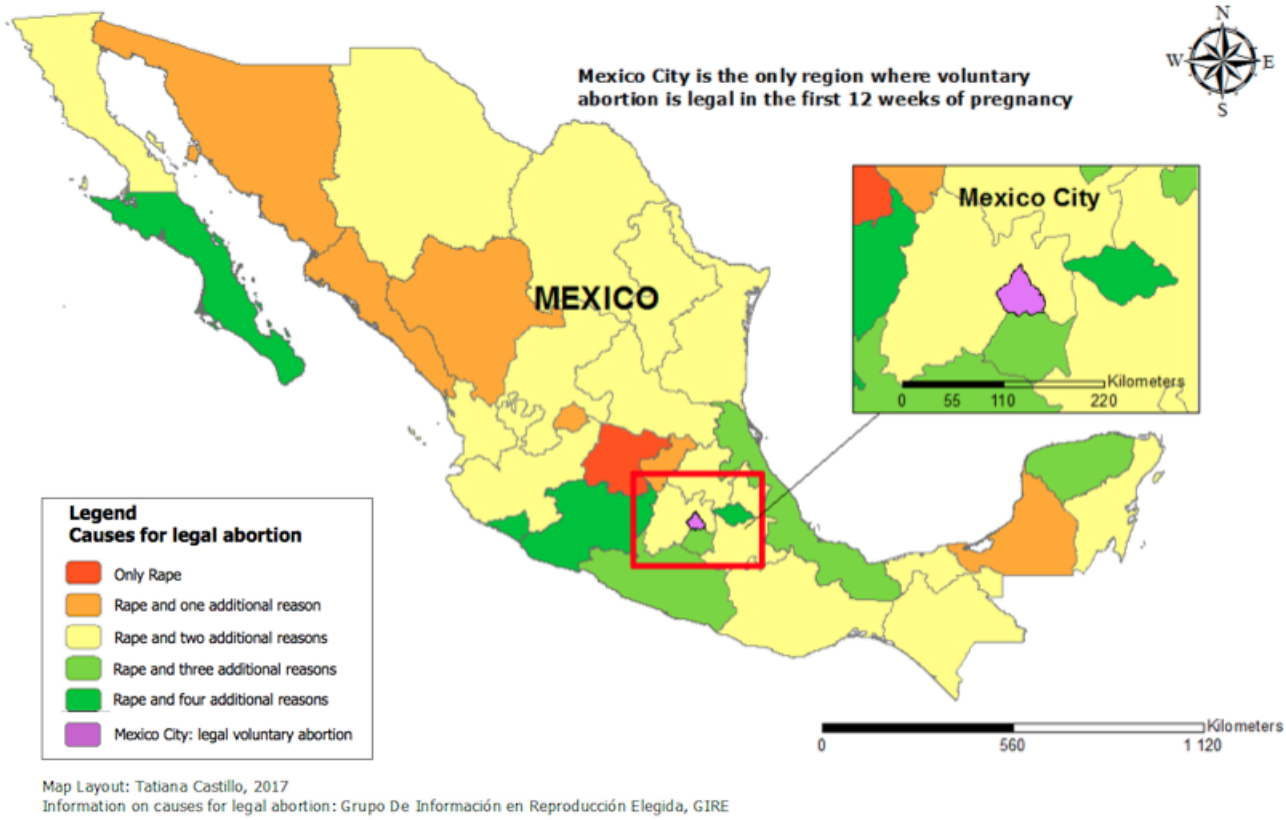
In addition to providing free abortion services, the program increased the availability of contraceptives by offering free post-abortion contraceptive services and counselling to pregnant women. Moreover, the policy reduced sentences for women who commit the crime of getting an abortion after 12 weeks of gestation and increased the penalty for anyone forcing a woman to have an abortion. More than 172,000 women have gotten abortions between April 2007 and February 2017 in Mexico City. Nearly 71% of these abortions were performed to residents of Mexico City, 25.2% to residents from the state of Mexico and less than 4% to women living in other states of the country.[4]

[3]Under aged girls still need to have a guardian's consent to undergo abortion.

[4]GIRE, Grupo de Información en Reproducción Elegida (2017b)

Nonetheless, this reform caused a conservative backlash in 16 states, where amendments have passed recognizing that the right to life starts at the moment of conception and abortion criminalization was increased (Becker, 2013). Today, rape is the only circumstance in all 32 Mexican Sates for which abortion is legal. In 24 states, abortion is legal when the life of a woman is at risk; in 16 in cases of foetal malformation; in 14 where is poses a threat to a woman's health; in 13 when the pregnancy results from artificial insemination without a woman's consent and only in the states of Michoacan and Yucatan for economic reasons.[5] The map in Figure 2 provides information on the location of the most conservative and liberal states in terms of recognition of legal causes for abortion. The most conservative state is Guanajuato, where abortion is legal only in the case of rape, while in the states of Baja California Sur, Michoacan, and Tlaxcala abortion is legal in 4 cases additional to rape.

Figure 2: Map of number of legal grounds for abortion in Mexico, 2017



[5]GIRE, Grupo de Información en Reproducción Elegida (2017a)

2 Literature Review

The legalization of abortion remains a very controversial topic. The importance of this issue was raised by the Roe v. Wade decision by the United States Supreme Court, which lead to all states in the country to decriminalize abortion in 1973. Today, voluntary abortion is legal in most developed countries but remains an important health issue in developing countries, where it is illegal in the most cases. To start, many religious and conservative leaders in developing countries oppose to this policy stating that it goes against traditional and cultural values. On the other hand, women's group state the importance of this policy in increasing their empowerment and reducing gender inequalities. In addition, researchers have found that decriminalising abortion could improve women's and children's health and educational outcomes. This section summarizes the main mechanisms through which the provision of abortion services affects children's welfare. Then, I present the different strands of literature that study changes in abortion legislation on different issues.

The most straightforward mechanism through which abortion affects children's outcomes is by reducing the number of unplanned or unwanted pregnancies. This, in accordance to the quantity-quality trade-off formulated by Becker and Lewis (1973) signifies that as families have fewer children, the "quality" of each child increases given that parents can invest more heavily on each one of their children. These authors imply that parents substitute the (high) quantity of children by investments in child health and education. More specifically, parents with fewer children can invest more on each child both in terms of prenatal and postnatal care which has direct effects on children's health.

This model predicts that, by reducing the number of unwanted children, abortion improves child quality. Li et al. (2008) test the trade-off between child quantity and quality using data from the Chinese Population Census for 1990. In order to deal with the endogeneity of family size, they instrument family size by twin births to better capture the effect of family size on child educational attainment. Their findings are consistent with the quantity-quality trade-off theory given that they find a negative effect of family size on children's education. Moreover, Jensen and Ahlburg (2002) find evidence that unwanted children are more likely to become ill and less likely to be treated due to their illness than wanted children, using data from the 1991 Indonesian Demographic and Health Survey.

Secondly, abortion helps delaying births until conditions are more favourable for parents, specially mothers. Having children in adolescence may severely affect women's employment and educational outcomes which can in turn affect the health and education of children. With the provision of free abortion services, young women can delay their first child and accumulate more education and work experience. This does not only improves mother's income but also implies that children are more likely to be born to families with higher incomes.

Moreover, education helps build the kind of habits that have a positive impact on children's health making educated mothers more capable of providing quality care to their children. A considerable number of authors have found empirical evidence that maternal education is key in determining child health in developing countries (Desai and Alva (1998), Aslam and Kingdon (2012) and Gunes (2015) among others). Chen and Li (2009) find that there is a positive and significant effect of maternal education on the health of young adopted children in China. These findings are similar to the effect found on own children which suggests that post natal nurturing is the most important channel through which women's education affects child health. Thus, by helping women optimise the time of birth, abortion can improve both mother's and children's outcomes.

Additionally, the availability of abortion services allows parents to avoid having children born in adverse circumstances such as poverty. Moreover, parents can use abortion to end pregnancies that have characteristics which they find undesirable (such as poor foetal health). This could lead to a positive effect on the welfare levels of children who are born. However, if the access to abortion services is limited and the most disadvantaged women cannot access it, the effect on children's health and welfare might be negative. There is no consensus on which of these effects prevails, and this might depend on the context on which abortion is provided. While Gruber et al. (1999) find that women from more disadvantaged socio-economic backgrounds underwent abortions relatively more than advantaged women in the United States during the 1970s, Pop-Eleches (2006) finds that highly educated women living in urban areas were more likely to get an abortion in Romania before the abortion ban was put in place in 1966.

Lastly, abortion could improve children's health outcomes by reducing the cohort size because of changes in the distribution of health resources among each child (Mitrut and Wolff, 2011). As cohort size reduces, public expenditures per child are likely to increase and children could further benefit from better and more frequent visits to hospitals and doctors.

To summarise, there are four important mechanisms through which abortion affects children outcomes. First, it reduces the number of unplanned pregnancies and increases the investments that parents make on each child, which evidently leads to better outcomes. Secondly, abortion allows women to delay their pregnancies and increase their educational attainment and work experience in the process. This raises children's outcomes not only because children would be born to families with higher incomes but also because maternal education is essential in determining child health. Thirdly, abortion helps parents terminate pregnancies under adverse circumstances such as poverty. At last, at macroeconomic level, abortion reduces cohort size which implies higher resource availability per child.

2.1 Abortion legalization and infant health

The ongoing debate on abortion has been enriched by an important number of empirical studies analysing the effects of abortion legalization on children's welfare in developed countries, transition economies and developing countries. Here I briefly describe some of these studies.

