Distance to Abortion Facilities and Child Living Conditions-Implication of the Abortion Law Change in the United States

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Abstract

This paper aims to study the effect of distance to abortion facilities on the birth rate, abortion ratio and pregnancy rate in the United States. It will further extend the effect of the change in birth statistics on child living conditions, measured by adjusted family income and the percentage of children living below the poverty line in a state. It will correspond to the amendment of the abortion law in the United States in 2022. Our results suggest that an increase in the distance to abortion facilities will reduce the birth rate, abortion ratio and pregnancy rate. However, for the living circumstances, the significant positive effect was shown only in the black children group and the general group when the distance increased. In the non-black children group, the effects were only marginally significant or not significant on their living conditions. The results may also imply different reasons for abortions among different races.

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1 Introduction

1.1 Background

After the Roe v. Wade in 1973, the United States court ruled that pregnant women were legally allowed abortions under certain rules in all states. In June 2022, the Supreme Court overturned this ruling, and the states are authorized to decide on the legalization of abortion. Some of the states are subjected to a trigger law, wherein once the Roe V. Wade is overturned, abortion will become illegal to a different extent(Nash & Guarnieri,2022). Figure 1.1 shows the legalization of abortion in different states up to December 2022(Nash & Ephross, 2022). In this way, the distribution of abortion facilities in the United States will have a tremendous change, and it will also affect the pattern of pregnancy, abortion and birth. The child's living circumstances may change correspondingly. In order to capture the effect of the change in the distribution of facilities in the United States, we will study the relationship between the distance to abortion facilities and birth statistics, and examine the result on the child's family financial situation. However, researches that studied the effect of abortion legalization focused on the the Roe v. Wade case in 1973. To understand what will possibly happen after the overturned ruling, we should update people's responses to the increase in abortion cost first.

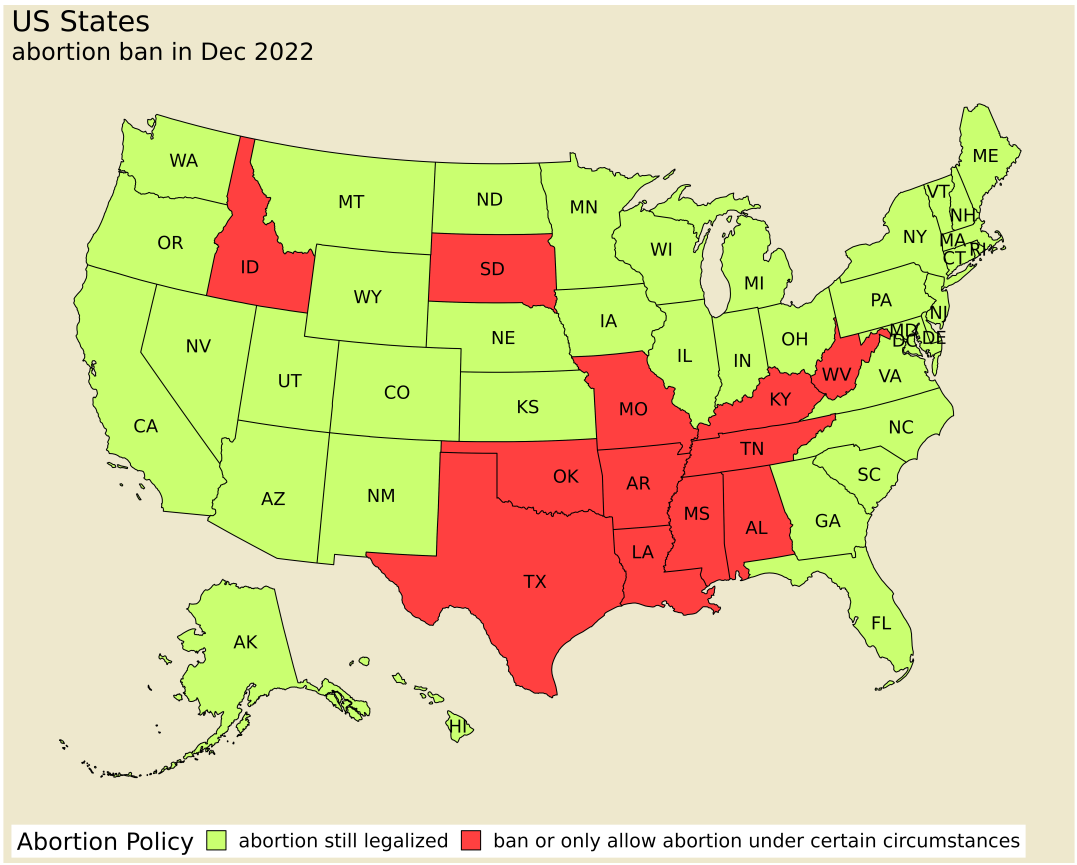


Figure 1.1: States that have Banned Abortion (December 2020)

1.2 Research Goal

Our research goal is to use distance to abortion facilities as an indicator of abortion cost to predict how people will respond to increasing abortion costs and further extend the result to the implication of abortion ban. The research questions are as follows: How will the increase in the distance to abortion facilities affect the birth rate, abortion ratio and pregnancy rate? How will this further affect the child's living circumstances by race, in terms of poverty and family income? What is the implication of this result to future births and the child's living circumstances after 2022?

1.3 Trend

Figure 1.2 shows the trend of birth statistics in the United States from 2009 to 2020. The states are separated into two groups: One is the states that banned abortion in December 2022, and another group is the states wherein abortion is still legalized. In general, states that ban abortion have higher birth rates but lower abortion ratios and pregnancy rates throughout the years investigated. It implies that even before the abortion ban, there were some differences in characteristics, such as religion and political stance, of these states that affect their pregnancy and abortion decisions. All of the variables show a decreasing trend.

The two figures below show the general situation of abortion access in the United States. Figure 1.3 shows the average distance to the closest abortion facilities in miles. States that banned abortion in December 2022 had an increasing distance to abortion facilities from 2013. It may be related to fewer abortion facilities caused by stricter abortion regulations, such as parental involvement and physician requirements (Guttmacher Institute, 2023). As for the other group, the average distance

remained at a lower level. Figure 1.4 shows the distribution of abortion facilities and the percentage of women with no facilities in their county of residence in 2009, 2020 and 2022. States wherein abortion was still legalized in December 2022 had greater density of abortion facilities, while some states which banned abortion in 2022 had reduced the number of abortion facilities in 2020 as compared to comparing 2009. Some of the states, such as Missouri (MO) and Texas (TX) , also showed an increase in the percentage of women living without any abortion facility.

The figures below illustrate the change in accessibility to abortion facilities in terms of distance after December 2022. Figure 1.5 and Figure 1.6 show the difference in the average distance to the closest abortion facilities within and outside the state in December 2022 compared to June 2020. For within-state abortion facilities, except for states that banned abortion, the change before and after the abortion ban was small, and the maximum change was only 30 miles. However, for facilities outside the state, the range of change was larger and was up to more than 400 miles. States, such as Texas (TX), Louisiana (LA), Mississippi (MS) and Arkansas (AR), were further away from the facilities because they were not surrounded by states that have abortion legalized; the opposite was true for the rest of the states that ban abortion. Therefore, for states that initially only had a few facilities and were at the same time surrounded by states that did not ban abortion, such as Missouri (MO) and Kentucky (KY), were unlikely to be greatly affected due to relatively easy access to abortion facilities even after the abortion ban.

Figure 1.7 shows the situation of cross-state abortion in 2011 and 2020. The local abortion proportion data are collected from additional data sets of the abortion surveillance reports of 2011 and 2020 (Pazol et al.,2014)(Kortsmit et al., 2022), named “Abortions Distributed by Area of Residence”,

which is provided by the CDC's Abortion Surveillance System. The local abortion proportion is calculated as the number of residents' abortions conducted in their states of residence divided by the total number of abortions by residence. States that have a percentage of local abortion lower than 0.75 were states that had fewer abortion facilities proportions, and most of them were the states that banned abortion in December 2022. The proportion of local abortions in some of these states showed a decrease from 2011 to 2020 to lower than 50 %. In general, staying in people's states of residence to conduct abortion was still a majority, and most of the states had proportions of local abortions greater than 75 %. However, when the states banned abortion, it is foreseeable that there would be more cross-state abortions.

