RUCH PRAWNICZY, EKONOMICZNY I SOCJOLOGICZNY
Rok LXXXVIII – zeszyt 1 – 2026
https://doi.org/10.14746/rpeis.2026.88.1.13

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THE IMPACT OF TIGHTENING THE ABORTION LAW IN 2020 ON FERTILITY IN POLAND

WPŁYW ZAOSTRZENIA PRAWA ABORCYJNEGO W 2020 ROKU NA DZIETNOŚĆ W POLSCE

Low fertility constitutes a major demographic and economic challenge, leading to population ageing, labour shortages, and increasing pressure on social security systems. One of the factors that may influence reproductive decisions is the restrictiveness of abortion laws. The primary aim of this study is to assess whether, and to what extent, the tightening of abortion law in Poland in 2020 affected fertility, measured by the total fertility rate as well as fertility rates by women's age group, place of residence, and relationship status. Using the augmented synthetic control method and data from 32 European countries, the study compares Poland's actual fertility trajectory with a counterfactual scenario assuming no legal change. The results indicate that the 2020 reform contributed to a decline in fertility, particularly among women aged 15–19, married women, and urban residents. This study contributes to the limited empirical literature on the demographic effects of abortion law restrictions in Europe and demonstrates the usefulness of advanced quasi-experimental methods in evaluating the effects of public policies.

Keywords: abortion; fertility; augmented synthetic control method
JEL: I18, J13, J18

Niska dzietność stanowi poważne wyzwanie demograficzne i gospodarcze, ponieważ prowadzi do starzenia się społeczeństw, niedoboru siły roboczej oraz rosnącej presji na systemy zabezpieczenia społecznego. Jednym z czynników mogących wpływać na decyzje reprodukcyjne jest restrykcyjność prawa aborcyjnego. Zasadniczym celem badania jest ocena, czy i w jakim stopniu zaostrzenie prawa aborcyjnego w Polsce w 2020 r. wpłynęło na dzietność, mierzoną współczynnikiem dzietności ogółem, a także współczynnikami dzietności według wieku kobiet, miejsca zamieszkania i stanu cywilnego. Wykorzystując rozszerzoną metodę syntetycznej kontroli (*augmented synthetic control method*) oraz dane z 32 krajów europejskich, przeprowadzono porównanie rzeczywistej trajektorii dzietności w Polsce z kontrfaktycznym scenariuszem zakładającym brak zmian prawnych. Wyniki wskazują, że reforma z 2020 r. przyczyniła się do spadku dzietności, szczególnie wśród kobiet w wieku 15–19 lat, kobiet zamężnych oraz mieszkanek miast. Badanie stanowi wkład w ograniczoną dotychczas literaturę empiryczną dotyczącą demograficznych skutków zaostrzenia prawa aborcyjnego w Europie oraz pokazuje użyteczność zaawansowanych metod quasieksperymentalnych w ocenie efektów polityk publicznych.

Słowa kluczowe: aborcja; dzietność; rozszerzona metoda syntetycznej kontroli
JEL: I18, J13, J18

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RPEiS 88(1), 2026: 241–261. *ISSN (Online) 2543-9170 ISSN (Print) 0035-9629*

I. INTRODUCTION

The abortion law in force in a given country regulates the principles, conditions, and procedures concerning the termination of pregnancy for women in that country. Abortion law in Poland has become one of the most controversial social and political issues in recent years. This is due to a change in Polish legislation following the Constitutional Tribunal's ruling of 22 October 2020.[1] As a result of its implementation, abortion in cases of congenital fetal abnormalities was banned in Poland, leading to a de facto complete ban on abortion. This decision caused a wave of protests, and the law in Poland became one of the most restrictive in Europe. These changes have been met with criticism from human rights organizations and international institutions, which have highlighted the potential threats to women's health and lives. On the one hand, restricting access to abortion may lead to an increase in unsafe, illegal procedures; on the other hand, it may negatively affect women's mental well-being, particularly among those facing serious health conditions. It is also important to note that the tightening of abortion laws has contributed to a chilling effect among healthcare professionals, who, fearing legal repercussions, have often been uncertain about performing procedures even in cases where the law permits such medical interventions.

The fertility rate in Poland has been on a downward trend for more than three decades. The last time the fertility rate was above 2.1, the level guaranteeing the replacement of generations, was at the end of the 1980s. In 2022, the value of this indicator in Poland was 1.26. For comparison, the average fertility rate in the European Union for the same period was 1.46, and globally it was 2.2 (World Bank, 2025). The most recent Eurostat (2025a) data from 2022 places Poland sixth from last in Europe, with a fertility rate of 1.29. However, according to the latest data for 2023 provided by the Central Statistical Office, the situation in Poland has deteriorated further. The fertility rate reached a level of 1.16 in 2023. In rural areas, it is higher and stands at 1.238, while in cities it is 1.106 (Central Statistical Office, 2025). Such a low fertility rate in Poland means that the country faces the prospect of a gradual population decline and an ageing population. This is associated with acute economic consequences, such as increased social welfare costs, a decrease in economic growth, and problems with the financing of pension systems. Given the significant restrictions on abortion in Poland, their potential impact on women's reproductive choices, and the country's already declining fertility rate, it is crucial to examine whether and to what extent the tightening of abortion laws has influenced fertility trends.

The main aim of this study is to assess the extent to which the 2020 tightening of Poland's abortion law influenced fertility patterns, as reflected in total fertility rates and age-, residence-, and relationship-specific fertility indicators. The study assumes that the political intervention took place in 2020

[1] Judgment of the Constitutional Tribunal of 22 October 2020, K 1/20 (Wyrok Trybunału Konstytucyjnego z 22 października 2020 r.), K 1/20, OTK ZU-A 2021, item 4.

(the Constitutional Tribunal ruling) and its impact is analysed for the years 2021–2023. The study uses data from the Central Statistical Office (GUS), Eurostat, and Our World in Data, covering the years 1950–2023, depending on variable availability, and applies the augmented synthetic control method (ASCM), a quasi-experimental approach that allows the construction of a counterfactual scenario for Poland, that is, the fertility trajectories that would have been observed in the absence of the 2020 legal change.