Between 1967 and 1970, five states of the United States reformed their abortion legislations to make abortion legal and widely available.[6] In 1973, after the Roe v. Wade decision by the United States Supreme Court, which deemed abortion a fundamental right under the Constitution, the remainder of the country began to decriminalize abortion. Gruber et al. (1999) take advantage of this natural experiment to asses the effect of abortion access on child living circumstances. Using microdata from the 1980 Census, they analyse the living standards of children by state and year of birth. Their findings suggest that "the marginal children who were not born as a result of abortion legalization would have systematically been born into worse circumstances had the pregnancies not been terminated"(Gruber et al., 1999, p.266). These children would have been 35% more likely to die before they turned one year of age and 40% more likely to live in poverty than the average child in their cohort.

Moreover, Grossman and Jacobowitz (1981) find that the most important factor behind the decline of infant mortality in the United States between 1964 and 1977 is the legalization of abortion and that this factor dominates the impact of maternal schooling. During this period, the health scenery drastically changed in the country with the introduction of Medicaid, maternal and infant care projects, the legalization of abortion and federally subsidized family planning services for low income women. Using socio-economic data from the 1970 census and information on deaths by age, race and sex for the years 1969 through 1976 from the National Center for Health Statistics, these authors quantify the relative contribution of each of these factors on Infant Mortality Rates. Their results further suggest the importance that the legalization of abortion in the United States had on child welfare.

Valente (2014) also takes advantage of a natural experiment and studies the impact of providing legal and affordable abortion services in Nepal, a country with high fertility and Maternal Mortality Rates. In 2004, the Nepalese government legalized abortion and began to open legal abortion centres that provide this service at very low cost. The provision of these services grew rapidly and by 2006, more than 141 legal abortion centres were available in the country. Combining fertility histories from the 2006 Nepalese Demographic and Health Survey (DHS), administrative data on registration dates of all legal abortion centers and GIS coordinates of each of these centers, the author analyses the impact of access to abortion on investments in neonatal health and sex selection.

[6] These states were: New York, Washington, Alaska, Hawai and California.

Using Difference-In-Differences, she compares the outcomes of siblings conceived before and after the opening of a legal abortion center in terms of neonatal mortality and investments in antenatal and perinatal care. Her findings suggest that proximity to a legal abortion center reduced the probability of pregnancy by 8.1% but had no impacts neither on antenatal and prenatal care, nor on sex-selective terminations.

So far I have illustrated how authors have studied the impact of abortion legalization. However, the case of Romania in the period between 1966 and 1989 allows for analysing the impacts of the criminalization of abortion on children's outcomes. In 1966, when the communist dictator Nicolae Ceausescu came to power, Romania changed its abortion policy to a restrictive and conservative one which made abortion and family planning illegal. This policy change increased the fertility rates of the country and was held in place until the communist regime was removed from power in 1989. Pop-Eleches (2006) studies the impact of this abortion ban on socio-economic outcomes of children. The author uses a 15% sample of the 1992 Romanian census which provides labor market outcomes for approximately 50,000 individuals for each year of birth. Controlling for observable background variables in a regression context, the author finds that children born after the ban had worse schooling and labor market outcomes than children born before the ban. His results show that in the short run, more educated women had the largest increase in fertility however in the long run, less educated women had the largest increase in fertility. Also, cohorts born after the ban were more likely to commit crimes in later life and had higher infant mortality propensities.

Additionally, Mitrut and Wolff (2011) study the impact of the lift of the abortion ban in Romania in December 1999 on children's health, specifically on children's weight at birth. The authors use two waves of the Romanian Integrated Household Survey which includes birth weight, in addition to socio-economic variables. They use Difference-In-Differences estimates and find that the legalization of abortion is not significant of birth weight outcomes. However, children born after abortion was decriminalized were 3.3% less likely to have a low birth weight compared to those born before the policy change.

2.2 Abortion legalization in Mexico City

A significant number of papers has analysed the effect of abortion legalization in Mexico City. Researchers have focused on quantifying the impact of this policy change on fertility and Maternal Mortality Rates. In this section, I discuss both of these subjects and the findings of three different group of researchers.

To start, Gutiérrez-Vásquez and Parrado (2015) and Clarke and Mühlrad (2016a) use a Difference-In-Differences methodology to study the impact of abortion legalization on fertility rates. Using data from three Mexican censuses (1990, 2000 and 2010) for 60 metropolitan areas and data on all registered births in Mexico between 2002 and 2011,

respectively, both studies find a significant decline in fertility propensities across all age groups. Gutiérrez-Vásquez and Parrado (2015) find that the legalization of abortion coincides with a 4 percentage point reduction in the probability of childbearing in Mexico City while Clarke and Mühlrad (2016a) find a fairly similar reduction of 3.7%. Nonetheless, the authors differ in the age group most affected since Gutiérrez-Vásquez and Parrado (2015) find that it is women aged between 20-29 whereas Clarke and Mühlrad (2016a) find that the impact of this policy change was greater for women younger than 20.

Moreover, Clarke and Mühlrad (2016a) use longitudinal data from the Mexican Family Life Survey to control for contraceptive usage and knowledge. This allows them to validate that the reduction in fertility is a direct effect of increased access to abortion rather than changes in sexual behaviour or contraceptive use. Additionally, these authors extend their analysis to account for changes in women's empowerment caused by the policy change. Using panel data on household decision making they find that women's decision making in the household is increased after the implementation of the law.

In their second paper "The Impact of Abortion Legalization on Fertility and Maternal Mortality: New Evidence from Mexico", Clarke and Mühlrad (2016b) find that this policy decreased maternal deaths by 11-20% for women of fertility age and between 15- 30.3% for teenage women. They use decease records for the period between 2002 and 2011, and Difference-In-Differences to estimate the impact of abortion legalization on maternal mortality. They also conduct a back of the envelope calculation "to determine what proportion of the reform's effect is due to the fact that there are fewer undesired births in general (and hence a lower likelihood of maternal death in childbirth), and what proportion is due to the remaining direct effect of the reform"(Clarke and Mühlrad, 2016b, p.15). They obtain that 16.2% of the reduction in maternal deaths is due to a direct effect of the reform.

Lastly, Koch et al. (2015) use official records of maternal deaths between 2002 and 2011 to determine the effects of abortion legislation on maternal mortality. After Mexico City legalized abortion, many states went in the other direction and strengthened the legislation and criminalization of abortion. The authors use this scenario to analyse whether more or less permissive abortion legislations have any effects on Maternal Mortality Rates. Using regression models these authors found that, paradoxically, the states that exhibited less permissive legislation exhibited lower levels of maternal mortality. However, the Maternal Mortality Rates were explained by differences in other independent factors such as female literacy and contraceptive use, rather than by legislation on abortion. Thus, they did not find that abortion legislation has a significant effect on overall Maternal Mortality Rates.

As seen in this section, so far researchers have focused on estimating the impact

of this policy change on fertility rates and maternal mortality, neglecting the important consequences for child health that this intervention may have caused. I intent to fill this gap by studying the effects on both the Infant and Under 5 Mortality Rates. To the best of my knowledge, this if the first paper that attempts to examine the effects of abortion legalization in Mexico City on child health. Also, I consider that using the rest of the country as a control group, ignoring the regional differences that exist between Mexico City and the other states, may lead to severe biases. This is why an analysis such as the one undertaken in the present paper, which only uses information of the cities with more than 100,000 people, is necessary to complement the existing literature.

Moreover, this is the first study that uses the Synthetic Control Method as a robustness check to estimate the effect that the 2007 abortion reform in Mexico City had on maternal mortality.

3 Methodology

In this section I explain the methodology used in this research. To begin, I describe the Difference-In-Differences (DID) technique and the assumptions that must hold in order to successfully apply DID to the data, particularly the parallel trend assumption. Then, I discuss the application of the Synthetic Control Method, the methodology used in order to obtain a more accurate control group. This method is performed as a robustness check for this study.

3.1 Difference-In-Differences

As previously stated, the objective of this research is to quantify the average impact that abortion legalization in Mexico City has had on maternal and infant health outcomes. To do this, I would need to compare the changes in outcomes in Mexico City after abortion legalization to its counterfactual, which are the outcomes that Mexico City would have had in the absence of abortion legalization. Given that this counterfactual does not exist (and therefore is not observed), it must be estimated using the rest of the country as a control group and Difference-In-Differences allow me to do so. Moreover, the decision to decriminalize abortion in the Federal District was not random but happened because of internal forces in the region (may these be a more educated population, less conservative politicians or simply unobservable variables) and DID permits to account for this endogeneity. Lastly, this methodology does not require for the treatment to be randomized but that both control and treatment groups have common trends in the outcomes of interest in the period before the intervention.

This methodology compares changes in outcomes in the treatment group (in this case Mexico City) before and after the policy change, to changes in outcomes in the control group (the rest of the country) before and after. DID allows to control for both observed

and unobserved characteristics from both groups and estimate more accurately the impact of abortion legalization. It is important to keep in mind that in order for the control group to truly represent what would have happened to the outcomes of interest in Mexico City in the absence of this policy change (the so called counterfactual) it is important that the parallel trend assumption holds. This assumption states that if the outcomes of interest in both groups follow similar trends before the policy change, it is likely that they would have followed the same path in the post-treatment period would have Mexico City not legalized adoption. This ensures that DID gives the casual impact of the reform on the outcome variables.

Graphical analysis is needed to determine whether both groups follow similar trends in the period before the intervention. In addition to this graphical analysis, I test the parallel trend assumption by estimating the effect of simulated reforms which are implemented in dates before (and after) the actual reform took place. These simulated reforms should not have a significant impact on the outcomes of interest, which will further suggest that parallel trends between both groups existed before the policy change.