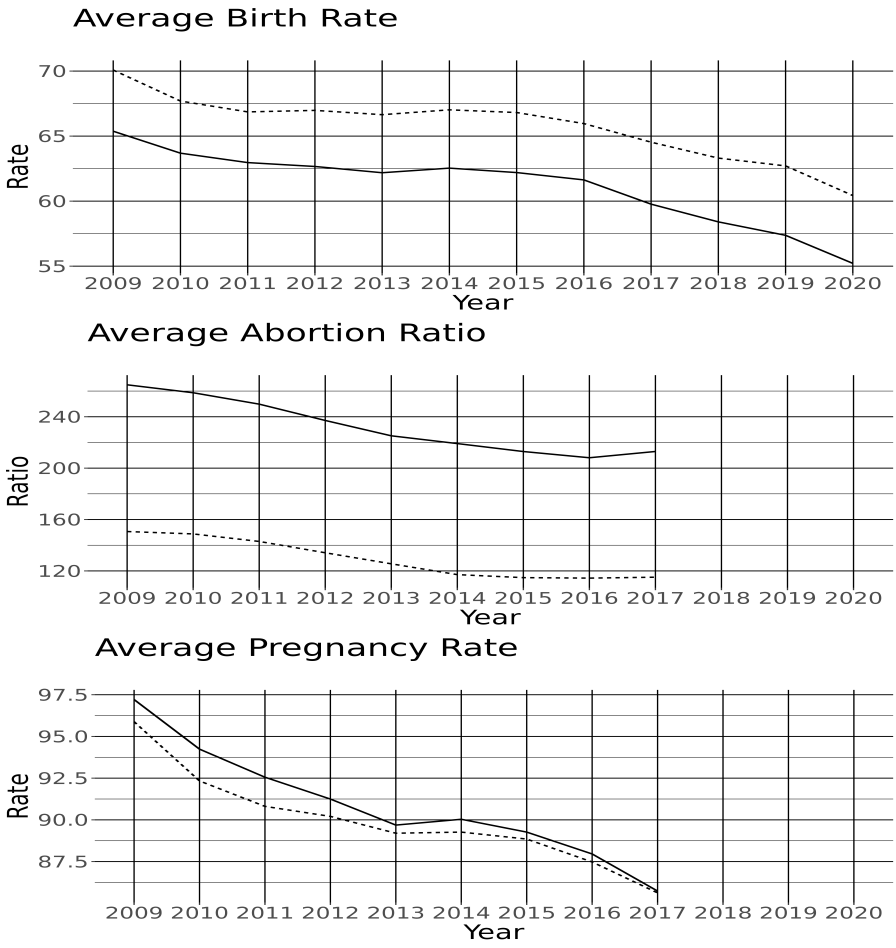
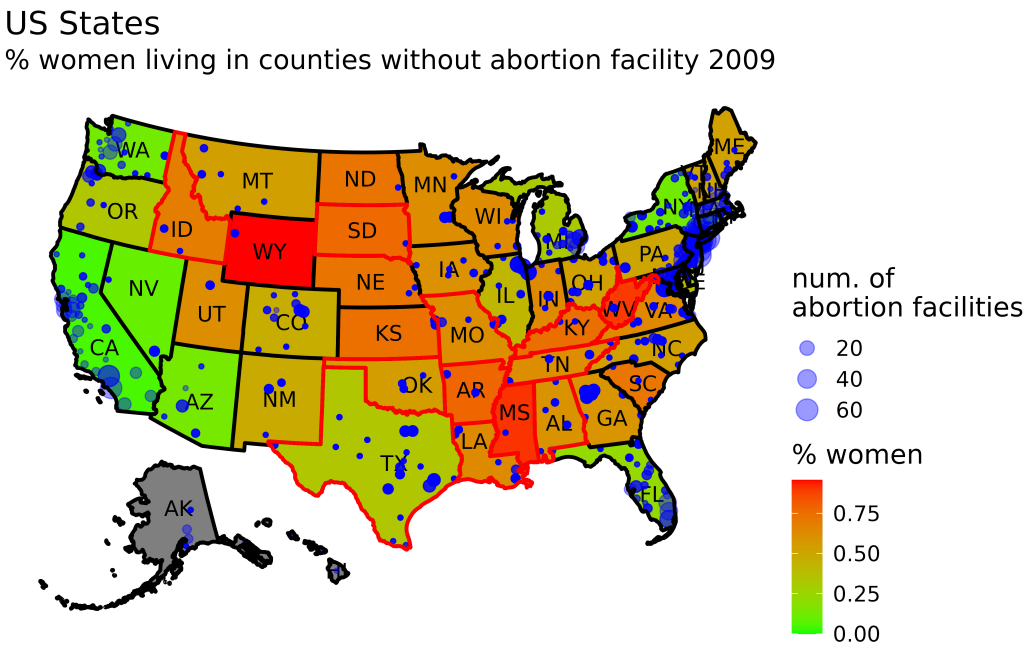
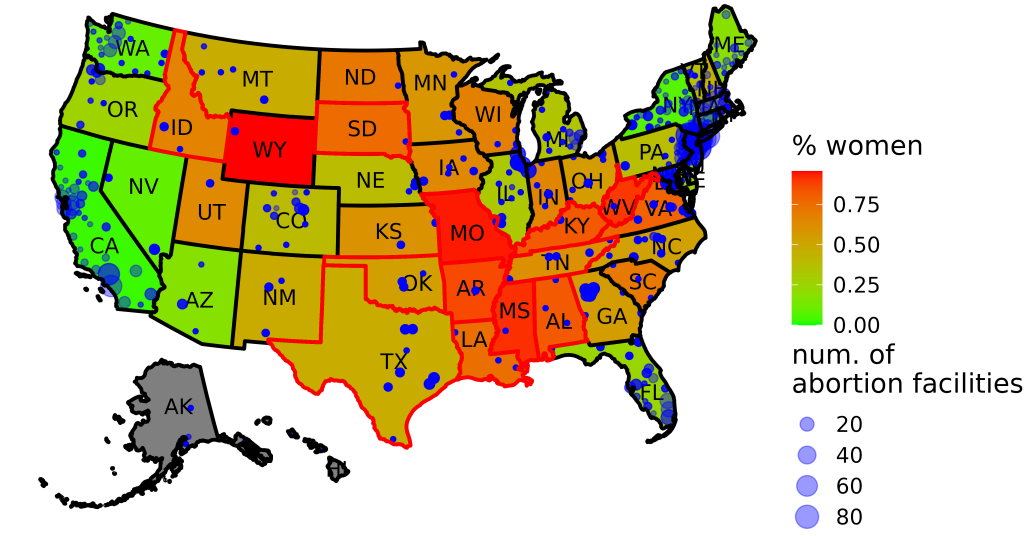


Figure 1.2: Birth Rate, Abortion Ratio and Pregnancy Rate

Note: Birth rate is calculated as the number of births per 1000 females aged 15-44; abortion ratio is calculated as the number of abortions per 1000 births, and pregnancy rate is calculated as the number of all pregnancies per 1000 females aged 15-44.

Figure 1.3: Average Distance to the Closest Abortion Facilities





Note: The states that have red borders are the states that banned abortion in Dec 2022

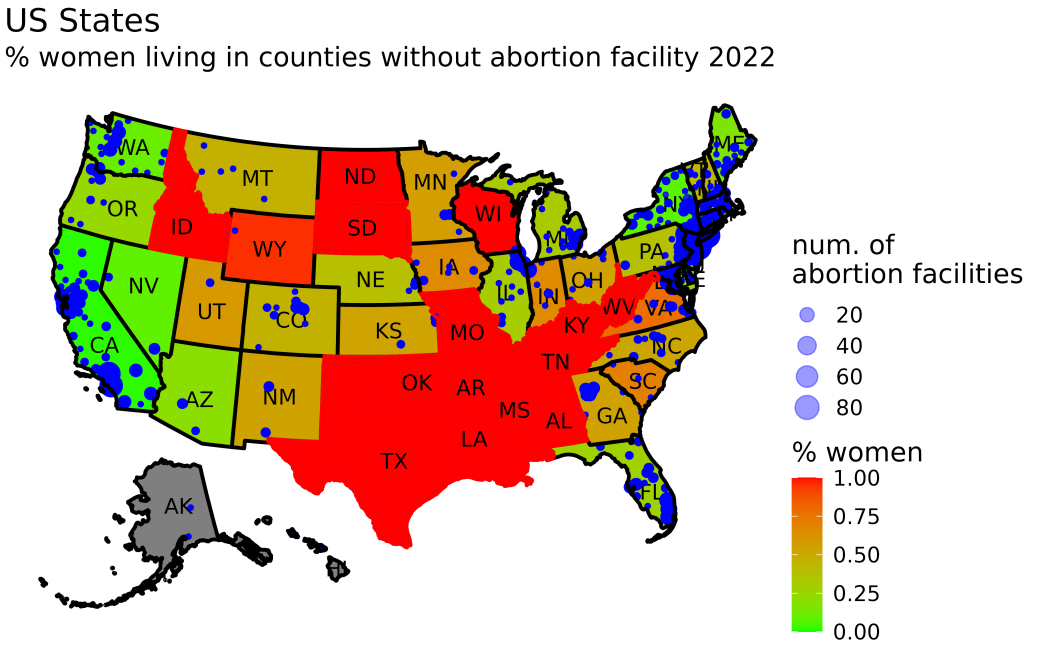


Figure 1.4: Location of Abortion Facilities and Percentage of Women Living in Counties without Abortion Facility in 2009,2020 and 2022

Note: The states that have red borders are the states that banned abortion in Dec 2022.