II. LITERATURE REVIEW

Several papers specifically explored the effects of abortion law on education levels and labour market outcomes. Pop-Elches (2006) indicated that the introduction of the abortion ban in Romania had a positive impact on the education level and labour market position of children born after its introduction. Hajdu and Hajdu (2021) found that in Hungary, children born after the introduction of restrictive abortion laws had poorer educational outcomes, a higher probability of being unemployed at age 37 and a higher probability of being a teenage parent. Ananat et al. (2009) argued in their study that, in the United States, liberalizing abortion laws increased the probability of completing higher education, reduced welfare receipt rates, and decreased the probability of being a single parent. Jones and Pineda-Torres (2024) concluded that, in the United States, the abortion ban has resulted in lower levels of female education. Kalist (2004) concluded that, in the United States, the liberalization of abortion laws contributed to a reduction in unwanted pregnancies and thus increased female labour force participation rates, especially for single black women. Similarly, Angrist and Evans (1996) reached comparable conclusions, demonstrating that the reduction in fertility due to greater access to abortion and contraception not only affected demographic structure but also served as an important driver of economic growth by increasing women's participation in the labour market. Collectively, these studies highlight that access to abortion and contraception has far-reaching socioeconomic implications, particularly through its influence on women's educational attainment and participation in the labour force.

Many authors also draw attention to the impact of changes in abortion law on the living conditions of children. Gruber et al. (1999) indicated that, in the United States, the liberalization of abortion law had a significant and positive impact on the living conditions of children born after this change. Mitrut and Wolff (2011), on the other hand, found that in Romania, the liberalization of the abortion law had a positive impact on the weight and the number of abandoned newborn children.

Another important aspect analysed in the context of abortion law is women's physical and psychological health. Clarke and Mühlrad (2021) examined the impact of both the liberalization and tightening of abortion laws on women's health in Mexico. Their findings indicate that legalization led to a significant decline in maternal morbidity, particularly cases of haemorrhage in

the early stages of pregnancy, while the tightening of abortion laws in other regions did not result in any improvement in women's health outcomes. Similarly, Farin et al. (2024) showed in their study that the legalization of abortion improves women's health, as measured by maternal mortality rates. Mukhopadhyay and Katsikas (2024) found that restrictive abortion laws contribute to a deterioration in the population's mental health, with more frequent symptoms of anxiety and depression. Both studies focus on the United States. Taken together, the evidence suggests that liberalization of abortion laws tends to improve women's physical and mental health, while restrictions either have no effect or exacerbate health disparities.

Authors of other studies verified the impact of abortion law changes on crime rates. Donohue and Levitt (2019) indicated that, in the United States, the legalization of abortion contributed to a reduction in crime. Similarly, François et al. (2014) showed that in Western European countries, abortion legalization contributed to a reduction in crime rates. Other researchers also point to the economic consequences of abortion laws. Thus, Miller et al. (2023) found that, in the United States, women who had limited access to abortion procedures experienced a significant increase in financial hardship that persisted for several years.

There is also a small number of studies in the literature whose authors attempt to examine the direct impact of changes in abortion law on fertility rates. Their results are not conclusive. The first group of studies concerns the impact of the liberalization of abortion laws. Among the earliest works analysing the effects of abortion law liberalization on fertility are those by Levine et al. (1999) and Klerman (1999), both examining the consequences of the *Roe v. Wade*[2] decision in the United States. Using a difference-in-differences approach, the authors demonstrated that the legalization of abortion led to a 4–14% reduction in the number of births, with the largest effects observed among teenagers, unmarried women, and non-white populations. Levine and Staiger (2004) attempted to examine the impact of changes in abortion laws in the 1980s and 1990s in Eastern European countries. The study used a regression model. The authors' results suggest that the elimination of strict abortion restrictions significantly reduced the number of births and maternal deaths in a country. On the other hand, no such effect was observed associated with the elimination of moderately restrictive abortion restrictions. Pop-Eleches (2010), in turn, investigated the impact of lifting the abortion ban in Romania in 1989 on fertility levels, using a quasi-experimental design based on the difference-in-differences (DiD) method and cohort data from population censuses. His findings indicated that the liberalization of abortion laws led to a roughly 30% short-term decline in fertility and a 25% reduction over women's life cycles. The strongest effects were observed among women with lower educational attainment, suggesting that access to abortion and contraception constitutes a key determinant of reproductive behaviour. Similar conclusions were reached by Antón et al. (2018). They examined the impact on fertility

[2] *Roe v. Wade*, 410 U.S. 113 (1973).

rates of the liberalization of the abortion law in Uruguay in 2012, legalizing abortions up to the twelfth week of pregnancy. The study used the difference-in-differences method. The results suggest that this policy change led to a reduction of approximately 11% in the number of births due to unplanned pregnancies among women aged 20 to 34 years, with a secondary education. The negative impact of liberalization – from the point of view of fertility rates – was also noted by Ozbeklik (2014). In his analysis, using a regression model, he verified the impact of the liberalization of the law in the USA in 1970. Legislation repealing abortion restrictions led to an approximately 6% decrease in the rate of non-marital births among white women aged 15–20. The results indicated a greater long-term impact of the legal changes on African-American women of the same age, with a 7.5%–13% reduction in non-marital births.

While liberalization tends to reduce fertility, evidence from contexts where abortion access has been restricted points to the opposite pattern. Fischer et al. (2018) analysed the effects of three pieces of legislation introduced in Texas between 2011 and 2014 that significantly reduced funding for family planning services and imposed stricter operational requirements on abortion clinics. Using a difference-in-differences approach, the authors found that in counties which lost an abortion clinic within a 50-mile radius, the number of abortions among Texas residents fell by 16.7%, while the number of births increased by 1.3%. Moreover, the closure of publicly funded family planning clinics within a 25-mile radius led to a 1.2% increase in the number of births. The issue of legislative changes in Texas was also examined by Lindo et al. (2020), who, applying the same methodological approach, analysed the effect of distance to the nearest clinic on abortion rates. Their results indicate a significant, non-linear relationship between distance and the frequency of abortions: an increase in distance from less than 50 miles to 50–100 miles reduced the number of abortions by 13%, to 100–150 miles by 24%, and to 150–200 miles by as much as 40%. Further increases in distance, however, did not produce additional effects. Dench et al. (2024) examined the impact on fertility rates in selected US states of a Supreme Court decision that resulted in a total ban on abortion in 13 of them. The analysis compared the actual fertility rates in these states with what they would have been had the ban not been enacted. The study used the synthetic difference-in-differences (SDID) method. The results indicate that the abortion ban increased the number of births by an average of 2.3%. These effects were particularly large for Hispanic women (4.7%) and women aged 20–24 years (3.3%). The magnitude of change also depended on the geographical location of the states studied. Similar results were obtained by Bell et al. (2025), who conducted a study covering all US states between 2012 and 2023, analysing the effects of implementing total abortion bans or bans after the sixth week of pregnancy. Using a Bayesian panel data model, the authors estimated that in states affected by these restrictions, the number of births increased on average by 1.7% compared with the expected level, corresponding to approximately 22,000 additional births. The strongest effects were observed among younger, unmarried women with lower levels of education, belonging to racial minorities, and participating in the Medicaid program.