The Difference-In-Differences model to be estimated in this study has the following specification:

$$Y_{et} = \alpha + \beta \mathbf{X_{et}} + \delta DF + \lambda Post + \gamma(DF \times Post) + \epsilon_{et} \tag{1}$$

where Y_{et} is one of the three variables of interest in federal entity e and year t. Keep in mind that the variables of interest are: the Infant Mortality Rate, the Under 5 Mortality Rate and the Maternal Mortality Rate. The first two outcomes are calculated as the number children under 1 year and under 5 years that die each year, per 1,000 live births, respectively. The Maternal Mortality Rate corresponds to the number of women who died each year while pregnant or within 42 days of termination of pregnancy from any cause related to or aggravated by pregnancy for every 100,000 live births. $\mathbf{X_{et}}$ is a vector of control variables that varies across time and federal entities. DF is a dummy variable equal to 1 for the state of Mexico City and to 0 otherwise, while $Post$ refers to a dummy variable indicating whether year t corresponds to a period after the intervention (equal to 1) or before the intervention (equal to 0). γ is the DID estimate given that $DF \times Post$ refers to a dummy treatment variable, taking the value of 1 for Mexico City after the intervention, which in this case is counted as six months after the reform was adopted (to account for the lag caused by the pregnancy length), meaning from the 28th of October 2008 onwards, and 0 otherwise. The error term, ϵ_{et}, is clustered at the federal entity level to allow for autocorrelation of unobserved shocks within entities. Moreover, I weight each entity by the size of its population to obtain more accurate results.

In addition, I include entity specific trends in the second specification of the model to allow for a more flexible approach as shown in equation 2. θ_{0e} represent entity specific intercepts given that D_e takes the value of 1 for entity e and 0 otherwise.

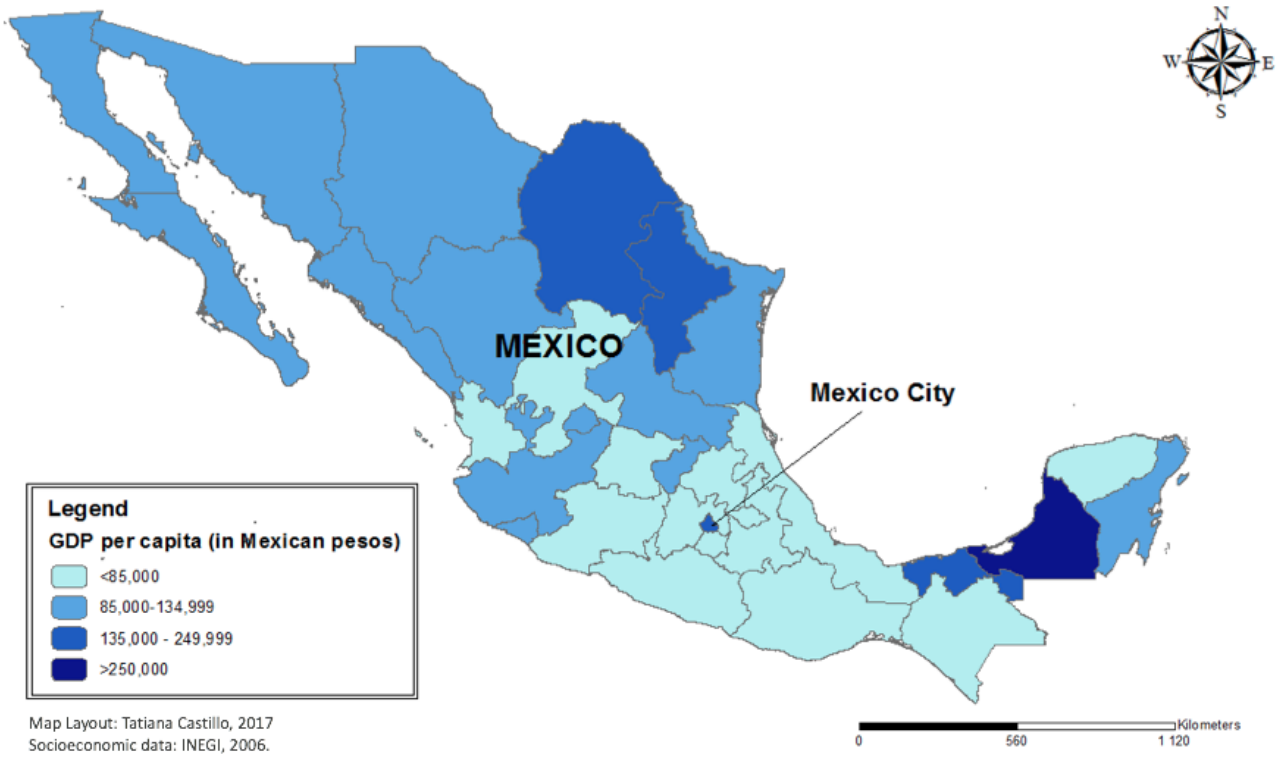
$$Y_{et} = \theta_{0e} D_e t + \beta \mathbf{X_{et}} + \delta DF + \lambda Post + \gamma(DF \times Post) + + \varepsilon_{et} \tag{2}$$

This is important given that the casual variable of interest might have omitted variables bias that come from unobserved state level variables that relate to both the policy change and the outcomes studied in this research. This implies that we need to control for unobserved state level variables to improve the accuracy of our results.

3.2 Synthetic Control Method

Mexico City has very distinct characteristics compared to the other entities in the country in terms of educational level, access to health facilities and the fact that it is urban whereas the entities in the control group are a combination of both rural and urban areas. As seen in Figure 3, Mexico City differs considerable from other states also in GDP per capita levels. To start, the Northern region is richer than the Southern Region and Mexico City does not have any close neighbouring entity with high income levels. On the contrary, the capital is surrounded by relatively poor entities and only 4 other entities in the country had GDP per capita levels similar to Mexico City in the period before the policy change.

Figure 3: Distribution of GDP per capita in Mexico in 2006



Given these characteristics, there is uncertainty about the ability of the control group to reproduce the counterfactual outcome that Mexico City would have experienced in the absence of abortion decriminalization. This is why I use the Synthetic Control Method (SCM) to generate a more adequate control group for which to compare Mexico City to. Under this methodology, I calculate a weighted average of the available control units so that they satisfy certain conditions that replicate the outcomes in Mexico City.

The main idea behind the SCM is that a combination of units is a more accurate comparison to a treated unit than one single unit alone or all the units altogether, because not all units truly represent the treatment group. According to Abadie et al. (2010), this methodology has two important advantages. The first is that, given the construction of the previously mentioned weighted average, the relative contribution of each control unit to the counterfactual of interest is know and made explicit. Secondly, the similarities and disparities between the treated and the untreated units are also shown specifically, both in terms of outcomes (pre and post treatment) and predictors. Moreover, "because the choice of a synthetic control does not require access to post-intervention outcomes, the synthetic control method allows researchers to decide on study design without knowing how those decisions will affect the conclusions of their studies"(Abadie et al., 2010, p.494).

The Synthetic Control Method constructs a Synthetic Control Group that most resembles the treatment group (in this case Mexico City) before the legalization of abortion. This group is created as a weighted average of all potential control states from the donor pool which in this case are the other 30 federal entities in the country. The independent variables used to generate these weights are entity level variables such as de natural logarithm of the GDP per capita, the average years of education and the Gini Coefficient. The weights for each entity are calculated as to minimize the mean squared prediction error of each dependent variable in Mexico City before the policy change. This imply that the Synthetic Control Group varies as the dependent variable changes and is not the same for all the outcomes of interest. I apply DID to the control group created under this methodology, which is a synthetic version of Mexico City, and compare the results to the ones found using DID alone.

4 Data

In this section I briefly describe each of the datasets, their source and their utility for this research. This research uses both individual level data and macroeconomic data at a federal entity level. I gathered information for the period between the 28th of October 2002 and the 27th of October 2012. The pre-treatment period covers births occurred between the 28th of October 2002 and the 27th of October 2007 whereas the post-treatment period goes from the 28th of October 2007 to the 27th of October 2012.

The choice of these periods can be explained by the fact that abortion services were offered in Mexico City from the 28th of April 2007 to women 12 weeks pregnant or less. This means that only women who became pregnant after January the 27th 2007 could undergo this procedure. Allowing for a standard pregnancy time of 9 months, this means that babies born after the 27th of October 2007 were the first newborns whose mother could have decided whether to abort or not.

4.1 Birth Records

I use individual level data from the Birth Records from the National Institute of Statistics and Geography (INEGI for its acronym in Spanish). This data is collected on a yearly basis from all live births registered by parents or guardians at the civil registry offices in the country. It contains information on the births as well as socio-economic information on mothers such as age, education and occupation. I collect the Birth Records from 2002 to 2012 and then kept the births that occurred between the 28th of October 2002 and the 27th of October 2012.

In order to maintain the quality of the data and avoid problems of under or double reporting I keep only data for children both born and registered during the analysed period. Moreover, I only use births that occurred in places with at least 100,000 inhabitants. This because as mentioned earlier, births occurred in small towns might not have the same characteristics as births occurred in big cities. In addition, the quality of birth records for towns might not be as good as the ones for bigger cities, which could bias our results. Only one of the 32 federal entities of the country (Tlaxcala) was excluded from the analysis due to this. As of 2015, approximately 98.9% of the population in the country lived in these 31 entities.

After cleaning the data, I was left with 12,322,088 live births occurring during the period under study of which approximately 49% took place in the pre-treatment period. The number of live births for each entity allowed me to calculate the Maternal Mortality Rate, the Infant Mortality Rate and the Under 5 Mortality Rate, all used as dependant variables in the study.

In Table 1 we can see that the percentage of pregnancies from adolescent mothers increased in both regions after the legalization of abortion. This however, does not mean that the number of adolescent pregnancies increased or that the adolescent pregnancy rate increased. On the other hand, a larger percentage of women had children while cohabiting with their partners in the post-intervention period. This is not surprising given that the importance of marriage as an institution has decreased even in very religious countries and couples have either postponed marriage or eliminated it altogether and decided on cohabitation instead. Also, we see that mothers have gotten more educated in the country. The average birth order has not significantly changed over the period. The variables

provided in Table 1 are used as entity-level covariates in this study.