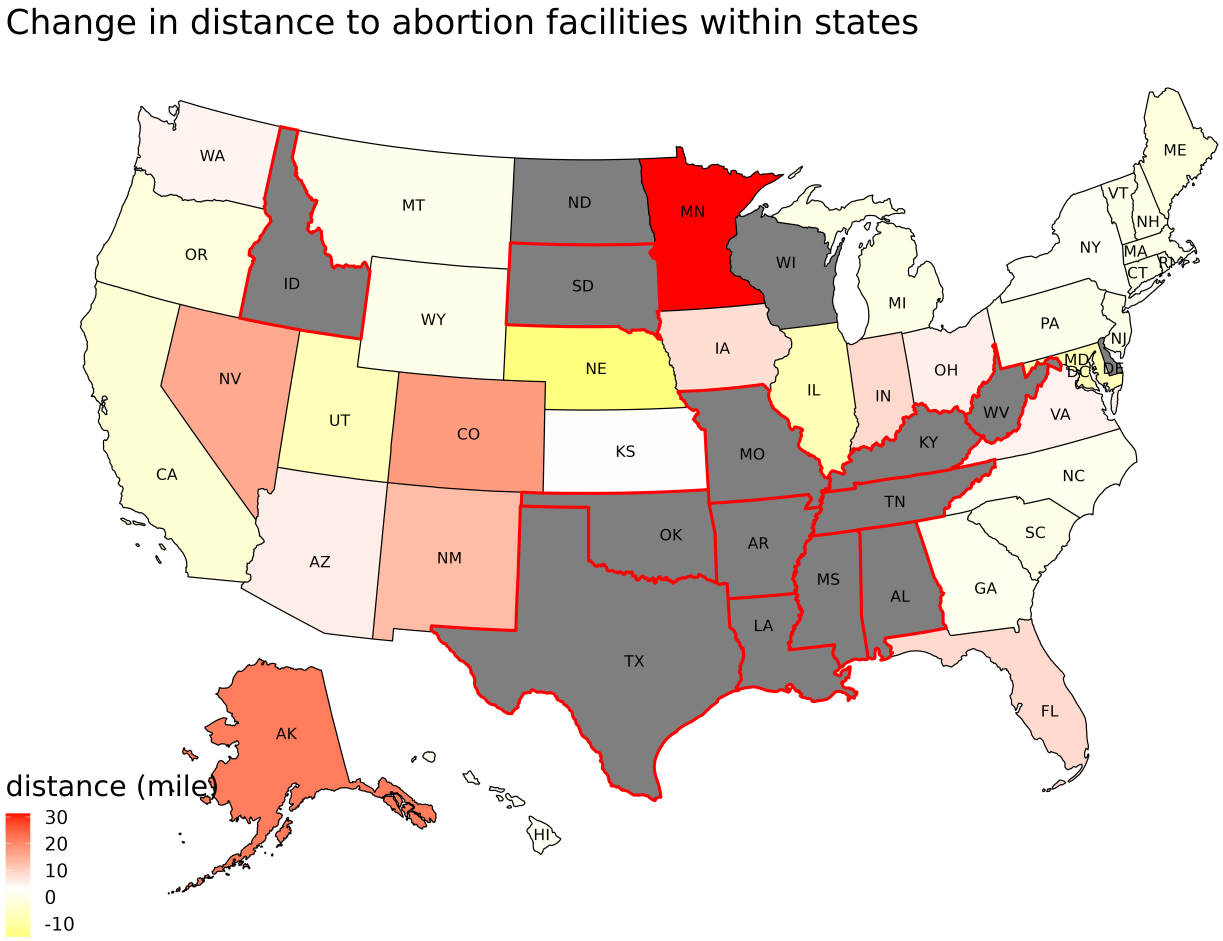


Figure 1.5: Change in Distance to Abortion Facilities Within a State

Note: The states that have red borders are the states that banned abortion in December 2022; the distance is based on the closest abortion facility in each county. The comparison is between June 2020 and December 2022.

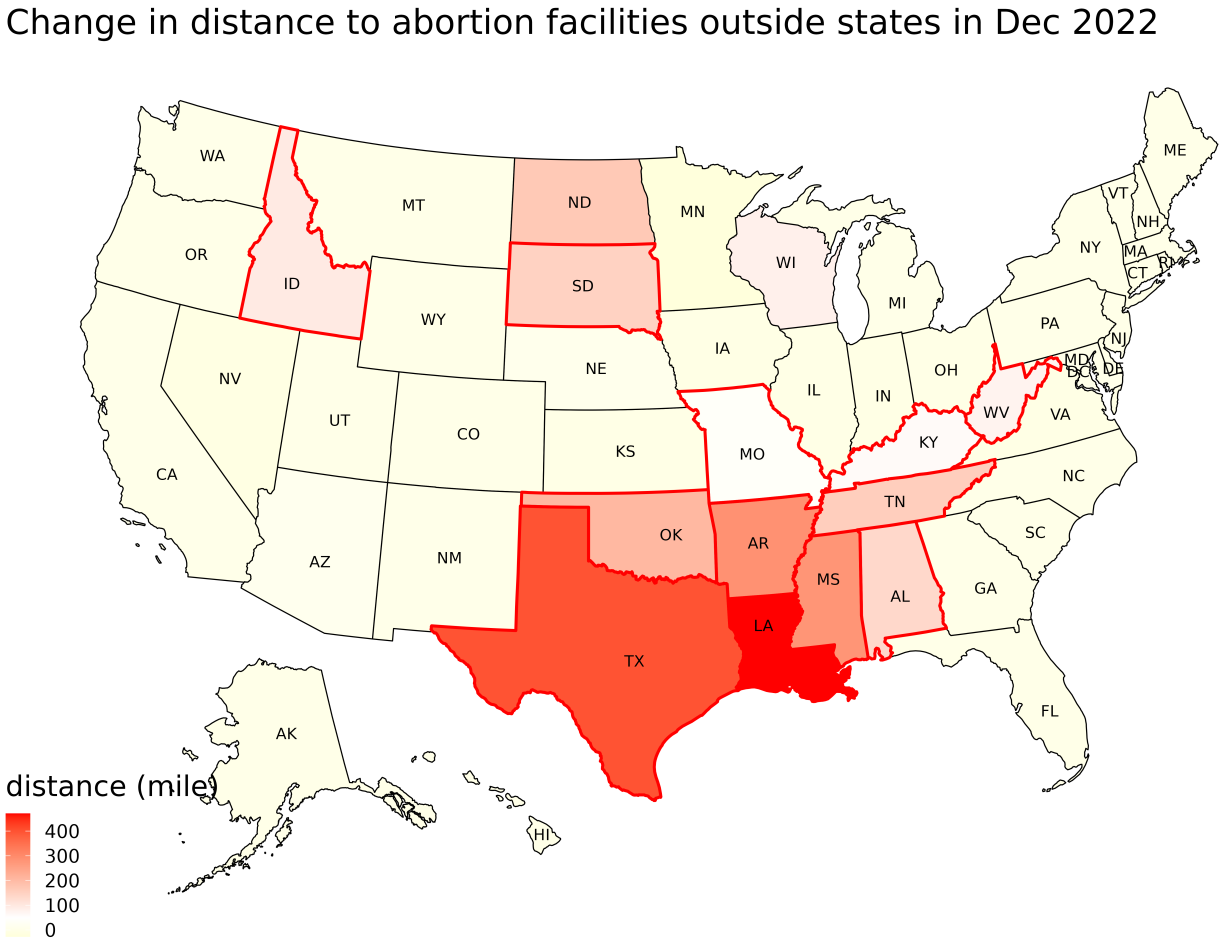
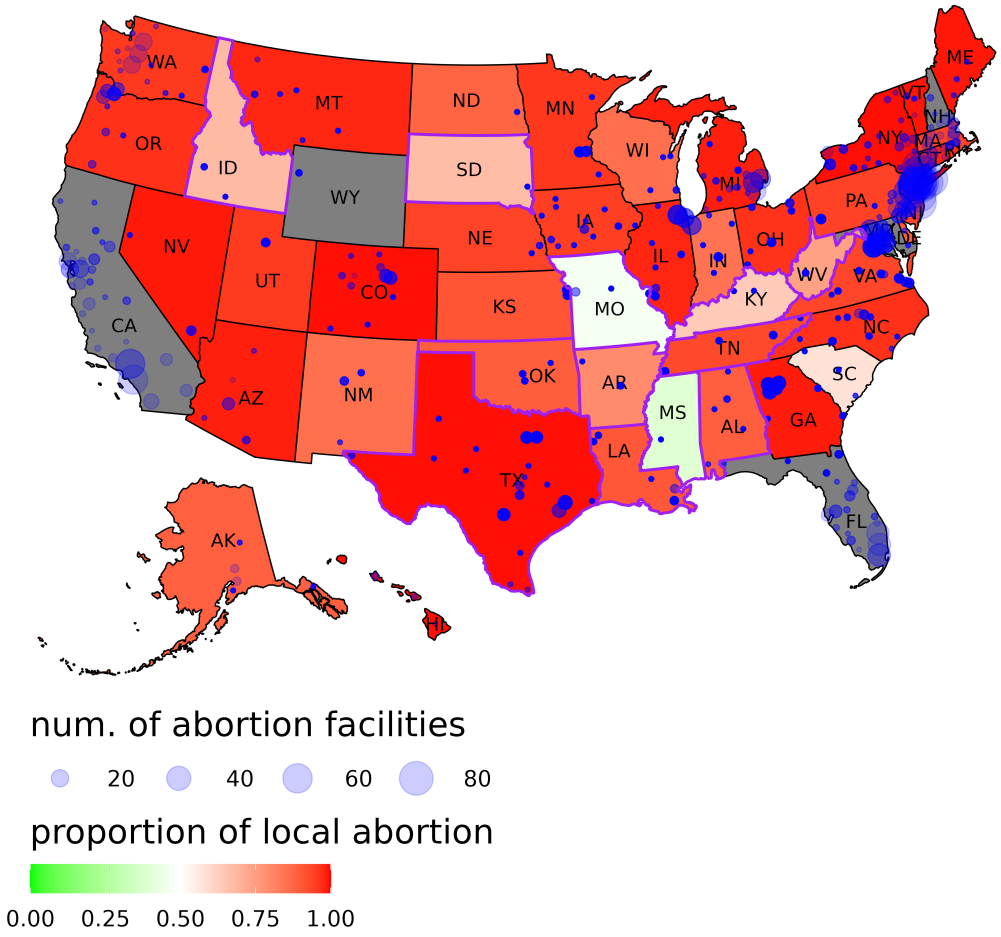


Figure 1.6: Change in Distance to Abortion Facilities Outside the State

Note: The states that have red borders are the states that banned abortion in Dec 2022. The distance is based on the closest abortion facility in each county. The comparison is between June 2020 and December 2022.