The final group of studies comprises those that find no relationship between changes in abortion policy and fertility rates. For example, Antón et al. (2016), using a descriptive analysis of data from 2010–2014, examined the impact of the liberalization of abortion laws in Uruguay on teenage fertility in Montevideo. The results showed no significant changes in the number or structure of births after the reform, which the authors attribute to the prior availability of contraception and pre-existing medical support practices. Møland (2016), employing the difference-in-differences method, analysed the impact of early abortion access in Oslo in the 1960s – where abortion was legal up to the twelfth week of pregnancy before being legalized throughout Norway – on women's reproductive behaviour. The results indicate that increased access to abortion delayed the timing of first births but did not affect the total number of children women had over their lifetimes. Fernández and Juif (2023) conducted a study using data on 195 countries over the period 1970–2019. The analysis used two-way fixed-effects models, where the dependent variable was the fertility rate, while among the independent variables, three indicators describing the level of liberalization of abortion laws in a country were used. In the vast majority of the estimated models, abortion reforms turned out to be insignificant predictors of fertility levels.

Despite extensive research on the broader social consequences of abortion law changes, empirical studies directly examining their effects on fertility remain limited. Most existing evidence concerns the impact of liberalization, while studies analysing the demographic consequences of abortion restrictions are comparatively scarce and geographically concentrated. The available empirical research on the demographic effects of tightening abortion laws comes exclusively from the United States, particularly from Texas and states affected by post-*Roe v. Wade* bans, leaving Europe and other regions largely unexplored in this regard. Existing findings indicate that legal changes can either increase or decrease fertility, depending on age, social status, and place of residence. Although most existing studies rely on the difference-in-differences (DiD) approach, few have applied more advanced quasi-experimental techniques, and none have utilized the augmented synthetic control method. To address these gaps, the present study examines total fertility, age-specific fertility, fertility by relationship status, and urban versus rural fertility in Poland following the 2020 abortion law reform. By applying the augmented synthetic control method with a donor pool of 32 European countries and carefully selected predictor variables, the study provides a robust framework to assess the effects of the legal reform on fertility outcomes.

III. ABORTION LAW IN POLAND AND EUROPE

After Poland regained independence in 1918, abortion was not defined in the Polish Penal Code until 1932. A total ban on abortion was in force, as specified in foreign criminal codes imposed during the period of the partitions. It

was considered an illegal procedure for which serious penalties were imposed. The situation changed in 1932, when the Criminal Code regulated the issue.[3] This lifted the total ban on abortion in favour of legalizing it in two cases: to save the health of the woman or when the pregnancy is the result of a crime. Between 1943 and 1945, during the Nazi occupation, the situation changed. During this period, the regulations allowed Polish women to carry out abortions without restriction. Another important change in the abortion law took place on 8 May 1956. On this day, the first Polish law concerning the termination of pregnancy[4] came into force. According to the provisions, a pregnancy could only be terminated if medical indications, difficult living conditions of the woman, or a reasonable suspicion of a crime justified it. In 1959, these provisions were amended so that a declaration of financial hardship was a sufficient condition for obtaining permission to terminate a pregnancy. The 1956 law was one of the most liberal in Europe, remaining in force until 1993.

Another important step from the point of view of the development of abortion law in Poland was the Act of 7 January 1993 on family planning, protection of the human fetus and the conditions of permissibility of abortion.[5] Abortion was legal in the following cases:

– the pregnancy posed a threat to the life or a serious threat to the health of the mother,

– when the death of the conceived child occurred as a result of measures taken to save the life of the mother or to counteract serious damage to the health of the mother,

– prenatal tests indicated severe and irreversible harm to the fetus,

– the pregnancy was the result of a criminal act.

Thus, through this act, the legalization of abortion was abandoned on the grounds of a difficult social situation, which significantly restricted access to these procedures in Poland. Although this legal ground reappeared in Polish legislation with the Act of 30 August 1996,[6] it was repealed on 18 December 1997, by a Constitutional Tribunal ruling declaring the provision unconstitutional.[7]

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[3] Regulation of the President of the Republic of Poland of 11 July 1932 – Penal Code (Rozporządzenie Prezydenta Rzeczypospolitej Polskiej z 11 lipca 1932 r. Kodeks karny), Journal of Laws of the Republic of Poland [JL] 1932, No. 60, item 571.

[4] Act of 27 April 1956 on the Conditions Permitting the Termination of Pregnancy (Ustawa z 27 kwietnia 1956 r. o warunkach dopuszczalności przerywania ciąży), JL 1956, No. 12, item 61.

[5] Act of 7 January 1993 on Family Planning, Protection of the Human Fetus, and Conditions of Permissibility of Termination of Pregnancy (Ustawa z 7 stycznia 1993 r. o planowaniu rodziny, ochronie płodu ludzkiego i warunkach dopuszczalności przerywania ciąży), JL 1993, No. 17, item 78.

[6] Act of 30 August 1996 Amending the Act on Family Planning, Protection of the Human Fetus, and Conditions of Permissibility of Termination of Pregnancy, and Certain Other Acts (Ustawa z 30 sierpnia 1996 r. o zmianie ustawy o planowaniu rodziny, ochronie płodu ludzkiego i warunkach dopuszczalności przerywania ciąży oraz o zmianie niektórych innych ustaw), JL 1996, No. 139, item 646.

[7] Judgment of the Constitutional Tribunal of 28 May 1997, K 26/96 (Wyrok Trybunału Konstytucyjnego z 28 maja 1997 r.), K 26/96, JL 1997, No. 157, item 1040.

The last significant event affecting abortion law in Poland, crucial for further empirical analysis, was the Constitutional Tribunal's judgment on 22 October 2020.[8] The Constitutional Tribunal ruled that allowing abortion in the case of fetal abnormalities was unconstitutional. The provision legalizing this procedure expired on 27 January 2021. As of that date, abortion is allowed in Poland only in two cases: when the pregnancy constitutes a threat to the life and health of the mother and when it is the result of a prohibited act.

As a result of this change, Poland is one of the few European countries with such restrictive abortion legislation. Currently, in 41 European countries, abortion is possible on demand, and the procedure depends solely on the woman's decision. Only 5 European countries have abortion laws so restrictive that they do not allow abortion on demand or for social reasons. These include Andorra, Liechtenstein, Malta, Monaco, and Poland. Andorra has a complete ban on abortion. Liechtenstein has the same restrictive abortion law as Poland – abortion is only permitted if the patient's life or health is at risk or if the pregnancy is the result of sexual violence. Monaco's law allows abortion only if the patient's life or health is endangered, the pregnancy is the result of sexual violence or involves serious impairment of the fetus. Maltese legislation permits the procedure when the patient's life is seriously endangered (The Center for Reproductive Rights, 2023).