Table 1: Descriptive Statistics of Births in Mexico

	Pre Treatment		**Post Treatment**	
	Mexico City	Rest of the country	Mexico City	Rest of the country
Characteristics of mothers				
Average age	26.57	25.71	26.47	25.53
	(6.2023)	(6.1852)	(6.4779)	(6.2799)
Percentage of adolescent pregnancies	13.99%	15.79%	15.81%	17.77%
	(0.0082)	(0.0190)	(0.0099)	(0.0176)
Marital Status*				
Single	10.38%	9.27%	11.24%	10.86%
	(0.0125)	(0.0400)	(0.0034)	(0.0517)
Married	46.40%	55.35%	34.55%	44.63%
	(0.0364)	(0.1138)	(0.0454)	(0.1133)
Cohabiting	42.45%	30.23%	53.71%	37.79%
	(0.0286)	(0.0972)	(0.0430)	(0.0886)
Separated or Divorced	0.15%	0.31%	0.26%	0.32%
	(0.0004)	(0.0021)	(0.0015)	(0.0016)
Widow	0.03%	0.07%	0.03%	0.09%
	(0.0001)	(0.0006)	(0.0000)	(0.0029)
Educational Attainment*				
Incomplete primary or less	2.25%	5.99%	1.95%	4.81%
	(0.0018)	(0.0249)	(0.0053)	(0.0266)
Primary	11.75%	19.82%	8.89%	15.79%
	(0.0058)	(0.0492)	(0.0044)	(0.0413)
Secondary	38.94%	35.38%	39.67%	35.93%
	(0.0129)	(0.0543)	(0.0160)	(0.531)
Preparatory School	27.33%	19.46%	29.65%	21.73%
	(0.0138)	(0.0423)	(0.0107)	(0.0399
Professional	17.27%	13.60%	19.40%	14.15%
	(0.0082)	(0.0415)	(0.0104)	(0.0358)
Contraceptive				
Women who know at least 1 method	98.64%	96%	98.81%	97.14%
	(0.0035)	(0.0344)	(0.0035)	(0.0329)
Women who use contraceptives	48.39%	43.57%	44.95%	43.12%
	(0.0532)	(0.0777)	(0.0657)	(0.0797)
Characteristics of births				
Average birth order	1.76	1.96	1.77	1.94
	(0.039)	(0.1413)	(0.0149)	(0.1182)
Birth type				
Singleton	98.19%	98.48%	98.64%	98.45%
	(0.0020)	(0.0034)	(0.0003)	(0.0049)
Twins	1.67%	1.46%	1.31%	1.44%
	(0.0014)	(0.0033)	(0.0002)	(0.0035)
Triplets or more	0.13%	0.05%	0.04%	0.09%
	(0.0008)	(0.0003)	(0.0000)	(0.0032)
Place of birth				
Clinic or hospital	98.08%	93.98%	99.43%	93.32%
	(0.012)	(0.075)	(0.0006)	(0.0733)
Total Births	**806,779**	**5,222,309**	**783,851**	**5,509,991**

* These percentages do not add up to 100% given that some birth registers did not have this information registered and was left as "unknown".

However, important differences remain between Mexico City and the rest of the country. To start, mothers are slightly younger on average in the rest of the country although this difference remains close to one year of age. In Mexico City more mothers are cohabiting with their parents and continue to reach higher levels of education. Nonetheless, the educational gap seems to be reducing and la lower percentage of mothers in the rest of the country have incomplete primary or less in the post-treatment period. The most important difference between these regions appears to be the percentage of mothers who gave birth in clinics or hospitals (instead of giving birth at home). At least 98% of mothers in Mexico City gave birth in clinics or hospitals throughout the period whereas approximately 6% or more births in the rest of the country occurred at home. Moreover, this gap does not appear to decrease in the post-treatment period.

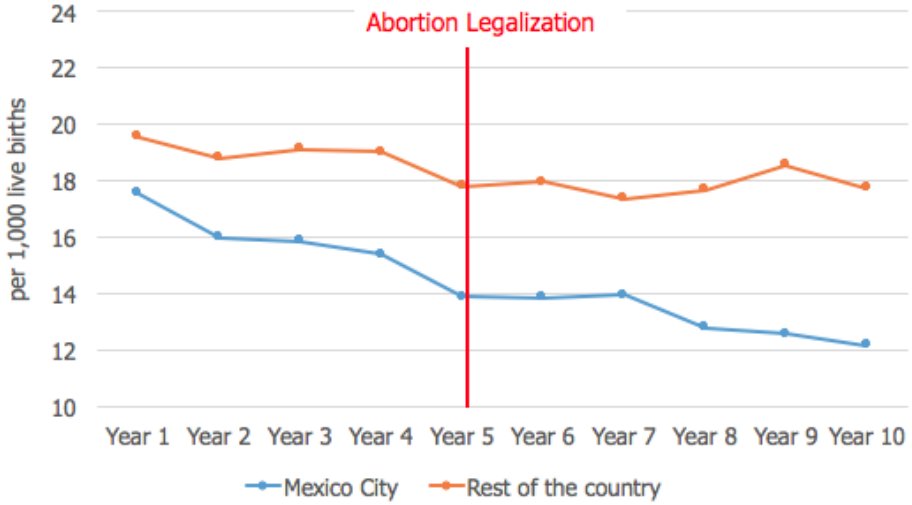
4.2 Death Records

INEGI collects individual level information on all deaths certificates in the country on a yearly basis in the Death Records dataset. I collected information an all deaths occurring in the period of study in order to estimate outcomes on both maternal and child health. To start, I use the cause of death stated on each certificate to calculate the Maternal Mortality Rate at an entity level and gather individual information on women who died while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy. During the pre-treatment period 5,031 deaths were registered as maternal deaths while 4,050 were registered as such during the post-treatment period in the 31 federal entities used in this study.

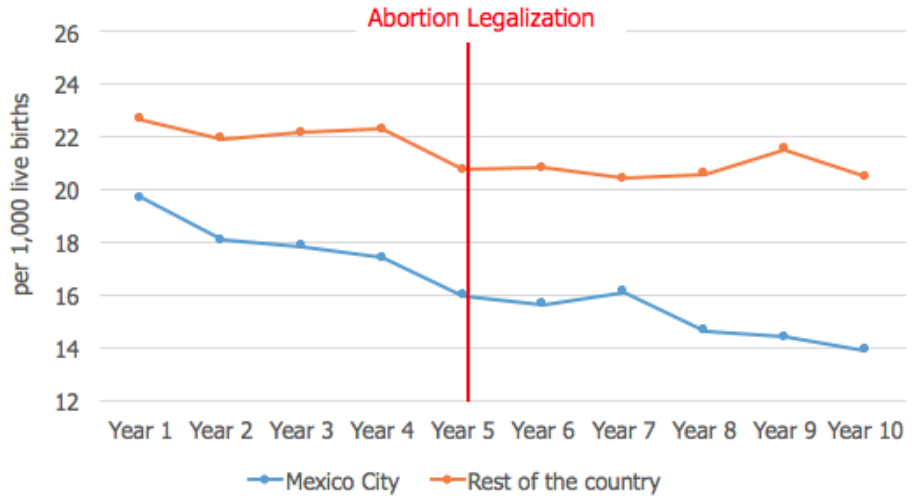
Additionally, this dataset allow me to collect the number of infant and under 5 deaths registered in the country. An infant death is defined as a child dying before completing the first year of age whereas an under 5 death is the death of a child aged less than 5 years. Between the 28th of October 2002 and the 27th of October 2012, 205,364 and 237,692 infant and under 5 deaths were registered in the country, respectively. In Figure 4 we can see the time evolution of Infant Mortality Rates, Under 5 Mortality Rates and Maternal Mortality Rates for both Mexico City and the rest of the country.

We can see that both the Infant Mortality Rate and the Under 5 Mortality Rate have evolved in a fairly similar way in both regions. Throughout the period, these rates are lower for Mexico City than for the rest of the country and this difference appears to be increasing over time. The similar evolution of both the Infant Mortality Rate and the Under 5 Mortality Rate in the pre-treatment period shown in Figures 4(a) and 4(b) lead us to believe that the parallel trend assumption holds for these indicators.

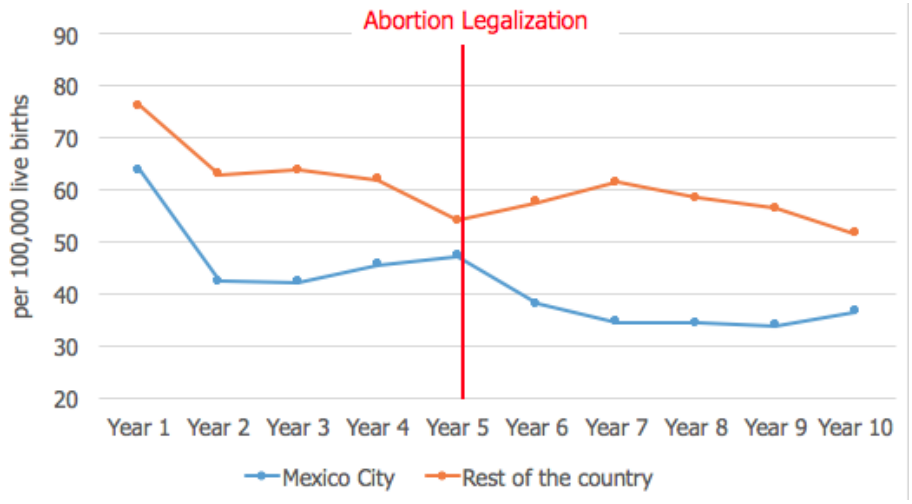
Figure 4: The evolution of Maternal and Child Mortality Rates in Mexico: 2002-2012



(a) Infant Mortality Rate



(b) Under 5 Mortality Rate



(c) Maternal Mortality Rate

This assumption is more difficult to suppose in the case of the Maternal Mortality Rate given that the difference in its evolution across regions is more noticeable. Up to

the third year the decreasing trend for Maternal Mortality appears to behave in a fairly similar way for both groups but in year 3, this indicator has a slight increase in Mexico City while it continues to decrease in the rest of the country. The generation of a Synthetic Control Group is of particular interest for this indicator. Nonetheless, it is important to highlight that the Maternal Mortality Rate in the rest of the country is slightly higher than the rate for Mexico City and this gap is maintained throughout the period.