Proportion of local abortion in 2011



num. of abortion facilities

20 40 60 80

proportion of local abortion

0.00 0.25 0.50 0.75 1.00

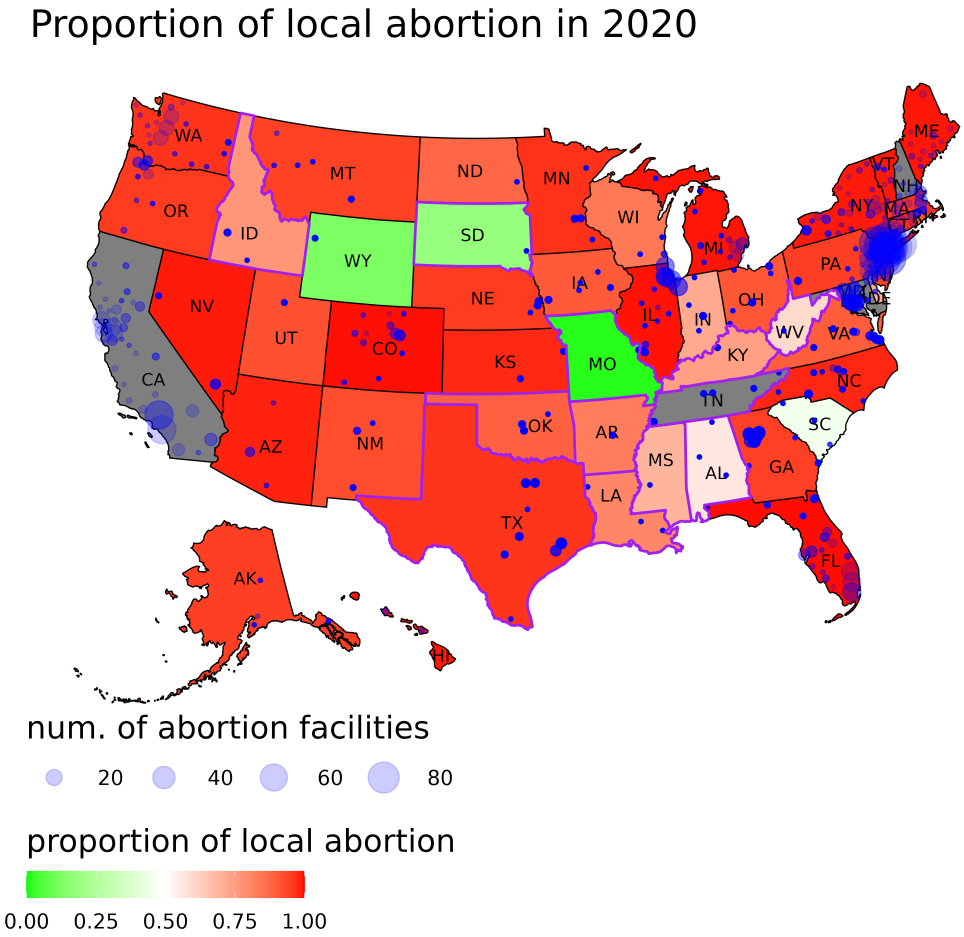


Figure 1.7: Proportion of Local Abortion

Note: The states that have purple borders are the states that banned abortion in Dec 2022. The Proportion is calculated as the number of residents' abortions conducted in their states of residence divided by the total number of abortions by residence.

2 Literature Review

To investigate the effect of abortion legalization in the United States, a common practice was to compare the five states where abortion was legalized before 1973, to the states that legalized abortion only after 1973, which is the year where abortion was legalized in all states. Levin et al.(1996) applied a quasi-experimental design to investigate the effect of legalization on the birth rate. The treatment groups were the repeal states, which had abortion legalized before 1973, and the reform states, which allowed abortion in some exceptional cases. While the control group was the rest of the states that allowed abortion after the Roe v. Wade in 1973. Levin et al.(1996) suggested that the birth rate of the repeal states fell by around 5% relative to non-repeal states due to the legalization of abortion, while there was no significant difference between the reform states and the non-repeal states. The birth rate was calculated as the number of births per 1000 females aged from 15 to 44. However, considering that there could be a "spillover effect", which means women in states that did not allow abortion could travel to nearby states where abortion was legally allowed. The "spillover effects" would lead to an underestimation of the decrease in birth rate. To evaluate the geographical factor, they separated the non-repeal states into three groups according to their distance to the closest repeal state, which were less than 250 miles away, between 250 and 750 miles away and greater than 750 miles away. The distance was measured by the population centroid of the non-repeal state to

that of the closest city in a repeal state. The result was that the birth rate associated with abortion legalization would fall by 8% relative to non-repeal states that were more than 750 miles away from the closest repeal state. This result may represent the true effect of abortion legalization on the repeal states under the assumption that women would not consider getting abortions in states that are more than 750 miles away due to high cost. The spillover effect of the non-repeal states grouped by distance is calculated as subtracting 8% from the the percentage decrease in the birth rate of repeal states relative to non-repeal states that were 250 miles and between 250 and 750 miles away respectively. The corresponding spillover effects were 3.7% and 1.9%.

The research of Gruber, Levine and Staiger(1999), which studied the relationship between abortion legalization and child's living conditions, also applied the above-mentioned categorization of states. They studied the selection effect of children due to the legalization of abortion in the United States. They measured the living conditions of children by whether the children were living in a single-parent household, living under poverty, receiving welfare, etc.. Selection effect conceptually is to measure the difference between the "marginal child" and the average child. "Marginal child" refers to the child that would be born if there is no abortion legalization in their case. The effect of being a repeal state and its interaction with the birth cohorts between 1965 and 1979 on children's living conditions in 1980 were studied. The marginal effect is measured by performing a two-stage least squares regression (TSLS). The first stage of the regression was the effect of the interaction between being a repeal state and the year of birth cohort on the birth rate, while the second stage was to regress the living conditions variables on the predicted value of birth rate. The reason for using a two-stage least squares regression was that if only the second stage was performed, it would

only capture the impact of the change in the birth rate on the child's outcomes in general instead of capturing the effect of change in birth rate due to abortion legalization. Their result showed that there was positive selection, which means the living conditions of children improved after the legalization. A similar TSLS regression analysis would also be applied in our research.

The extended version of the research above was written by Ananat et al.(2006). Not only the birth rate but also the ratio of abortion to pregnancy was used. One of the differences between the two variables was that the difference between the abortion ratio of repeal and non-repeal states after 1975 did not bounce back to the level before 1970 as it did in the birth rate. The decline in the cost of abortion does not simply decrease the birth rate because of an increase in abortion per pregnancy; the birth rate may instead remain unchanged because the pregnanacy rate also increases. Therefore, solely using the change in birth rate may not be able to reveal the true difference between the marginal child and the average child. They used the United States Census in 2000 as the source of child outcome data, which means unlike the previous research, they measured the child outcomes with the birth cohort from 1965 to 1979 when they were from 21 to 35 years old.

Donohue et al.(2001) investigated the effect of abortion on crime. In their research, they have applied an "effective abortion" concept and calculated a weighted average abortion: $Effective\ Abortion_t = \sum_a Abortion_{ta}(Arrest_a/Arrests_{total})$, where t and a represent the year and the age of a birth cohort. This formula represents a summation by age of the number of abortions in a year multiplied by the proportion of arrests of that age group. After the Roe V. Wade case in 1973, the effective abortion increased from 63 to 180 and from 126 to 252 for violent crime and property crime, respectively. They hypothesised that if the effective abortion increased, crime would fall. In their

state-level regression analysis, they regressed three dependent variables, namely the natural log of "violent crime per capita", "property crime per capita" and "murder per capita", on the effective abortion rate using data from 1985 to 1997. The coefficients were negative and significant. They had shown another regression analysis that included single age factors. The dependent variables were the number of arrests for different types of crime and the actual abortion rate was used as no weighted average abortion was needed when the single age effect was investigated. The result was similar to the previous one with more nuanced effects of different ages. Our second-stage regression showed similarity to this regression.

Apart from the "spillover effect" from Levin et al.(1996) and Ananat et al.(2006) we mentioned, several studies had used distance to abortion providers as their variables. Kane and Staiger (1996) investigated how abortion access affected teen birth rates from 1973 to 1988. Abortion access was a function of distance to the nearest abortion provider, state regulations on abortion and economic variables by county. Brown et al.(2020) also used distance to the abortion provider as a variable to study its effect on the abortion rate in the United States using data from 2000 to 2014. They showed that each mile increase to the facility could decrease 1% of abortion rate. Joyce et al.(2013) conducted a research focused on New York State and studied the effect of the distance to the closest abortion facility.