IV. RESEARCH METHODOLOGY

The study used the synthetic control method proposed by Abadie and Gardeazabal (2003) and further developed by Abadie et al. (Abadie, 2021; Abadie et al., 2015) and Ben-Michael et al. (2021). This method allows the estimation of the impact of a policy intervention (treatment) on the individual under study. Let $i = 1, \ldots, N$ denote units and let $t = 1, \ldots, T$ denote time periods, with $i = 1$ receiving the intervention at To and the others forming the control group. W_i indicates treatment status ($W_1 = 1$, $W_i = 0$ for controls). Let $Y_{it}(1)$ denote the potential outcome that would have been observed for unit i in period t if there had been an intervention and $Yit(0)$ the outcome if there had been no intervention. The treatment effect for the first unit is:

$$\tau_{1t} = Y_{1t}(1) - Y_{1t}(0), \tag{1}$$

where $Y_{1t}(1)$ is observed and $Y_{1t}(0)$ is estimated from a weighted combination of control units. 10

Assume that $\boldsymbol{\gamma} = (\gamma_2, \ldots, \gamma_N)'$ is the vector of weights assigned to the units in the control group, for which the following restrictions are assumed:

$$\gamma_i \geq 0 \text{ for } i = 2, \ldots, N, \tag{2}$$

[8] Judgment of the Constitutional Tribunal of 22 October 2020, K 1/20 (Wyrok Trybunału Konstytucyjnego z 22 października 2020 r.), K 1/20, OTK ZU-A 2021, item 4.

$$\Sigma_{Wi} = {}_0\gamma_i = 1. \tag{3}$$

Using such a vector of weights, the following estimator $Y_1t(0)$ can be constructed:

$$Y_{1t}(0) = \Sigma_{Wi} = {}_0\gamma_i Y_{it}. \tag{4}$$

The main challenge lies in estimating the vector of weights $\boldsymbol{\gamma}$. Let $\boldsymbol{Y_i}$ denote the vector of the outcome variable under study for each unit i in the pre-intervention period, while $\boldsymbol{Z_i}$ denotes the vector of predictors (covariates) of this outcome variable. With this notation $\boldsymbol{X}_1 = (\boldsymbol{Z}_1', \boldsymbol{Y}_1')'$ describes the unit subjected to the intervention before the period To. In turn, the matrix X_0, each i-th column of which is $\boldsymbol{X_i} = (\boldsymbol{Z_i}', \boldsymbol{Y_i}')'$ $(i = 2, \ldots, N)$, describes the individuals in the control group. With these notations, the vector of weights in the standard synthetic control method, γscm, is the solution to the optimization problem:

$$\min_{\boldsymbol{\gamma}} \left\| \boldsymbol{V}^{\frac{1}{2}}(\boldsymbol{X_1} - \boldsymbol{X_o'\gamma}) \right\|_2^2 = \min_{\boldsymbol{\gamma}} [(\boldsymbol{X_1} - \boldsymbol{X_o'\gamma})'\boldsymbol{V}(\boldsymbol{X_1} - \boldsymbol{X_o'\gamma})], \tag{5}$$

with conditions:

$$\gamma_i \geq 0 \text{ dla } i = 2, \ldots, N, \tag{6}$$

$$\sum_{W_i=0} \gamma_i = 1, \tag{7}$$

where $\boldsymbol{V}$ is a symmetric, positively semidefinite matrix, determined a priori (e.g. unit matrix) or based on the observed data.

Using the vector of weights thus determined, the results for the synthetic unit in the pre-intervention period are computed as a linear combination of the results obtained for the control units. These results should match as closely as possible the actual outcomes of the treated unit. This fit can be measured, for example, by the root mean squared prediction error calculated using the formula: $\sqrt{\frac{1}{T_0}\sum_{t=1}^{T_0}(Y_{1t} - \sum \gamma_i^{scm} Y_{it})}$.

The bias of the SCM estimator arises from the assumed data generation process. Let us assume that:

$$Y_{it}(0) = m_{it} + \varepsilon_{it}, \tag{8}$$

where m_{it} is a function of the outcome and/or predictor variables in the pre-intervention period and the component responsible for the error ε_{it} has a mean equal to 0. The bias of the SCM estimator depends on the form of the m_{it} component.

The constraints in conditions (6) and (7) make the results easier to interpret. On the other hand, however, these constraints mean that obtaining

a sufficiently high fit is sometimes not possible. This occurs when, in the pre-intervention period, the values of the outcome variable and the predictor variables for the intervention unit $\boldsymbol{X}_1 = (\boldsymbol{Z}_1', \boldsymbol{Y}_1')'$ lie far from the convex hull of the values for the control units $\boldsymbol{X}_0$. In order to improve the fit, a number of extensions of the originally proposed synthetic control method have been proposed in the subsequent literature. To simplify the description, it is assumed that $\boldsymbol{X}_1$ and $\boldsymbol{X}_0$ only contain information in the outcome variable before the intervention. Ben-Michael et al. (2021) also present a derivation when additional predictor variables are present. Thus, the augmented synthetic control method (ASCM) estimates the bias arising from poor fit in the pre--intervention period using a regression model, and then attempts to adjust the SCM estimate by this bias. It is assumed here that the data generation process is described by equation (8). Let m_{iT} denote the estimator of m_{iT}. The estimator of the augmented synthetic control method for $Y_{1T}(0)$ can then be represented as:

$$\hat{Y}_{1T}^{aug}(0) = \sum_{W_i=0} \gamma_i^{scm} Y_{it} + \left(\hat{m}_{1T} - \sum_{W_i=0} \gamma_i^{scm} \hat{m}_{iT}\right). \tag{9}$$

It follows that it is the sum of the standard SCM estimator and an additional element, $\hat{m}_{1T} - \sum \gamma_i^{scm} \hat{m}_{iT}$, which is responsible for the bias correction. When the bias is small, the ASCM estimator is close to the SCM estimator. Assuming that $\hat{m}_{iT}$ is a linear combination of the pre-intervention results $\hat{m}(\boldsymbol{X}) = \hat{\eta}_0 + \hat{\boldsymbol{\eta}} \cdot \boldsymbol{X}$, the estimator of the augmented synthetic control method is as follows:

$$\hat{Y}_{1T}^{aug}(0) = \sum_{W_i=0} \gamma_i^{scm} Y_{it} + \sum_{t=1}^{T_0} \hat{\eta}_t \left(X_{1T} - \sum_{W_i=0} \gamma_i^{scm} X_{it}\right). \tag{10}$$

One of the estimators in the ASCM group is the Ridge ASCM estimator, which estimates using a linear model with ridge regularization, that is, $\hat{m}(X_i) = \hat{\eta}_0^{ridge} + X_i' \hat{\boldsymbol{\eta}}^{ridge}$ where $\hat{\eta}_0^{ridge}$ and $\hat{\boldsymbol{\eta}}^{ridge}$ are obtained by solving the following problem:

$$\arg\min_{\eta_0, \eta} \frac{1}{2} \sum_{W_i=0} (Y_i - (\eta_0 + X_i' \boldsymbol{\eta}))^2 + \lambda^{ridge} ||\boldsymbol{\eta}||_2^2. \tag{11}$$

Ridge regularization introduces a penalty term proportional to the squared magnitude of the coefficients, which stabilizes the estimates when predictors are highly correlated and reduces overfitting. This penalty shrinks the regression coefficients toward zero, preventing extreme values that could arise from multicollinearity. The regularization parameter λ^{ridge} controls the strength of the penalty and was chosen using cross-validation.