4.3 ENADID

The National Survey of Population Dynamics (ENADID for its name in Spanish) is the fourth and last individual level dataset used in this study. It is collected by INEGI and CONAPO (the National Population Council of Mexico) and it is significant at a federal entity and national level. The purpose of this Survey is to enhance the statistical information related to the level and behaviour of the main components of population dynamics, such as fertility, mortality, migration and household dynamics. In addition, ENADID contains a section to be answered by women aged between 15 and 54 years of age.

This module gathers data on women's sexual and reproductive health, among which we find information on contraceptive knowledge and use. With information provided by this module, I estimate the percentage of women that both know how to use at least one contraceptive method, and the percentage of women that currently use contraceptives at an entity level for every year between 2002 and 2012. This in order to control for the increased availability and education on contraceptives that the abortion legalization program provided in Mexico City. I use information from the last 3 waves (2006, 2009 and 2014) and I am left with 64,261 observations after cleaning the data. The percentage of women who know about at least one contraceptive method and women who use contraceptives for both the pre and post-treatment period can be found in Table 1.

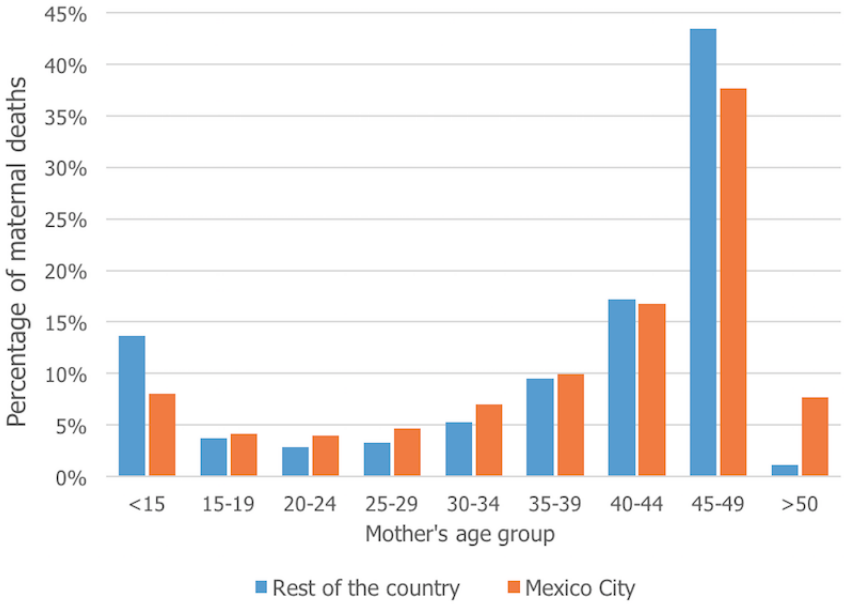
4.4 Dependent Variables

All the dependent variables that study child health (Infant Mortality Rate and Under 5 Mortality Rate) were calculated at a federal entity level by aggregating individual level data from birth and death certificates. Given that I use 31 of the 32 federal entities in Mexico and I gathered information for 10 years, this means that I use 310 observations to study the impact of abortion legalization on child health. On the other hand, I aggregated individual level data on maternal deaths by dividing mothers in 9 different age groups. This implies that the model that studies the effect of the policy change on maternal mortality uses a total of 2,790 observations (310×9).

Figure 5 shows the age distribution of maternal deaths occurred in Mexico City and in the rest of the country. This distribution resembles between the two regions with the only difference that a higher percentage of the maternal deaths in the rest of the country

occurred among adolescent mothers, specially those younger that 15 years, whereas in Mexico City a large percentage of these deaths occurred to mothers over 50 years of age. Moreover, we can see that for both regions the highest percentage of maternal deaths occurs to women aged between 45 and 49 years.

Figure 5: Age distribution of maternal deaths in 2006



Elaborated by the author using data from INEGI

4.5 Yearly Statistics and Geographic Report

The macroeconomic indicators used as covariates in this study were collected from the Yearly Statistics and Geographic Report generated by INEGI. This report offers information on main demographic and socio-economic characteristics disaggregated at an entity level. The range of covariates gathered from this source includes the percentage of population with access to clean water sources, average income, GINI coefficient, female participation rate and number of doctors per 1,000 people, all indicators per federal entity. These indicators are essential when studying health.

To start, lower mortality is associated with almost any positive indicator of socioeconomic status, a relationship that has been documented in the literature as "the gradient". Income is an important predictor of health given that low income can limit the access to medical care and medical insurance. Wealthier families can provide better medical care, more nutritious foods and safer environment for children. Moreover, these correlations are also attributed to the effects of education given that more educated people (specially more educated women) are better able to understand and use health information to benefit both themselves and their families. This is why I consider important to control for average income and the GINI at a federal entity level.

Additionally, I control for the percentage of the population with access to clean water and sanitation per entity given that the health consequences of lacking access to these

services are severe, specially for young children. Fink et al. (2011) find that access to improved sanitation was associated with lower mortality, lower risk of child diarrhoea and lower risk of stunting using surveys for 70 low and middle income countries between 1986 and 2007. Also, they associate access to improved water to lower risk of diarrhoea and lower risk of stunting.

As shown in Table 2, Mexico City is a considerable much richer region, more educated and with a higher percentage of the population with access to basic services than the average in the rest of the country. The number of doctors per 1,000 people is also significantly higher in Mexico City as well as the female participation rate.

Table 2: Socio-economic federal entity covariates

	Pre Treatment		**Post Treatment**	
	Mexico City	Rest of the country	Mexico City	Rest of the country
Average GDP per capita (in Mexican Pesos)	183,278 (2,585)	96,000 (11,234)	232,739 (9,531)	120,784 (12,086)
GINI Coefficient	0.496 (0.0135)	0.496 (0.0351)	0.491 (0.0317)	0.485 (0.0277)
Number of doctors per 1,000 people	2.71 (0.485)	1.33 (0.342)	3.25 (0.1751)	1.58 (0.3657)
Percentage of the population with access to clean water	98.36% (0.0083)	90.05% (0.0802)	98.16% (0.0039)	91.20% (0.0709)
Percentage of the population with access to sewage systems	98.78% (0.0053)	81.00% (0.1206)	99.12% (0.0024)	88.00% (0.0776)
Average years of education	10.14 (0.1516)	8.00 (0.819)	10.58 (0.1303)	8.54 (0.8546)
Female Participation Rate	44.56% (0.0314)	38.85% (0.0528)	48.99% (0.0168)	42.48% (0.0476)

Moreover, as shown in Figure 6 we can see that the disparities across the country are important when it comes to educational levels. The population in the Southern Region appears to have completed less years of education on average than the population in the Northern Region in 2006. Nonetheless, Mexico City appears to be surrounded by neighbouring entities with relatively high educational levels.

Figure 6: Years of education by federal entity, 2006

In this section I have described the four different data sources used to complete this research. The Infant Mortality Rate and the Under 5 Mortality Rate, both used as dependent variables in this paper, are calculated at an entity level using data from the Birth Records and Death Records provided by INEGI. The Maternal Mortality Rate is aggregated by age group of the mother at an entity level using data from both Death and Birth Records. Additionally, I use the National Survey of Population Dynamics, which contains information on usage and knowledge of contraceptive methods and socio-economic data at a federal entity level provided by the Yearly Statistics and Geographic Reports.

5 Results

This section discusses the results found using the Difference-In-Differences methodology. Also, I examine the results for the test of the parallel which provides information about the validity of the parallel trend assumption. The first subsection studies the results for both the Infant Mortality Rate and the Under 5 Mortality Rate. The second subsection analyses the effect on the Maternal Mortality Rate.

5.1 Infant Mortality Rate and Under 5 Mortality Rate

As shown in Table 3 the effect of the policy change on Infant Mortality Rate in Mexico City is negative and significant in two of the specifications at a 10% level and in the other

two at a 1% level. The impact ranges from -2.314 (column (3)) to -4.237 (column (4)). This signifies that the decriminalization of abortion in Mexico City reduced the Infant Mortality Rate between 2.3 and 4.3 deaths per 1,000 live births. It is particularly important to highlight that only when I control for time varying entity level controls such as average GDP per capita (in natural logarithm), average mother's education and female participation rate is the significance of the DID coefficient at its highest. This implies that this coefficient is not capturing the effect that these covariates might have on Infant Mortality, nor entity effects (as specification (4) controls for entity Fixed Effects), but the real impact of abortion legalization on this health indicator.

Moreover, the effects of the intervention on the Under 5 Mortality Rate are quite similar (Table 4), except for being slightly higher. According to these findings, the effect of this intervention on Under 5 Mortality Rate ranges between 2.4 and 4.4 less deaths per 1,000 live births. For both indicators I find that including time varying controls increases the significance of the results. As for the Infant Mortality Rate, we can see that the coefficient for the DID estimate is highest in the fourth specification, which includes both entity Fixed Effects and time varying controls.