3 Methodology

3.1 Theoretical Model and Hypothesis

Our theoretical model will follow the one in Ananat et al.(2006) and Levine and Stagier(2002). The pregnancy and the abortion decisions depend on the comparison of the expected payoff from giving birth and the abortion cost. The first stage is the pregnancy decision. Firstly, the woman has an expected payoff from giving birth and the possibility of having an abortion. The payoff from giving birth is different among women. A woman will choose to get pregnant when the expected payoff from giving birth minus the expected abortion cost is positive. The change in the number of pregnancies due to the change in abortion cost is a "marginal pregnancy". Likewise for the abortion decision, after the pregnancy, the woman has an updated expected payoff from giving birth. If the expected payoff is greater than the negative of abortion cost (-A), she will choose abortion. It implies that abortion is a better choice than giving birth in terms of payoff. The change in the number of abortions due to the change in abortion cost is a "marginal abortion". In our case, we will focus on the increase in abortion cost as our independent variable is the distance to abortion facilities.

Following the concepts above, the number of pregnancies will fall when abortion cost increases. Women who are at the "marginal pregnancy" will not choose to get pregnant now. As a higher expected payoff implies that the child is more "wanted" by his mother, positive selection is ex-

pected. Positive selection here means the reduction in births improves the average living conditions. Similarly, the number of abortions will fall when abortion cost increases. Women who are at the "marginal abortion" will not choose to get an abortion now. As a lower expected payoff implies that the child is more "unwanted", negative selection is expected. Negative selection here means that the increase in births worsens the average living conditions.

As for the overall effect on the birth rate and its relationship to the living circumstances, it will depend on the extent of the effect of the fall in pregnancies and abortions. It is hypothesised that the effect from the pregnancy side will be greater than the effect from the abortion side because the change in the number of births caused by the pregnancy side should be greater.

3.2 Model

$$\begin{aligned} y_{st} =& \beta_{0_{st}} + \beta_1 \%\ same\ state_{st} * avg.distance(within\ state)_{s_t} + \\ & \beta_2 (1 - \%\ same\ state)_{s_t} * avg.distance(outside\ state)_{s_t} \\ & + \beta_3 State_s + \beta_4 birth\ year_t + \beta_5 covid\ year_t + \beta_6 Control_{st} + \epsilon_1 \end{aligned} \tag{3.1}$$

$$\begin{aligned} C_{st} =& \gamma_{0_{st}} + \gamma_1 predicted\ value_{s_t} + \gamma_2 State_s + \gamma_3 birth\ year_t \\ & + \gamma_4 covid\ year_t + \gamma_5 Control_{st} + \epsilon_2 \end{aligned} \tag{3.2}$$

A TSLS regression was used, which was suggested by The research of Gruber, Levine and Staiger(1999). Equations 2.1 and 2.2 are the first-stage and the second-stage regressions' respectively. s represents the state and t represents the birth year. The TSLS regression aims at extracting the marginal birth, marginal pregnancy and marginal abortion caused by the difference in distance to abortion facility,

and it is to ensure the impact on child's living conditions relies on the change in birth statistics caused by the abortion cost changes (Gruber et al.,1999), which in our case is the distance to the closest abortion facility. States with county-level data of fewer than 15 in that year will be removed from our dataset, and our regression is weighted by the population of women aged from 15 to 44 included in the distance to facilities dataset in each state.

For the first-stage regression, the birth rate, abortion ratio and pregnancy rate were used as dependent variables. For the abortion cost, there were two representative variables: One is the percentage of counties where the closest facilities were located inside their state of residence multiplied by the average distance to the closest abortion facilities of those counties, and the second one is the percentage of counties where the closest facilities were located outside their state multiplied by the average distance to the closest abortion facilities of those counties.

In our research, we assumed people tend to go to the closest abortion facility to conduct abortions. Figure 3.1 shows the relationship between the percentage of counties whose closest facility is located within their belonging state and the percentage of local abortion, which is number of residents' abortions conducted in their state of residence divided by the total number of abortions by residence(Kortsmit et al., 2022). There was a clear positive correlation. It implies that people at least tend to stay in their state for abortion if the abortion facility within the state is closer than that outside the state.

For the second-stage regression, the dependent variables were the percentage of children living below the poverty line and the adjusted family income. The same set of variables was separated into black and non-black children groups. Also, we will only include the predicted birth rate and the

abortion ratio as independent variables because the effect of pregnancy and abortion change could not be separated in the pregnancy rate variable.

The control variables were the percentage of black people in a state, percentage of violent crime, percentage of property crime, unemployment rate, per-capita income, child's age during the census year, the year 2019 and 2020 as covid year dummy, and state and year dummy variables.

3.3 Variables and Data

For the first-stage regression, our dependent variables were the birth rate, pregnancy rate and abortion ratio. The birth rate from 2009 to 2020 was extracted from the Centers for Disease Control and Prevention (CDC) and was defined as the number of births per 1000 females aged 15-44. The abortion ratio and the pregnancy rate from 2009 to 2017 were extracted from the Guttmacher Institute(2022). They were defined as the number of abortions per 1000 births and the number of all pregnancies per 1000 females aged 15-44.

The data for the independent variables under investigation, which were the distance to the closest abortion facilities inside and outside one state, other abortion facilities-related variables and the population of females included in the facility dataset used as weights were extracted from the Myers Abortion Facility Database at the Open Science Framework (OSF). As the data are on a monthly basis and the unit of geographical location is the county, the data in June of each year were employed (except for the later part about the implication on abortion law in which data in December 2022 were used). The data on distance to the closest abortion facilities were aggregated into state-level data by averaging the travel distance to the closest abortion facility in each county. The abortion facili-

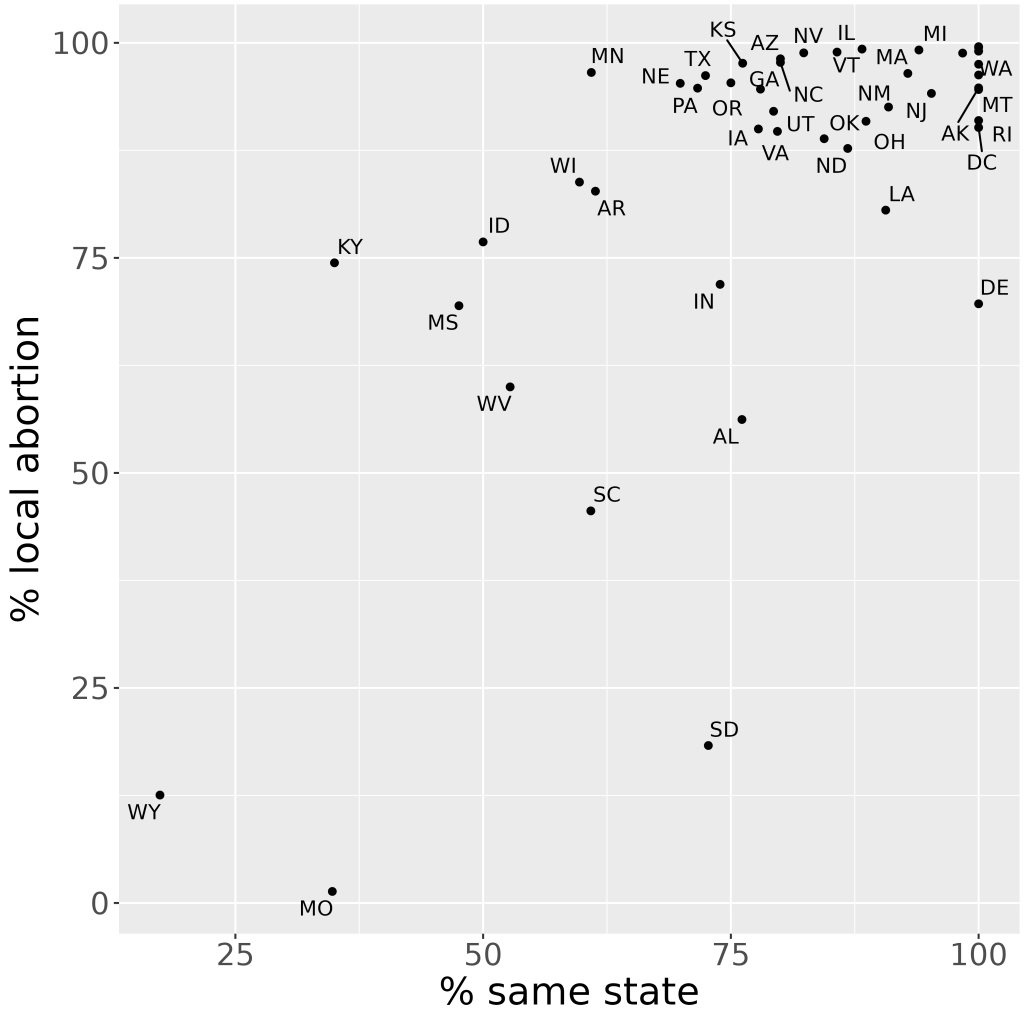


Figure 3.1: Relationship of % same state and % local abortion in 2020

Note: % local abortion is calculated by the number of residents' abortions conducted in their state of residence divided by the total number of abortions by residence times 100. % same state represents the percentage of counties whose closest facility is located in their states. The text alongside the points is the abbreviation of the state.

ties that were under investigation were all "publicly-identifiable" facilities (Myers, 2023). The mile distance was measured by the distance from the population center of a county to the geographical coordinates of the facility, using the Stata georoute module (Myers, 2023). We separated the counties of each state into counties that have its closest abortion facility inside the state that they belong to and counties that have the closest facility outside the state that they belong to. $\%samestate$ is the number of counties in a state that have its closest abortion facility inside the state that they belong to divided by the total number of counties in a state that is recorded in this database, $1-\%samestate$ represents the opposite. The average distance within a state is calculated by taking the average of the distance to the closest abortion facility of the counties that have its closest abortion facility inside the state that they belong to, while the average distance outside a state is calculated by the same method but the distance of the second group of counties is used.