Substituting the defined $\hat{m}_{it}$ into equation (10) yields the Ridge ASCM estimator:

$$\hat{Y}_{1T}^{aug}(0) = \sum_{W_i=0} \gamma_i^{scm} Y_{iT} + \left(X_1 - \sum_{W_i=0} \gamma_i^{scm} X_i\right) \hat{\boldsymbol{\eta}}^{ridge}. \tag{12}$$

Alternatively, it can be written as:

$$\hat{Y}_{1T}^{aug}(0) = \sum_{W_i=0} \gamma_i^{aug} Y_{iT}, \tag{13}$$

where:

$$\boldsymbol{\gamma_i^{aug}} = \boldsymbol{\gamma_i^{scm}} + (\boldsymbol{X_1} - \boldsymbol{X_0'\gamma^{scm}})'\left(\boldsymbol{X_0'X_0} + \lambda^{ridge}\boldsymbol{I_{T_0}}\right)^{-1}\boldsymbol{X_i}\,, \tag{14}$$

where I_{T_0} is the identity matrix. In this form, the Ridge ASCM weights $\boldsymbol{\gamma_i^{aug}}$ are the solution to the problem:

$$\min_{\boldsymbol{\gamma}} \frac{1}{2\lambda^{ridge}} \|\boldsymbol{X_1} - \boldsymbol{X_0'\gamma}\|_2^2 + \frac{1}{2}\|\boldsymbol{\gamma} - \boldsymbol{\gamma^{scm}}\|_2^2\,, \tag{15}$$

subject to constraint (3).

It is worth noting that, in this case, the $\boldsymbol{\gamma_i^{aug}}$ weights may be negative. For this reason, the fit obtained using Ridge ASCM yields a pre-intervention fit that is as good as or better than that obtained using the standard synthetic SCM control method (i.e. $\|\boldsymbol{X_1} - \boldsymbol{X_0'\gamma^{eug}}\|_2^2 \leq \|\boldsymbol{X_1} - \boldsymbol{X_0'\gamma^{scm}}\|_2^2$).

V. RESEARCH SAMPLE AND ASSUMPTIONS CONCERNING THE CONDUCTED STUDY

The aim of the empirical study is to verify whether, and to what extent, the tightening of the abortion law in Poland, which took place in 2020, has affected the fertility rate. The augmented synthetic control method was used for its implementation. The study sample included the treated unit, Poland, and a donor pool composed of EU member states as well as selected non-EU European countries (Iceland, Norway, Switzerland, Serbia, North Macedonia, and the United Kingdom).[9] The selection of countries was based on the availability of empirical data. The year 2020 was set as the moment of intervention – a ruling by the Constitutional Tribunal.

In the subsequent steps of the research, it was assumed that different variables would serve as the outcome variable Y_{it}. In the first step of the analysis, the total fertility rate, denoted hereafter by Y_{total}, was used, followed by fertility rates by age, calculated as the ratio of the number of live births by mothers in a given age group to the average population of women in that group. The female age ranges used were 15–19, 20–29, 30–39, and 40–49, designated as Y_{15-19}, Y_{20-29}, Y_{30-39} and Y_{40-49}, respectively. Data on these variables covered the period from 1950 to 2023. The study also used fertility rates by women's relationship status, calculated as the ratio of the number of children born to women who are in or out of wedlock to the total number of women, designated as $Y_{inmarriage}$ and $Y_{outsidemarriage}$. In this case, the studied period was

[9] Malta was excluded from the EU sample due to its highly restrictive abortion law.

1990–2022, due to data availability. The last outcome variable examined was total fertility, broken down by rural and urban areas (Y_{rural}, Y_{city})

Additionally, the study considered 8 potential predictor variables: GDP per capita (at purchasing power parity), urbanization rate (%), unemployment rate (%), social benefit expenditure (% of GDP), percentage of women aged 15–64 with tertiary education (%), healthcare expenditure (% of GDP), average age of women at childbirth, and average age of women at the birth of the first child. For these variables, average values from the period 2011–2020 were used. The selection of predictor variables was based on their availability and the literature review. Finally, for each outcome variable, the predictor variables were chosen to minimize the root mean squared prediction error (RMSPE) for the periods 1950–2020 (for variables Y_{total} , Y_{15-19}, Y_{20-29}, Y_{30-39}, Y_{40-49}) and 1990–2020 (variables $Y_{inmarriage}$, $Y_{outsidemarriage}$).

All the data used in the study were sourced from the Central Statistical Office database (2025), Eurostat (2025b), and Our World in Data (2025).[10]

VI. RESULTS OF THE EMPIRICAL STUDY

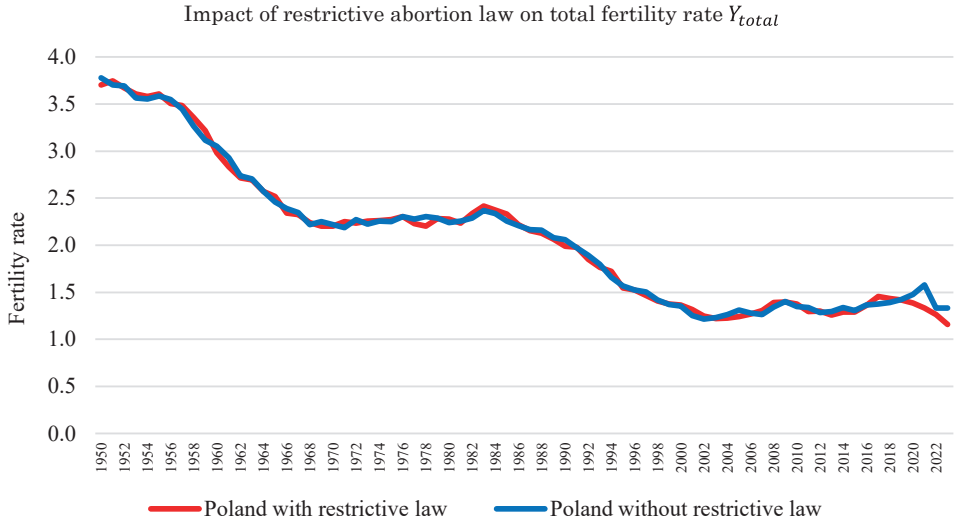
Following the procedure of the augmented synthetic control method and based on the data described in the previous section of the article, a synthetic unit was first constructed. It illustrates hypothetical fertility trajectories for Poland where the abortion law was not tightened following the Constitutional Tribunal ruling in 2020. Comparing the fertility rates of the synthetic unit with actual results for Poland helped determine whether, and to what extent, the tightening of the abortion law affected them. The first outcome variable analysed was the total fertility rate Y_{total}. Figure 1 illustrates how fertility rates would have evolved in synthetic Poland (without restrictive abortion laws) compared to their actual values in Poland (with restrictive abortion laws).