Table 3: The effect of abortion legalization on Infant Mortality Rate

	(1)	(2)	(3)	(4)
VARIABLES	infant_mortality	infant_mortality	infant_mortality	infant_mortality
Mexico City	-3.702***	0.454	-2.718	-13.33
	(1.332)	(5.524)	(2.244)	(9.053)
Post Treatment	-0.340	1.597	-0.357	1.696
	(1.153)	(1.407)	(1.184)	(1.058)
DID effect	-2.330*	-2.689***	-2.314*	-4.237***
	(1.153)	(0.797)	(1.184)	(1.312)
Constant	19.46***	99.21***	18.47***	76.59*
	(1.332)	(29.97)	(2.244)	(39.63)
Time varying entity level controls	No	Yes	No	Yes
Federal entity Fixed Effects	No	No	Yes	Yes
Observations	**310**	**310**	**310**	**310**
R-squared	0.027	0.222	0.319	0.460

Robust p-value in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4: The effect of abortion legalization on Under 5 Mortality Rate

VARIABLES	(1) under5_mortality	(2) under5_mortality	(3) under5_mortality	(4) under5_mortality
Mexico City	-4.795***	0.00258	-3.569	-15.37
	(0.00343)	(1.000)	(0.168)	(0.146)
Post Treatment	-0.437	1.845	-0.458	1.811
	(0.743)	(0.260)	(0.738)	(0.141)
DID effect	-2.413*	-2.797***	-2.392*	-4.457***
	(0.0778)	(0.00362)	(0.0881)	(0.00451)
Constant	22.61***	117.7***	21.38***	93.16**
	(0)	(0.00161)	(1.89e-09)	(0.0477)
Time varying entity level controls	No	Yes	No	Yes
Federal entity Fixed Effects	No	No	Yes	Yes
Observations	**310**	**310**	**310**	**310**
R-squared	0.031	0.237	0.333	0.471

Robust p-value in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Additionally, I created six simulated reforms to perform DID simulations, each one occurring in a simulated year (year 2, year 3, year 4, year 6, year 7 and year 8). These simulations allow me to test the validity of the Difference-In-Differences strategy by examining the parallel trend assumption. These tests are done by interacting a dummy variable of Mexico City with the years preceding and posterior to the reform (3 years in each case) and including these new variables as explanatory variables in the original model. The specification used for these tests follow equation (2) precisely and include federal entity Fixed Effects, standard errors clustered at an entity level and macroeconomic covariates. However, I do not include the DID coefficient for the year in which the policy change was really implemented (year 5) given that the effect on health outcomes should begin after that year. If the DID estimate of these reforms is statistically different from 0, there trends are not parallel and the original Difference-In-Differences estimates is likely to be biased. Figures 7 and 8 show the point estimate and the 95% confidence interval of these estimates for both the Infant Mortality Rate and the Under 5 Mortality Rate, respectively.

Figure 7: Event study DID estimate of simulated reforms for the Infant Mortality Rate

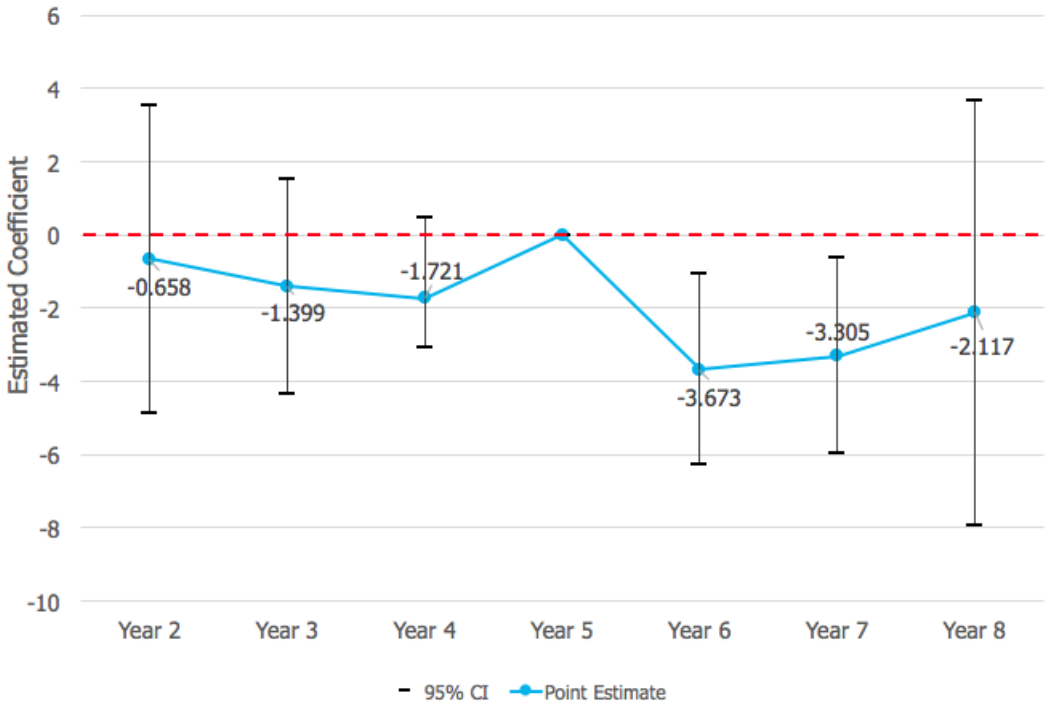
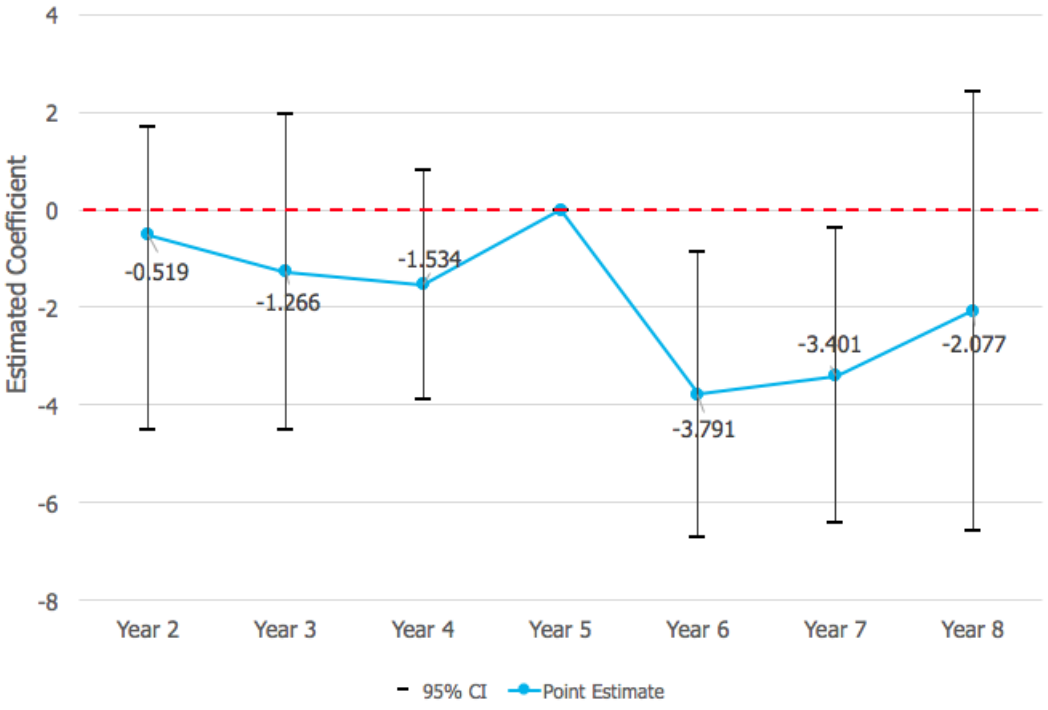


Figure 8: Event study DID estimate of simulated reforms for the Under 5 Mortality Rate



As seen in these figures, the coefficient for the lags of the intervention are not significant. These findings support the parallel trend assumption needed to provide unbiased results of the DID coefficients. On the other hand, we can see that the estimates for the years following the intervention are not statistically equal to 0. This is not very surprising given that we expect abortion legalization to have a long impact in reducing child mortality rates. Nonetheless, this impact seems to be reducing in time which is to be expected.