For the second-stage regression, the dependent variables, age and race of the child from 2019 to 2021 were extracted from the Integrated Public Use Microdata Series (IPUMS). The "adjusted family income" was recorded as "poverty" in their dataset. This variable considers family income and family structure and then determines how far the family was from the poverty line. If this variable equals 100, it means the family is at the poverty line. As this dataset is an individual-level dataset, the family income data were averaged by the state of birth and the birth year. The percentage of children living below the poverty line is caluclated as the number of individuals that have family income below 100 divided by the number of individuals with the same state of birth and birth year. If the birth year and the state of birth are 2010 and in Texas, the average adjusted family income of this group of children will be matched to the birth rate or abortion ratio in 2010 and at Texas. It is also important to note

that the state-level data were grouped by the place of birth instead of the place of residence because it can reduce the impact of mobility across states throughout the years between the birth year and the census year(Gruber et al.,1999). For the black and non-black children group, the aggregation method is the same, but the individuals are separated according to their race. For example, the adjusted family income of the black children group is calculated by taking the average of the family income among the black individuals in the same state and birth year.

For the control variables, the percentage of black people in a state was collected from the Surveillance, Epidemiology, and End Results (SEER) Program (National Cancer Institute, 2022). The unemployment rate, per-capita income and crime rate were retrieved from the Inter-university Consortium for Political and Social Research (ICPSR) (Graves et al.,2022), the U.S. Bureau of Economic Analysis and the Federal Bureau of Investigation (FBI).

Table 3.1: Summary Statistics

Statistic	N	Mean	St. Dev.
Birth Rate	504	63.656	6.170
Pregnancy Rate	378	91.581	7.333
Abortion Ratio	378	190.694	101.234
% of black people	504	12.2	9.9
% of violent crime	504	0.4	0.1
% of property crime	504	2.6	0.6
unemployment rate	504	6.145	2.330
per-capita income	504	45,913.250	8,201.310
% same state	504	76.4	18.7
Average distance to abortion facility if the closest facility is within state	504	70.163	42.634
Average distance to abortion facility if the closest facility is outside state	504	92.790	66.664
% living below poverty	504	16.1	4.7
% living below poverty (black children group)	494	32.9	15
% living below poverty (non-black children group)	504	14.3	3.8
Adjusted family income	504	283.099	30.777
Adjusted family income (black children group)	494	195.615	48.792
Adjusted family income (non-black children group)	504	292.174	30.287
Cell Size	504	73.024	43.166
Population involved (female)	504	1,399,966.000	1,529,974.000

Note: Cell Size represents counties included in the Myers database of each state. ”Population involved” represents the female population involved in each state based on the Myers database, which is the number of women in each county of a state included in the Myers database.

4 Result

4.1 Regression Result

Table 4.1 shows the first-stage regression result, with robust standard errors applied. In general, regardless of whether the closest facilities were inside or outside the state, the abortion ratio and the pregnancy rate decreased when the distance increased. The birth rate also decreased. Every 10-mile distance increase within the state led to a decrease in all three birth variables by 0.8%, 3% and 0.9% respectively. Every 10 -mile distance increase outside the state led to a decrease in all three birth variables by 0.4%, 2.5% and 0.5% respectively. The magnitudes of change due to the increase in the distance to facilities outside one state were smaller than those due to the increase in distance to facilities within one state. Although the result of outside state distance seems to be trivial compared to that within a state, the change in distance outside a state after the abortion ban could be up to 400 miles, while the maximum change in distance within a state was only around 30 miles, as shown in Figure 1.5.

Table 4.2 is the second-stage regression result, robust standard errors were applied in our result. The black children group has shown significant results due to the changes in the two birth variables. As the increase in the average distance to abortion facilities led to a fall in the birth rate and abortion ratio, our discussion will focus on the effect on child's living circumstances when the birth rate and

the abortion ratio decrease. When the abortion ratio and the birth rate decreased, the adjusted family income of the black children group increased. One percent decrease in abortion ratio will increase the family income by 0.49 unit, while one percent decrease in birth rate will increase the family income by around 4.1 units. Although the non-black children group did not yield significant results in most of the coefficients, they also exhibited the same direction of change in income as the black children group, but the magnitude was smaller than that in the black children group; the changes in family income for the non-black children group and the general group were not greater than 1. For the percentage living below the poverty line, only the black children group showed significant coefficients of the birth variables. The signs of the coefficients of interest were different between the black and non-black children group. The black children group showed a fall in the percentage living below poverty by 1.18 percentage points and 0.17 percentage point, respectively, when the birth rate and the abortion ratio fell.

For the diagnostic tests, all of the regressions showed ideal results in the weak instrument test. Some of the regressions had a p-value greater than 0.1 in the Wu-Hausman test, which means the ordinary least squares (OLS) and 2SLS estimators are consistent, but the coefficients in these regressions were not significant.

For the first-stage regression, the signs of the coefficients of the distance-related variables matched our hypothesis. Both the pregnancy rate and the abortion ratio decreased when the abortion cost, which was measured by the average distance, increased. The overall effects on birth rates in both within and outside-state cases were also negative. For the same mile increase, people exhibit greater response when the change is within the state. In decisions concerning pregnancy and abortion,

when people take account of the abortion cost factor, they may be more sensitive to the information around them or within their state of residence. It may also be explained by the higher cost of conducting abortions outside their state of residence. Extra cost, such as travel cost, is involved in cross-state abortion, so with the same mile increase, the rise in the relative cost of outside-state abortion is lower.

For the child's living circumstances, there was an improvement shown within the black people group when abortion costs increased or when the birth rate and the abortion ratio decreased. This result is different from the positive selection found from the research of Gruber, Levine and Staiger(1999), which suggested an improvement in child's living conditions after the abortion legalization, implying a fall in abortion cost. According to the Wu-Hausman test results of our TSLS regression, the significant coefficients were inconsistent with the OLS result, which means our first-stage regression isolated the effect of the availability of the abortion facility from other factors that affect the birth rate or the abortion rate. At the same time, we are able to find the "marginal birth" group that is affected by the abortion access level in a state. Therefore, the second-stage regression

	log (Birth Rate)	log (Abortion Ratio)	log (Pregnancy Rate)
% same state	-0.0008^{***}	-0.0030^{***}	-0.0009^{***}
* avg. distance (within state)	(0.0002)	(0.0006)	(0.0002)
(1-% same state)	-0.0004^{**}	-0.0025^{***}	-0.0005^{***}
* avg. distance (outside state)	(0.0001)	(0.0004)	(0.0001)
R^2	0.9412	0.9923	0.9644
Adj. R^2	0.9334	0.9910	0.9582
Num. obs.	504	378	378

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table 4.1: First-Stage Regression Result.

Dependent Variable	Adjusted Family Income					
Race	/	/	Black	Black	Non-Black	Non-Black
predicted value	Birth rate	Abortion ratio	Birth rate	Abortion ratio	Birth rate	Abortion ratio
log(predicted value)	-68.71°	-17.99^{*}	-408.13^{**}	-48.56^{*}	-64.75	-19.55°
	(39.03)	(8.56)	(150.31)	(22.87)	(43.38)	(10.36)
Num. of Observations	504.00	378.00	494.00	373.00	504.00	378.00
Weak Instrument test	0.02	0.00	0.02	0.00	0.02	0.00
Wu-Hausman test	0.24	0.06	0.01	0.01	0.32	0.08

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$; $^{\circ}p < 0.08$

Dependent Variable	% living below poverty line					
Race	/	/	Black	Black	Non-Black	Non-Black
predicted value	Birth rate	Abortion ratio	Birth rate	Abortion ratio	Birth rate	Abortion ratio
log(predicted value)	0.01	0.00	1.18^{*}	0.17^{*}	-0.03	-0.00
	(0.08)	(0.02)	(0.47)	(0.07)	(0.08)	(0.02)
Num. of Observations	504.00	378.00	494.00	373.00	504.00	378.00
Weak Instrument test	0.02	0.00	0.02	0.00	0.02	0.00
Wu-Hausman test	0.94	0.71	0.02	0.00	0.66	0.41

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$; $^{\circ}p < 0.08$

Table 4.2: Second-Stage Regression

potentially compared the average living conditions of a birth cohort to that of the "marginal birth" group(Gruber et al.,1999). In our case, when abortion cost increased and the birth rate decreased, the marginal child that orignally would have been born has a lower adjusted family income than the average group, and thus, the average adjusted family income rose and the percentage of children living below the poverty line of the black children group fell in general. Also, the increase in adjusted family income was not caused by a smaller family size as this variable was adjusted by family size and ages of family members.