An analysis of the graph indicates that in the pre-intervention period (1950–2020), the two trajectories were very similar. This is demonstrated by the root mean squared prediction error (RMSPE), which was 0.04, or only 2.09% of the average level of the studied variable during this period. Thus, it can be concluded that it was possible to construct a synthetic unit that reflects very well the behaviour of the fertility rate for real Poland before the Constitutional Court ruling. However, more important for the purposes of the study is the period 2021–2023. The fertility rate values for synthetic Poland, where there was no restrictive abortion law, are higher than those observed in reality. The differences are respectively: 0.25 (18.83% change) for 2021, 0.07 (5.53%) for 2022, and 0.18 (15.24%) for 2023. In order to verify the reliability of the results obtained, placebo tests were conducted over time and space. In the case of the first study, the analysis was again performed, but this time it was assumed that the Constitutional Court ruling took place in 2014. Figure 2 shows how the value of fertility rates would have developed in such a situation. As before, the fit of the

[10] All calculations were performed using the *R* statistical environment and the augsynth package (version 0.2.0), which is available at https://github.com/ebenmichael/augsynth

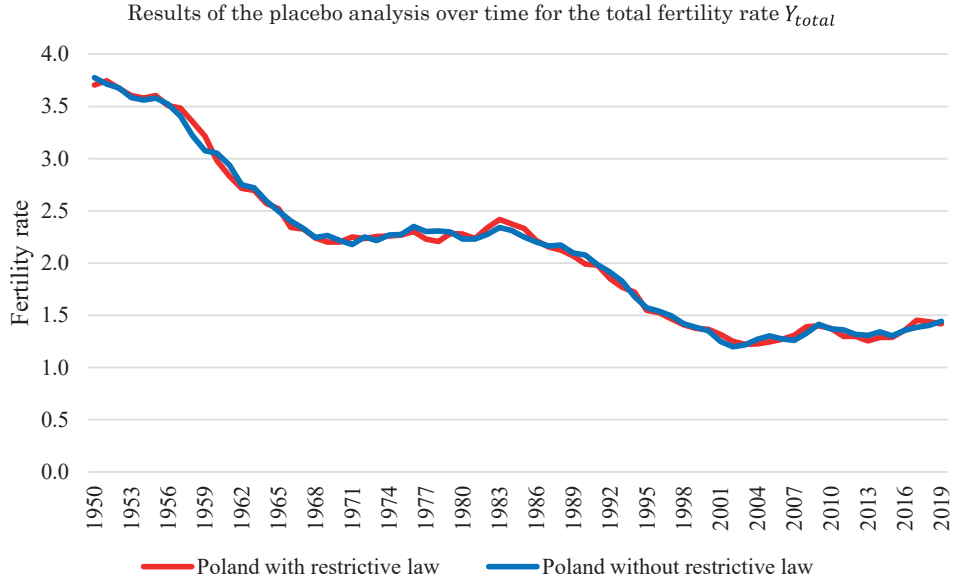
trajectory before the intervention period is very good (RMSPE equal to 0.05). This time, however, there is no clear response in the post-intervention period, for 2015–2019. Such a situation is in line with expectations. A significant reaction would indicate low reliability of the results obtained earlier.

Figure 1



Source: the author's calculations, based on data from Central Statistical Office (2025), Eurostat (2025b) and Our World in Data (2025).

Figure 2

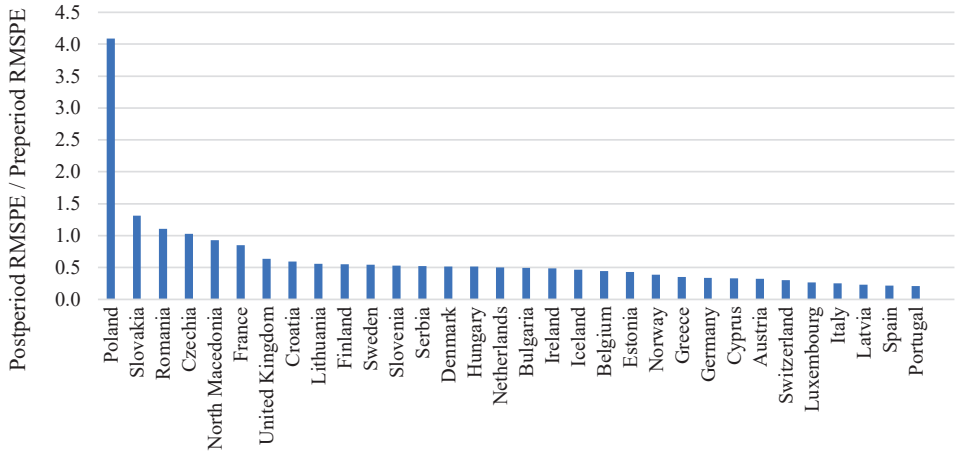


Source: the author's calculations, based on data from Central Statistical Office (2025), Eurostat (2025b) and Our World in Data (2025).

The placebo study in space involved performing 32 analogous analyses, each assuming that a different country from the donor pool was subjected to the intervention. In this way, it is possible to juxtapose the effects of a policy intervention for Poland and those that would have been obtained for any other country (where, in fact, this intervention – a change in the law – did not occur). The intervention effect for Poland is considered significant if it is substantially larger than the estimates for other countries. Figure 3 shows the ratio of the primed root mean square error of RMSPE for the period 2021–2023 to the same error for the period 1960–2020 for all analysed countries. RMSPE measures the size of the gap (difference) in fertility rates between each country and its synthetic counterpart. A high RMSPE after the intervention does not necessarily indicate a strong intervention effect if the RMSPE was also high before the intervention. For this reason, the error quotient, shown in Figure 3, is important. As shown in the figure, this ratio is highest for Poland. In Poland, the gap after the policy intervention is more than 4 times larger than before the intervention. This confirms that Poland experienced the strongest intervention effect and that the previously obtained results are reliable.