5.2 Maternal Mortality Rate

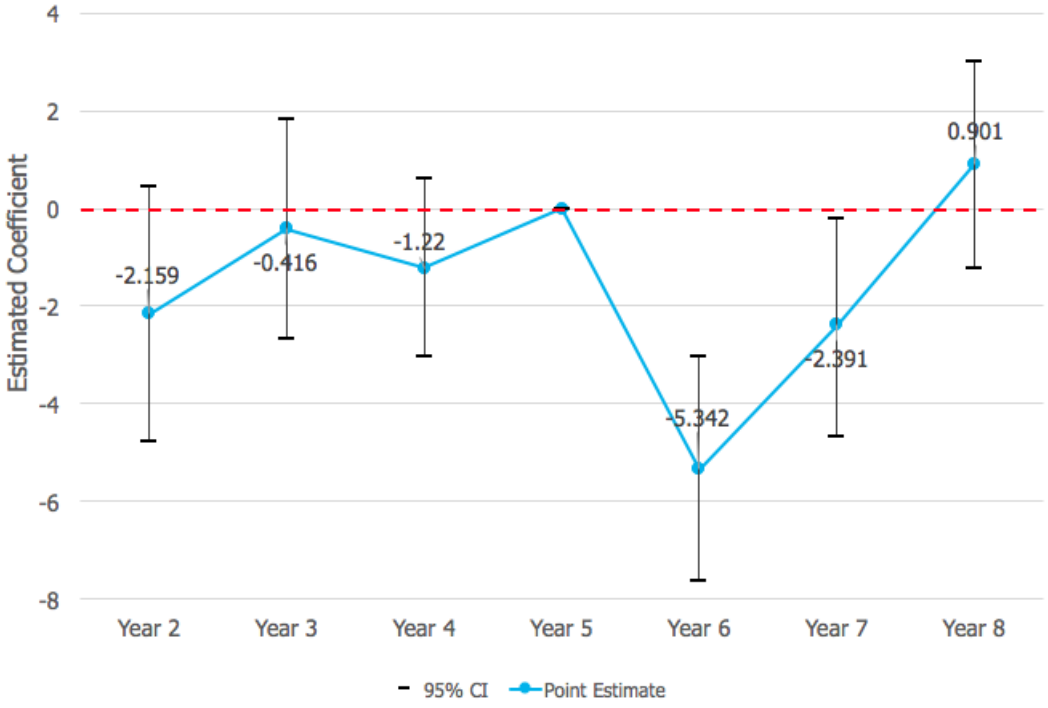
For the case of the Maternal Mortality Rate, we can see in Table 5 that the estimates of the effect of abortion legalization are significant at a 1% level under all the specifications. According to these results, the policy change decreased the Maternal Mortality Rate between 5.5 and 6.07 maternal deaths per 100,000 live births in Mexico City. Moreover, these results are convincing given that the test of the parallel trend assumption show that the DID estimates for the lags of the intervention are not significant, whereas the leads are. This implies that the parallel trend assumption holds and that the DID estimates for abortion legalization are likely to be unbiased.

Table 5: The effect of abortion legalization on the Maternal Mortality Rate

	(1)	(2)	(3)	(4)
VARIABLES	maternal_rate	maternal_ratea	maternal_rate	maternal_rate
Mexico City	-15.49***	-7.856***	-15.49***	1.513
	(0)	(1.26e-05)	(0)	(0.585)
Post Treatment	-6.720***	-2.774***	-6.719***	0.0151
	(0)	(0.000630)	(0)	(0.991)
DID effect	-6.076***	-5.740***	-6.077***	-5.494***
	(0)	(0)	(0)	(2.70e-06)
Constant	63.78***	92.82***	63.78***	102.2***
	(0)	(9.06e-07)	(0)	(0.000411)
Time varying entity level controls	No	Yes	No	Yes
Federal entity Fixed Effects	No	No	Yes	Yes
Observations	**2,790**	**2,790**	**2,790**	**2,790**
R-squared	0.558	0.654	0.558	0.719

Robust p-value in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Figure 9: Event study DID estimate of simulated reforms for the Maternal Mortality Rate



In this section I have presented the results from the research. It appears that the change in the abortion legislation in Mexico City has had a negative and significant effect on the Infant Mortality Rate, the Under 5 Mortality Rate and the Maternal Mortality Rate. Most importantly, the results of the parallel trend assumption test that used the lags and leads of the policy change as the year of the intervention show that the parallel trend assumption holds in all cases.

6 Robustness checks

In addition to performing DID for each outcome of interest, I perform two robustness checks. The first extends the treatment group and includes the neighbouring state of Mexico in addition to Mexico City. For the second, I use the Synthetic Control Method to create a more accurate control group that respects more correctly the parallel trend assumption. These robustness checks will allow me to validate the results found in the previous section.

6.1 Mexico State as the treatment group

According to the Information Group on Reproductive Choice (GIRE for its acronym in Spanish), 71.1% of women who have had an abortion performed in Mexico City since its legalization come from Mexico City. However, 25.2% of the women come from the state of Mexico. Given the high percentage of women coming from the neighbouring state of Mexico, I believe it is important to calculate the effect that this intervention has had on this region. In order to do this, I apply the Difference-In-Differences methodology

expanding the treatment group to include the state of Mexico. This allows me to account for the externalities that this policy change may have created in the neighbouring region.

Table 6: The effect of abortion legalization in the state of Mexico

	Mexico City			Mexico State		
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	infant_mortality	under5_mortality	maternal_mortality	infant_mortality	under5_mortality	maternal_mortality
Mexico City	-13.33	-15.37	1.513			
	(0.151)	(0.146)	(0.585)			
Post Treatment	1.696	1.811	0.0151	2.395**	2.557*	0.0230
	(0.119)	(0.141)	(0.991)	(0.0467)	(0.0584)	(0.986)
DID effect	-4.237***	-4.457***	-5.494***			
	(0.00301)	(0.00451)	(2.70e-06)			
Mexico City and State				1.119	0.801	-0.818
				(0.724)	(0.822)	(0.590)
DID effect				1.295	1.725	-2.459
				(0.441)	(0.352)	(0.208)
Constant	76.59*	93.16**	102.2***	127.9***	150.1***	106.9***
	(0.0628)	(0.0477)	(0.000411)	(0.00705)	(0.00531)	(0.000109)
Time varying entity level controls	Yes	Yes	Yes	Yes	Yes	Yes
Federal entity Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	**310**	**310**	**2,790**	**310**	**310**	**2,790**
R-squared	0.460	0.471	0.719	0.394	0.409	0.714

Robust p-value in parentheses
*** p<0.01, ** p<0.05, * p<0.1

As seen in Table 6, none of the health indicators in the state of Mexico were significantly affected by the intervention. Even though a large number of women from the neighbouring state got abortions in the Federal District of Mexico (approximately 43,000), the chosen child and maternal health indicators were not influenced by it. This can be explained by the fact that the state of Mexico has 14% of the population of the county, and even though the number of women who got an abortion might seem large enough to produce a change, it is in fact a very small percentage of the women of reproductive age.

Furthermore, these results are important to illustrate that the effect found in the previous section corresponds to the true effect that this policy change has had on Mexico City and that these were not produced by chance.

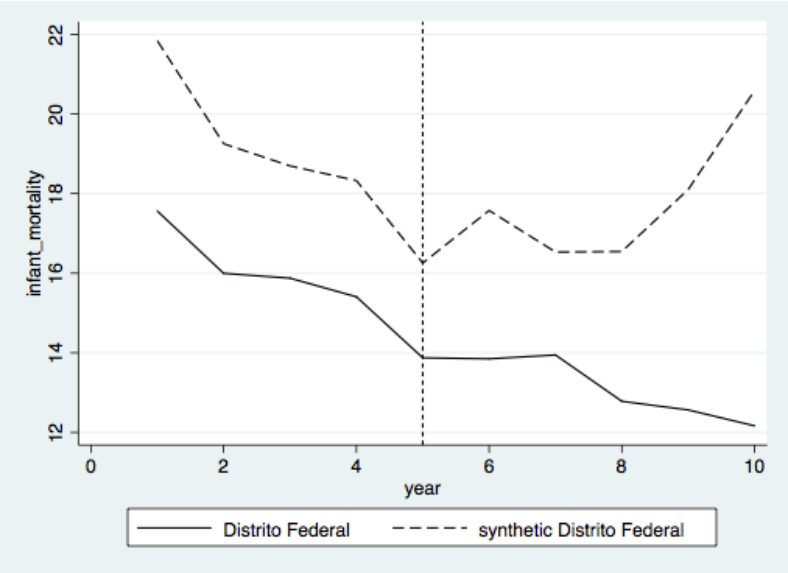
6.2 Synthetic Control Method

As previously explained, Mexico City has very distinctive characteristics that make it hard to compare it with all other regions in the country. In order to create a more precise control group, which has similar characteristics in terms of the outcomes to Mexico City, I use the Synthetic Control Method. This methodology allows to reproduce a more accurate counterfactual outcome that Mexico City would have experienced in the absence of abortion decriminalization. This section shows the results for these methodology for all outcomes. Nonetheless, we give special importance to the Maternal Mortality Rate given that the graphical analysis previously undertaken did not assure us that the parallel trend assumption held for this outcome.

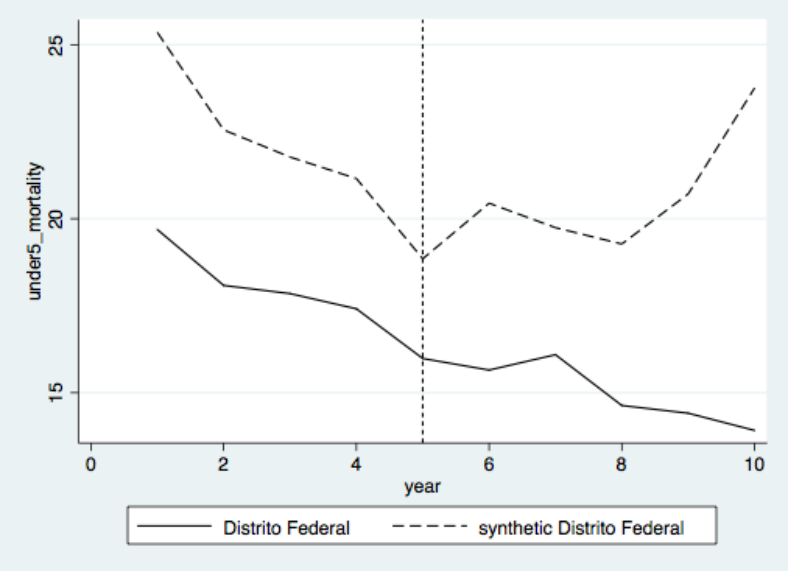
Figure 10 shows that with the Synthetic Control Method I was able to create a control group that has parallel trends with Mexico City in the period before the legalization of abortion for every outcome variable. The weights for every entity used to create each Synthetic Control Group (remember that I need one group for every outcome of interest) are presented in Appendix A.