Interestingly, when the abortion ratio decreased, the living conditions also showed an improvement in the black children group. Contrary to our result, our theoretical model predicts that this fall in abortion ratio will worsen children's financial situation in their families. It may prompt us to think about whether economic factors are important to black women when making abortion decisions. However, apart from the increase in income, the percentage living below the poverty line also decreased. From the perspective of abortion, the marginal children that were born because of the increase in abortion cost reduced the percentage of children living below the poverty line, which implies that these families or women that were making abortion decisions at the margin were likely to be living in poverty. The second question would be why there is an improvement in the living conditions even for the low-income families? A research (Finer et. al, 2005) suggested that reasons for abortion were different among different races. For black people, reasons or factors for them to decide on abortion were likely to be "completed childbearing or have dependents", and "interference of school or career" among items in the survey. Although the group of women that are at the margin are most likely to be also living under or around the poverty line, apart from simply not

being able to afford the increasing abortion cost financially, there are other reasons for choosing to abort which affects the payoff of giving birth. With financial factors not being the focus, it is possible that children can have improvement in living conditions in general. Our result does not exclude the possibility that the financial situation is a factor for abortion; it only suggests that there may be other reasons predominating over financial reasons. It may suggest the mothers in the black children group may have a lower expected payoff in giving birth, so their payoff from giving birth was closer to the abortion cost, and at the same time, this group of women also had a higher chance of living in poverty.

Although we cannot isolate the effect of pregnancy rate in the regression analysis, all of the living conditions variables in the black children group had significant results, so the effect of the fall in pregnancy rate could still be estimated. If the distance to abortion facilities outside a state remains unchanged, then for a 10-mile increase within a state, the adjusted family income of the black children group will increase by 1.47 (3 * 0.49) through a fall in the abortion ratio, and it will increase by 3.26 (0.8 * 4.08) through a fall in the birth rate. We could therefore conclude that the fall in pregnancy rate also leads to an increase in income, and the effect of the decreased pregnancy rate would be 3.26-1.47= 1.79. If the distance to abortion facilities within a state remains unchanged, the effect of the pregnancy rate is estimated to be 0.41 (0.4*4.08 − 2.5*0.49) for a 10-mile increase in distance outside a state. There will be an improvement in family income. People are likely to be more "cautious" about making pregnancy decisions when an abortion facility is less accessible and when economic factors tend to be one of the dominating factors so only women with enough financial support to bear the risk of abortion will choose to get pregnant.

Comparing the black children group and the general group, the black children group had a lower mean family income than the general group, and the magnitude of the coefficients of the black children group was still greater. The coefficients in the general group are relatively trivial, considering that the mean of their adjusted family income is 283. Unlike the black children group, the mothers or families in the general group who were at the margin of choosing abortion were less likely to be living in poverty because significant results were only observed for the income variable but not for the percentage living below the poverty line.

4.2 Endogeneity

There may be a concern that access to abortion facilities and the abortion ratio may be a demand and supply relationship, and therefore endogeneity may exist in the regression analysis. However, the unit of the raw data is based on counties and our measure of distance is the average of the distance to abortion facilities in each county in a state. The abortion facilities will likely be located in area that are surrounded by counties with higher abortion demand, so if one county has high abortion demand, there may be more abortion facilities nearby, and this county will therefore have a shorter distance to the facilities. However, in our regression analysis, the distance information based on counties is aggregated to state level, and the abortion ratio is also based on the total number of abortions by state of residence instead of counties. The distances are likely to be evened out across counties in a state, so that even if the abortion ratio increases in a state, it may not decrease the average distance to the facilities. Also, the distance to abortion facilities is also affected by the population density in different counties, the size of a state and demand for abortion in nearby states

if the facility is located around the border of a state. The abortion ratio is measured by residence rather than by occurrence, and as mentioned in the "Trend" section, not all residents will choose to conduct abortions at their state of residence.

Another endogeneity concern is the different restrictions on legal gestational age for abortion. There were changes and differences in related legal regulation throughout the years and across states. If the gestational age limit is higher, it is expected that the number of abortions will be higher and therefore the number of abortion facilities will be higher. However, in the report of abortion surveillance 2020 of the United States (Kortsmit et al.,2022), it is shown that among all of the reporting states, except for Missouri, around or over 90 % of abortions were carried out before 13 weeks. Therefore, it is unlikely that the gestational age will affect the abortion ratio greatly. As for Missouri, the state had only 167 cases of abortion in 2020, so the cases of abortion were expected to be some extreme cases such as life-threatening ones. Also, from 2011 to 2020, over 90% of the abortions were conducted at or below 13 weeks of gestation in the reporting areas (Kortsmit et al.,2022).

Although the demand and supply relationship may be mitigated by the reasons mentioned in the previous part, endogeneity issues may still remain. For the regression of the $\%samestate * avg.distance(withinstate)$ on the abortion ratio, it is shown that the abortion ratio is negative and significant, which means the endogeneity issue may still be affecting our first-stage result. Brown et al.(2020) suggested an approach of using an instrumental variable to measure the distance to abortion facilities; the instrument in their case was the distance to a college enrolled by a large female population. This instrumental variable is only associated with the demand for abortion from fe-

males below 25 but is not correlated with the abortion demand from females of other ages. At the same time, this variable is correlated to the increase in the supply of facilities in that area. Another suggestion is that the first-stage regression with the abortion ratio as the dependent variable could be conducted by different age levels of the mothers, because it is unlikely that the distance to an abortion facility or the number of abortion facilities could be affected by a single age level. Similar approaches were applied in the research of Joyce et al.(2013) and Kane and Staiger (1996). However, for the regression of the $\%samestate * avg.distance(withinstate)$ on the pregnancy rate, the coefficient on the pregnancy rate is positive and significant, which means the increase in pregnancy rate may not increase the availability of abortion facilities because it instead increases the distance to the facilities.

Table A.2 in the appendix shows the results of the first-stage regression on the abortion ratio of different age levels of the mothers, and the control variables used were the same as the first-stage regression. Abortion Ratio was based on the number of abortions of that age group per 1000 births of the same group. The effect of an increase in distance to abortion facilities by 10 miles within or outside a state was between 2% and 6%. Also, most of the mother's age groups follow the pattern of our first-stage regression result, in which the effect of distance change within the state is greater than that outside the state, whereas the below 15 age group and above 40 age group show the opposite. Therefore, this regression analysis by age levels indicates that our result was still able to reflect the pattern of people's reactions to the change in distance to abortion facilities. In the future, more detailed investigation could be conducted on the sensitivity to change in distance from abortion facilities among different mother's age groups, especially those in the teens and those above 40.

5 Implication of abortion law change

5.1 Prediction

Using the distance to abortion facilities as an indicator, it is expected that states that ban abortion will experience a greater fall in birth rates in general, especially for states that rely heavily on their abortion facilities, such as Oklahoma (OK), Texas (TX), Louisiana (LA) and Arkansas (AR). Their change in the distance outside the state was greater than 100 miles, with a maximum of around 400 miles, as shown in Figure 1.6. As after the abortion ban, the variable $\%samestate$ will become 0, if the change in the average distance outside the state is 100 miles, the birth rate could fall by at least 4 %, with a fall in the abortion ratio and the pregnancy rate by 25 % and 5 %, respectively. However, if the states were originally largely relying on states that do not ban abortion, the birth statistics may not change significantly. It is expected that the birth statistics due to the change in distance to abortion facilities will be affected only among the states that ban abortion; as for the rest of the states, the distance changes were trivial.

Following the decrease in the abortion ratio and the birth rate for states that ban abortion, it is predicted that the black children group in states that ban abortion will have a rise in family income and also a reduction in the percentage of children living below the poverty line. Using the 100-mile increase outside a state as an example, for the black children group, a 25% decrease in the abortion

ratio could increase the adjusted family income by 13.8 units, while a 4% decrease in the birth rate could increase the income by 16.32 units. For the general group, 100-mile increase will lead to 2.76 units of increased family income through the birth rate. Therefore, the income gap between the two groups will be reduced. Also, the percentage living below the poverty line of the black children group will fall by 4.72 percent unit through the 4% fall in the birth rate.

The predictions above do not include the possible effect of the change within a state. However, in our model, distance to facilities is used, and after the abortion ban, there will be no facility within such states; consequently, the effect of it cannot be predicted through our model. It is suggested that the impact of the abortion ban overall should be greater than the number we described in the previous part.

For the pregnancy rate and its impact, it is expected that there will be an improvement in living conditions due to the fall in the pregnancy rate, especially for the black people group. It was discussed that people tended to be more sensitive to change within their state of residence when making pregnancy decisions, and financial reasons seem to dominate. There will be no abortion facility open to the public after an abortion ban, so it will likely alter people's pregnancy decisions if they are living in a state that bans abortion, thus improving the average children's living conditions.

5.2 Limitations and Other Factors For Prediction

Selection Bias may be found in places that ban abortion, which may lead to overestimation of the effect of an abortion ban. It is because if residents conduct abortion in illegal ways, such as using services of or gaining access to abortion pills from unqualified clinics and stores, they may choose

not to report abortion. The difference in abortion ratio between states that ban abortion and states that allow abortion may be overestimated if data released after the abortion ban are used in the future. However, it will not affect our results as we are using data before 2022.