Figure 3

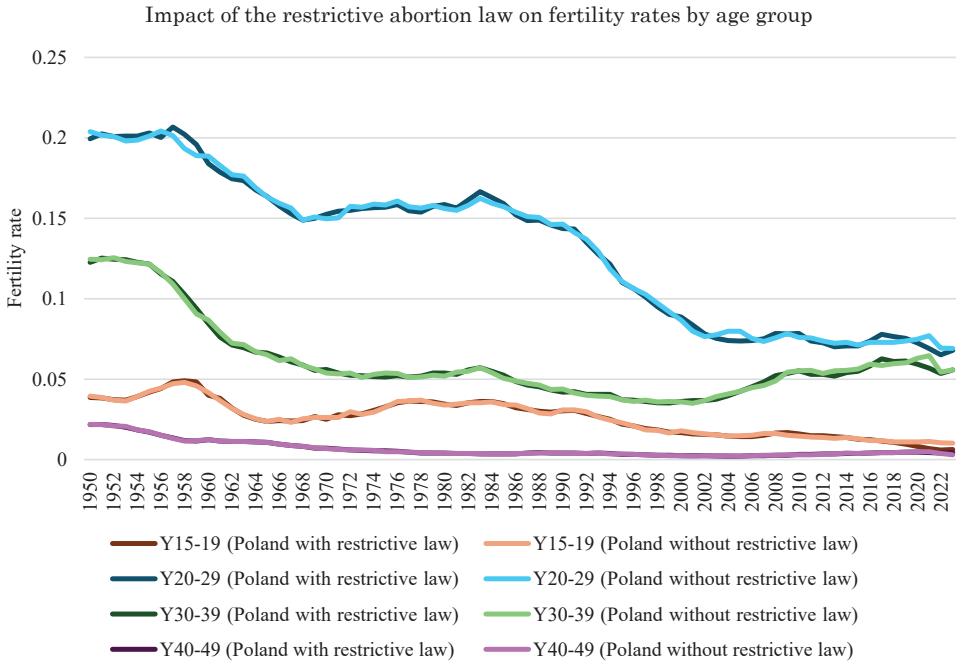
Results of the placebo analysis in space for the total fertility rate Y_{total}



Source: the author's calculations, based on data from Central Statistical Office (2025), Eurostat (2025b) and Our World in Data (2025).

In the next stage of the study, analogous analyses were conducted for fertility rates by mother's age – the outcome variables were $Y_{15-19}, Y_{20-29}, Y_{30-39}, Y_{40-49}$, as described earlier. The results for all age groups are presented in Figure 4.

Figure 4



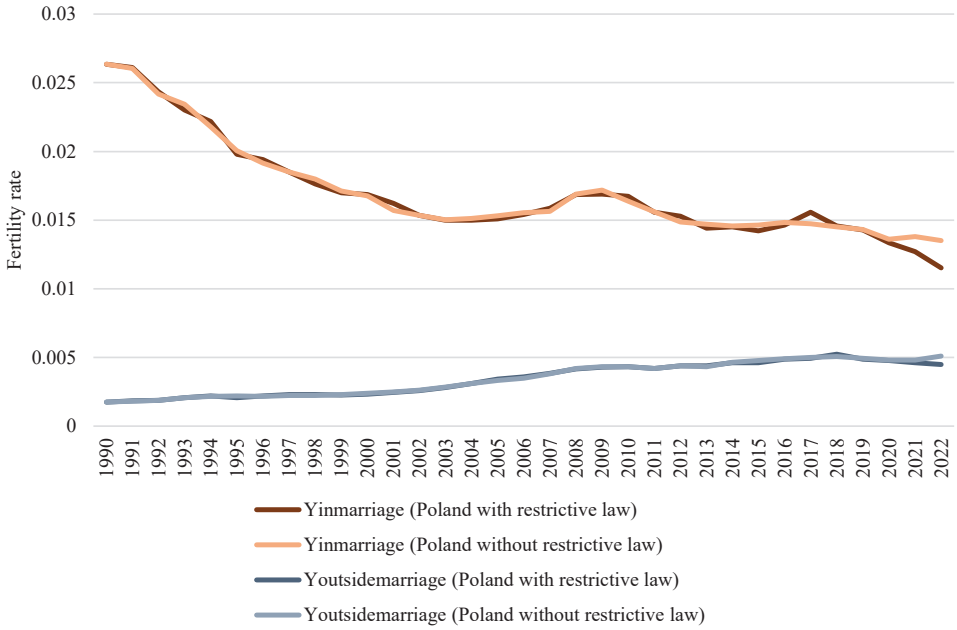
Source: the author's calculations, based on data from Eurostat (2025b) and Our World in Data (2025).

A key feature of each graph is the strong fit of the curves during the 1950–2020 period. The ratio of the root mean squared error to the average level of the variable under study ranged from 2.20% in the age group 20–29 to a maximum of 3.57% for women aged 15–19. It can be concluded from this that the research method used made it possible to construct synthetic units representing Poland without the restrictive abortion law, which reflect well the level of fertility rates before the change in the law. However, from the point of view of the study, the shape of the graphs in the period 2021–2023 is crucial. The results indicate that the largest difference in fertility rates between Poland with and without the restrictive law occurs among women aged 15–19. As a result of the introduction of the restrictive abortion law, fertility rates in this age group decreased by 67.22% in 2021, 77.76% in 2022 and 64.41% in 2023, respectively. A similar pattern was observed for the 20–29 and 30–39 age groups. In 2021, the fertility rate decreased by between 11.31 to 13.27%, while in subsequent years the differences were smaller, with a maximum of 6.49%. For women aged 40–49, the reduction in the level of fertility rates occurred only in 2021 and amounted to 10.65%.

In the next step of the study, a similar analysis was performed for fertility rates for married and unmarried women (Figure 5).

Figure 5

Impact of restrictive abortion laws on fertility rates:
married women ($Y_{inmarriage}$) and unmarried women ($Y_{outsidemarriage}$)



Source: the author's calculations, based on data from Eurostat (2025b).