Given that now we can be sure that the parallel trend assumption holds, I perform a DID including time varying entity level controls and Fixed Effects by federal entity using the weights calculated under the SCM. The results of these regressions can be found in Table 7. To start, these results show that the intervention has reduced, on average, the Infant Mortality Rate for Mexico City by 1.59 deaths per 1,000 live births, significant at a 10% level. Also, it has reduced Under 5 Mortality Rates by 1.79 deaths per 1,000 live births at the same significance level. This reduction is in line with the results found previously, although in this case we have an increase of the significance level from 1% to 10%. This implies that using the SCM, the effect of abortion decriminalization is somewhat smaller and less significant for both Infant and Under 5 Mortality Rates.

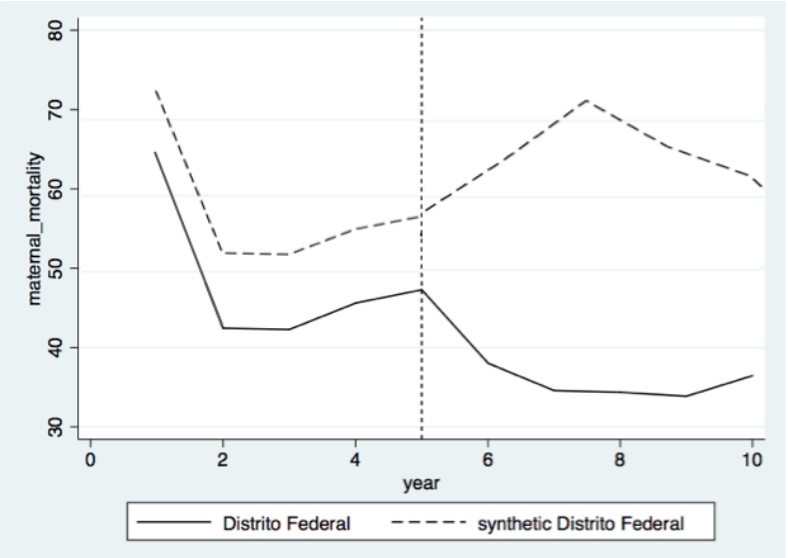
Figure 10: Evolution of the outcomes of interest for the Synthetic Control Groups



(a) Infant Mortality Rate for the Synthetic Control Group



(b) Under 5 Mortality Rate for the Synthetic Control Group



(c) Maternal Mortality Rate for the Synthetic Control Group

Moreover, the use of the Synthetic Control Method confirms the results found for the Maternal Mortality Rate. In this case, not only is the coefficient of the DID effect larger than the one found previously but the significance level of 1% is maintained. According to these results, the legalization of abortion in Mexico City reduced the Maternal Mortality Rate by 6.25 deaths per 100,000 live births. Given that Clarke and Mühlrad (2016b) found that the policy reduced maternal deaths by 8.8% to 16.2% for women aged between 15 and 44 years, and our results are in line with these findings, we believe the use of the DID methodology with the SCM was successful in truly representing the effect of abortion legalization on maternal mortality.

Table 7: DID using the Synthetic Control Group

	(1)	(2)	(3)
VARIABLES	infant_mortality	under5_mortality	maternal_mortality
Mexico City	-4.062	-4.899	1.189
	(0.498)	(0.472)	(0.617)
Post Treatment	-0.174	-0.166	1.661
	(0.817)	(0.862)	(0.111)
DID effect	-1.597*	-1.796*	-6.255***
	(0.0774)	(0.0908)	(6.29e-07)
Constant	160.0***	184.2***	130.9***
	(0.000516)	(0.000526)	(0.00694)
Time varying entity level controls	Yes	Yes	Yes
Federal entity Fixed Effects	Yes	Yes	Yes
Observations	**310**	**310**	**2,790**
R-squared	0.580	0.605	0.867

Robust p-value in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Discussion

In 2007, Mexico City legalized abortion in the first 12 weeks of pregnancy. By doing so, it became the first and only state in Mexico where abortion on demand is legal. This policy change is important not only because it represents a major institutional step in a region characterised by its deep catholic rules, but also because it can have considerable consequences for the health outcomes of the population. To start, by providing legal, free and safe abortions, this intervention may reduce maternal mortality. On the other hand, by reducing the number of unplanned pregnancies and increasing the investments that parents make on each child, children health outcomes are likely to improve. Moreover, abortion allows women to delay their pregnancies and increase their educational attainment and work experience in the process. This raises children's outcomes not only because children would be born to families with higher incomes but also because maternal education is essential in determining child health.

Given that children and pregnant women are among the most vulnerable population, and their health levels are a good indicator of the living standards of a country, I decided to study the impact of abortion decriminalization on both child and maternal health. Moreover, health outcomes in early life have been found to be a good predictor of later life outcomes such as employment and income which makes this research a valuable contribution to the continued development of the country. I specifically focus on the the impact that the change in the abortion legislation in Mexico City had on Infant Mortality Rates, Under 5 Mortality Rates and Maternal Mortality Rates in the period between 2002 and 2012.

In order to isolate the effect on the outcomes of interest caused by the policy change I perform a Difference-In-Differences methodology. This methodology compares changes in outcomes in the treatment group (in this case Mexico City) before and after the policy change, to changes in outcomes in the control group (the rest of the country) in the same period. Using information on all births and deaths that occurred and were registered between 2002 and 2012, I am able to calculate the three dependent variables at an entity level. These datasets, made available by INEGI, also include important socio-economic information which allow me to create state averages in order to control for characteristics of the mothers at an entity level. Moreover, I use data at a federal entity level provided by the Yearly Statistics and Geographic Reports to control for the socio-economic environment of each entity. It is important to highlight that, to avoid biasing my results due to the fact that Mexico City is an urban area and the rest of the country is divided in both rural and urban regions, I use only information from births and deaths that occurred in cities with more than 100,000 inhabitants. This implies that the state of Tlaxcala is excluded from this study.

According to my results, it appears that the change in the abortion legislation in Mexico City has reduced the Infant Mortality Rate between 2.31 and 4.23 deaths per 1,000 live births, results that are significant at a 10% and 1% level, respectively. The impact on the Under 5 Mortality Rate is fairly similar, ranging from -2.39 to -4.45 deaths per 1,000 live births (at the same significance levels). However, the Maternal Mortality Rate appears to be the most affected by this policy change with estimations ranging from -5.49 to -6 deaths per 100,000 live births, significant a 1% level. Most importantly, the results of the tests show that the parallel trend assumption holds in all cases which implies that the DID methodology can be used without fear of generating biases. Moreover, these results are validated by the use of a more accurate control group generated by the Synthetic Control Method.

These results are in line with the findings from previous research such as the ones estimated by Clarke and Mühlrad (2016b) who found that the policy change reduced maternal deaths by 8.8% to 16.2% for women aged between 15 and 44 years.

To the best of my knowledge, this if the first paper that attempts to examine the effects of abortion legalization in Mexico City on child health. So far, researchers have focused on estimating the impact of this policy change on fertility rates and maternal mortality, neglecting the important consequences for child health that this intervention may have caused. Moreover, this research is relevant to develop more precise policies and to better understand the obstacles that remain in Mexico and in developing countries to reduce infant and maternal mortality. This is of special importance in the context of the Sustainable Development Goals, given that Goal 3 focuses on reducing child and maternal mortality, as well as the spread of communicable diseases such as Tuberculosis and HIV/AIDS. The natural experiment provided by the legalization of abortion in Mexico City shows that one way to reduce child and maternal mortality rates and achieve Goal 3 is trough the legalization of abortion.

Nonetheless, this study presents a number of limitations that might be addressed in future research. To start, by studying the effects of abortion legalization on maternal and infant health at an entity level, I do not address the individual characteristics that might influence these issues. Given that the National Institute of Geography and Statistics has information on all births occurred in the country since the 1990s, which includes socio-economic information on the mothers and fathers of each birth, it would be interesting to include this dimension in a subsequent research. This because aggregate data may hide internal inequalities and it would be interesting to assess whether the effect of abortion decriminalisation has been homogeneous across all socio-economic groups or if it has had a larger impact on richer or poorer women and children.

Also, I consider relevant to analyse the long term impact of this policy change. This is why it would be interesting to estimate the effect of this intervention on the educational, labor and income outcomes of children born after the policy change after a relevant number of years has passed.

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Appendix

Appendix A: Weights given to each entity according to Synthetic Control Method for each outcome variable

Federal Entity	Infant Mortality Rate	Under 5 Mortality Rate	Maternal Mortality Rate
Aguascalientes	0.019	0.013	0.025
Baja California	0.01	0.011	0.027
Baja California Sur	0.222	0.239	0.027
Campeche	0.379	0.378	0.389
Coahuila	0.029	0.025	0.033
Colima	0.013	0.013	0.023
Chiapas	0.008	0.07	0.008
Chihuaua	0.025	0.024	0.026
Durango	0.015	0.015	0.021
Guanajuato	0.014	0.014	0.019
Guerrero	0.009	0.008	0.01
Hidalgo	0.006	0.006	0.014
Jalisco	0.015	0.015	0.024
México	0.015	0.013	0.015
Michoacán	0.015	0.014	0.013
Morelos	0.008	0.009	0.017
Nayarit	0.006	0.006	0.014
Nuevo León	0.036	0.035	0.044
Oaxaca	0.007	0.006	0.008
Puebla	0.006	0.006	0.014
Querétaro	0.011	0.012	0.027
Quinatan Roo	0.029	0.028	0.033
San Luis Potosí	0.013	0.013	0.018
Sinaloa	0.01	0.01	0.019
Sonora	0.009	0.009	0.026
Tabasco	0.017	0.018	0.033
Tamaulipas	0.015	0.015	0.029
Veracruz	0.011	0.011	0.014
Yucatán	0.025	0.023	0.018
Zacatecas	0.006	0.006	0.011