Some anticipation effects of the abortion ban could be discussed. From the perspective of women, women who have planned to conduct abortion may conduct it sooner, but it is unlikely that women will make a choice of abortion because of the foreseeable abortion ban. Therefore, the number of abortions in a year is unlikely to be affected by this change in policy. From the perspective of clinics, they may close down or remove abortion services months before the abortion ban. For example, in Figure 1.4, there were no abortion facilities in North Dakota (ND) in December 2022, according to our data source, but the abortion ban in ND was only implemented in April 2023(Abortion Finder,2023). Women might have difficulties accessing abortion services a few months before the abortion ban. Therefore, it is important to take account of the birth data for around four to five months before the abortion ban in the future as a pre-treatment effect. However, it still does not affect our results.

Another factor to consider in the future is whether a state will ban abortion to the extent that its residents cannot travel outside one's state to conduct abortion. However, it is not yet adopted at this stage. The second possibility in the future is the expansion of telehealth service on medication abortion (Sobel et al.,2022). Telehealth services had more demand during the Covid period. However, different states have various restrictions on this type of service, such as in-person visits and ultrasound checking. With these requirements, abortion facilities will still be needed, and the distance to abortion facilities still matters. If the states do not require in-person visits, then it would mean the number of abortion facilities may be less important because people could have access to

the medication without visiting the facilities. Also, if telehealth services become more common, it may become one of the ways for women in states that ban abortion to gain access to abortion medication. The predicted fall in abortion rates may be overestimated.

Our analysis only shows the short-term effect of the abortion ban on the birth variables and the child's living conditions, using distance to facilities as an indicator. To have a consistent effect in the long run, the supply and the locations of the abortion facilities need to be unchanged. However, for states that allow abortion and have fewer restrictions on clinics or hospitals that provide abortion services, such service providers could easily target states that ban abortion, for example, by moving or adding abortion facilities closer to the border of the states. After the abortion ban, once the supplier obtains enough information on the demand for abortion in nearby states, the limitation on accessing abortion facilities will be reduced for states that ban abortion. The difference between the two types of states will be reduced because the distance to abortion facilities is shortened.

Another limitation could be that the income level of a county may affect the number of abortion facilities around the area. However, due to insufficient county-level data, our research only focused on the state level. If an abortion facility tends to be located in counties that have higher income levels and that state has an uneven income distribution, a state-level investigation may overlook this phenomenon and even out the distance to an abortion facility within a state.

6 Limitation

The association between the distance to abortion facilities and the child's living conditions may still be ambiguous in our research, especially in the analysis concerning the abortion ratio. In our theoretical model, the increase in the distance to abortion facilities would worsen the living conditions or reduce the average family income of the birth cohort that is affected by the increase in distance to abortion facilities from the perspective of abortion. This is because it is expected that there will be more "unwanted children" born in a birth cohort. For example, some research showed that the expansion in abortion availability due to abortion legalization in the United States reduced the instances of child maltreatment (Bitler & Zavodny,2002; Bitler & Zavodny,2004). However, our result was on the opposite side: the financial conditions improved. It may imply that the effect of an abortion ban may not simply be the reverse of the effect of the abortion legalization in the United States in 1973; this in turn suggests that using more updated data about abortion is needed. However, the causal relationship between the distance to an abortion facility and the living conditions also becomes ambiguous in our case.

It would be unreasonable to claim a causal relationship for a small distance change to an abortion facility and the future conditions of children living. However, in our research, we focused on discussing the potential effect of an abortion ban. As discussed in the "Implication of abortion ban"

part, some of the states had very limited abortion access, and their distance change could be up to 400 miles after the abortion ban. This research may still give some intuitions about how limited abortion access would affect states that show a tremendous change in distance to abortion facilities.

It is suggested that, in the future, we could categorize distance to abortion facilities into different levels (Levine et al.,1996; Brown et al.,2020), such as below 100 miles and between 100 and 200 miles to better represent the abortion access in a state, instead of using a continuous distance variable. This method could also capture the potential non-linear relationship between abortion access and birth statistics. Also, other state-level control variables, such as different abortion restrictions and insurance policies on abortion, could be included so that we could measure the sole effect of abortion facility availability, without introducing the effect of such policy restrictions (Bitler & Zavodny,2002; Bitler & Zavodny,2004). The Wu-Hausman test results of our TSLS regression suggest that the average living conditions of a birth cohort is compared to that of the "marginal birth" group(Gruber et al.,1999). However, the continuous distance variable in our regression hindered us from making a clear comparison between the average and the marginal birth groups. Therefore, with the TSLS regression and discrete levels of abortion access, we may be able to claim some causal relationship between abortion facility access and the abortion rate and whether the birth cohort with a lower level of abortion access also had better average family financial situations.

The role of contraception is not discussed in our research. However, states that have more abortion facilities or shorter distance to abortion facilities may have more related services or greater awareness of contraception. Lower abortion per birth may result in these states. However, in our analysis, we have controlled for the economic situation of each state, which is likely to be correlated

to the prevalence of contraception in a state. Therefore, the effect of the difference in contraception is unlikely to affect our results.

7 Conclusion

When the distance to abortion facilities increases, birth rates, abortion ratio and pregnancy rates will decrease. The fall in the birth statistics in general improves children's living conditions in terms of adjusted family income, especially for the black children group. However, for the percentage living below the poverty line, only the black children group is positively affected. Black women who made abortion decisions at the margin were likely to be living around or below the poverty line. However, the improvement in financial situations suggested that they may have factors other than financial reasons to consider when making abortion decisions. At the same time, we found that people were more sensitive to changes within their state of residence when making pregnancy and abortion decisions.

After the abortion ban was imposed in some states (using December 2022 as a cut-off), states that rely heavily on their own abortion facilities were predicted to have a fall in birth rate by at least 3% and therefore an improvement in living conditions, especially for the black children group, through the fall in abortion ratio and pregnancy rates.

In general, an abortion ban in a state may induce more prudent family planning at the pregnancy stage. At the same time, this research has found no evidence of worse living conditions for the future generation after the abortion ban. It is also worth noting that the abortion ban seems to generate

greater influence on the black children group. It may imply a lower expected payoff from giving birth in this group.

In the future, more birth-related variables, such as perinatal mortality and miscarriages, could be included because a long travel time to an abortion facility may put a risk on mothers. If there is more data on the pregnancy rate and the abortion rate by race, we could also discuss more on the racial differences in abortion decisions and how race would interact with the family's financial situations.

A Appendix

State Name	State Abbreviation
Alabama	AL
Alaska	AK
Arizona	AZ
Arkansas	AR
California	CA
Colorado	CO
Connecticut	CT
Delaware	DE
District of Columbia	DC
Florida	FL
Georgia	GA
Hawaii	HI
Idaho	ID
Illinois	IL
Indiana	IN
Iowa	IA
Kansas	KS
Kentucky	KY
Louisiana	LA
Maine	ME
Maryland	MD
Massachusetts	MA
Michigan	MI
Minnesota	MN
Mississippi	MS
Missouri	MO
Montana	MT
Nebraska	NE
Nevada	NV
New Hampshire	NH

State Name	State Abbreviation
New Jersey	NJ
New Mexico	NM
New York	NY
North Carolina	NC
North Dakota	ND
Ohio	OH
Oklahoma	OK
Oregon	OR
Pennsylvania	PA
Rhode Island	RI
South Carolina	SC
South Dakota	SD
Tennessee	TN
Texas	TX
Utah	UT
Vermont	VT
Virginia	VA
Washington	WA
West Virginia	WV
Wisconsin	WI
Wyoming	WY

Table A.1: State Name and Abbreviation

Dependent Variable	log(Abortion Ratio by Age)			
Age of Mother	below 15	15 to 19	20 to 24	25 to 29
% same state	-0.0066^{*}	-0.0036^{***}	-0.0040^{***}	-0.0039^{***}
* avg. distance (within state)	(0.0033)	(0.0008)	(0.0007)	(0.0007)
(1-% same state))	-0.0012	-0.0028^{***}	-0.0030^{***}	-0.0030^{***}
* avg. distance (outside state)	(0.0023)	(0.0005)	(0.0004)	(0.0004)
R^2	0.9125	0.9908	0.9930	0.9917
Adj. R^2	0.8941	0.9892	0.9918	0.9903
Num. obs.	300	378	378	378

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$; $^{\circ}p < 0.1$

Dependent Variable	log(Abortion Ratio by Age)		
Age of Mother	30 to 34	35 to 39	40 or above
% same state	-0.0036^{***}	-0.0031^{***}	-0.0026^{*}
* avg. distance (within state)	(0.0007)	(0.0007)	(0.0010)
(1-% same state)	-0.0023^{***}	-0.0024^{***}	-0.0037^{***}
* avg. distance (outside state)	(0.0004)	(0.0005)	(0.0007)
R^2	0.9873	0.9780	0.9303
Adj. R^2	0.9850	0.9742	0.9182
Num. obs.	378	378	378

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$; $^{\circ}p < 0.1$

Table A.2: Abortion Ratio by Age

Note: Abortion Ratio was based on the number of abortions of that age group per 1000 births of the same group.

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