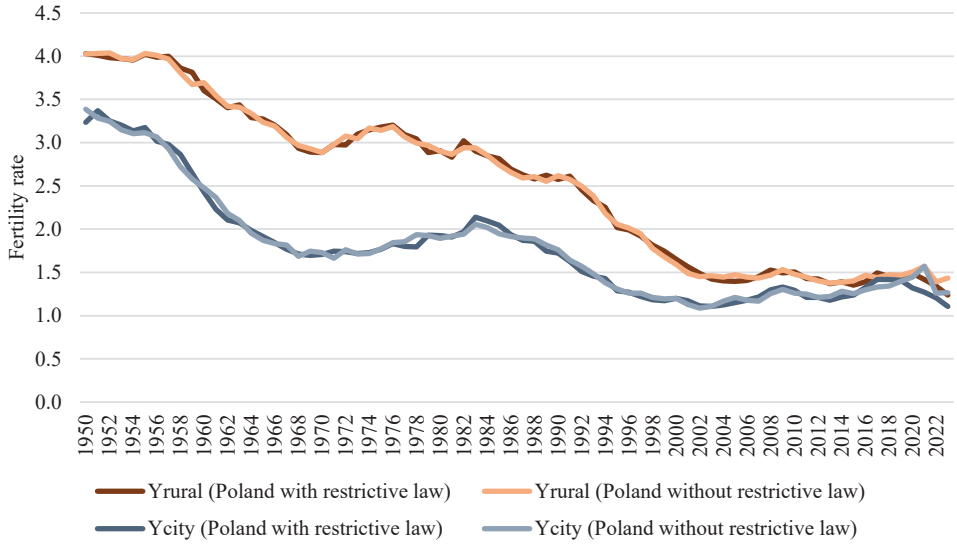
For both outcome variables, the trajectory fit before the law change was strong. The corresponding root mean squared errors for the analysed fertility rates were low, at 1.65% and 1.83%, respectively. As in the previous figures, it is evident that fertility rates would be higher in a country without restrictive abortion laws. The differences are greater for married women (differences of 8.52% in 2021 and 17.24% in 2022) than for mothers giving birth outside marriage (3.98% and 13.31%, respectively).

In the final stage of the analysis, a similar study was conducted, this time comparing fertility rates in rural and urban areas of Poland (Figure 6).

The trajectory fit before the law change remained strong, with relative errors of 1.84% and 3.16%. Notably, the fertility rate decline in cities during the first year after the abortion law change was more than twice as large as in rural areas – 23.78% versus 10.65%. In the subsequent years, the changes were of a similar magnitude.

Figure 6

Impact of restrictive abortion laws on fertility rates in rural (Y_{rural}) and urban (Y_{city}) areas



Source: the author's calculations, based on data from Central Statistical Office (2025), Eurostat (2025b) and Our World in Data (2025).

VII. DISCUSSION AND CONCLUSIONS

A global decline in fertility rates has been systematically observed. This presents a significant demographic and economic challenge. An ageing population leads to a shrinking workforce, placing pressure on pension and healthcare systems. Governments in many countries are trying to counteract this situation with measures such as tax incentives, family benefits, and extended parental leave. Meanwhile, most countries have recently amended their abortion laws. With few exceptions, these changes have trended toward liberalization. Empirical studies suggest that changes in abortion laws influence fertility rates, though the direction of this relationship remains unclear. Further research is essential to gain a deeper understanding of this issue.

The primary goal of this empirical analysis was to determine whether, and to what extent, the tightening of abortion laws in Poland affected fertility rates. The results indicate that the legal change in Poland led to a decline in the total fertility rate. The decline varied between 5.53% and 18.83% during the study period. Placebo analyses over time and regions confirmed the reliability of the findings. The magnitude of this effect varied. The impact of legal changes was stronger among mothers aged 15–19, married women, and urban residents. These findings contradict previous research. Dench et al. (2024)

found that stricter abortion laws increased fertility rates. Conversely, Levine and Staiger (2004), Antón et al. (2018), and Ozbeklik (2013) argued that liberalizing abortion laws, rather than tightening them, leads to lower fertility rates. None of these studies focused on a single European country. This study is the first to apply the augmented synthetic control method to analyse the impact of abortion law changes on fertility.

The tightening of abortion laws in Poland has led to a decline in fertility rates, contrary to supporters' expectations. Restricting abortion access has heightened uncertainty among women and families, prompting them to delay or forgo having children. Several factors may have contributed to this. The first factor was maternal health and safety, as women feared that doctors might delay intervention due to the restrictive law. Another concern was the direct consequence of the legal change in Poland – the obligation to carry pregnancies with severe fetal defects to term. This situation imposes a significant psychological, physical, and financial burden. Moreover, mothers raising children with disabilities cannot rely on consistent state support. These assumptions are supported by the study's findings. The strongest response to the legal changes was observed among young women aged 15–19. This group was the most affected by the legal changes. This is primarily due to financial constraints, as well as social and familial pressures that limit access to alternative abortion methods. Older women in the study had greater financial and social resources in this regard. They also had a higher rate of planned pregnancies and a greater desire to start a family compared to younger women. Therefore, abortion restrictions played a smaller role in their reproductive decisions. A similar pattern can be observed regarding relationship status. Married women are more likely to consider long-term factors when making family planning and child-rearing decisions. Restrictions on abortion rights may have led them to reconsider having children due to health and social concerns. The same trend applies to the place of residence. Urban residents were likely more aware of legal and health implications than those in rural areas, which may explain their stronger response to legal changes. Conservative social norms in rural areas may shape attitudes toward family and motherhood, potentially leading to a smaller decline in birth rates following legal changes.

When interpreting the findings of this empirical study, it is important to bear in mind that, despite the legal changes in Poland significantly limiting access to abortion, Polish women can still obtain the procedure abroad or use medication-induced abortion. The prevalence of this phenomenon has significantly increased since 2020. For instance, the Abortion Without Borders initiative reported that within three years of the ruling, it assisted over 125,000 people from Poland in accessing safe abortion services (Aborcja bez granic, 2023). Another important limitation is that the analysed period overlaps with two major external shocks: the COVID-19 pandemic and the war in Ukraine. Both events significantly affected demographic behaviour in Poland and across Europe. While the augmented synthetic control method mitigates this issue by comparing Poland with other countries exposed to these shocks,

it cannot be ruled out that their effects were stronger or different in Poland than in the donor pool. Therefore, part of the observed changes may reflect not only the impact of the abortion law but also the consequences of the pandemic and the war. A key limitation of this study is the availability of data. Since only four years have passed since the legal change, the period available for studying its impact on fertility remains limited. Repeating the analysis in the future would provide valuable insights into the long-term effects of the Constitutional Tribunal's ruling. Existing literature highlights women's education levels as one of the most significant factors influencing fertility rates. Therefore, conducting a follow-up study that examines fertility rates while accounting for women's education levels appears justified.

Author contributions / Indywidualny wkład autora (CRediT): **Sergiusz Herman** – 100% (Conceptualization / Konceptualizacja; Data curation / Zarządzanie danymi; Investigation / Przeprowadzenie badań; Formal analysis / Formalna analiza; Methodology / Metodologia; Resources / Zasoby; Software / Oprogramowanie; Supervision / Nadzór; Validation / Walidacja; Visualization / Wizualizacja; Writing – original draft / Pisanie – pierwszy szkic; Writing – review & editing / Pisanie – recenzja i edycja).

Conflict of interest / Konflikt interesów: The author declares no conflict of interest. / Autor nie zgłosił konfliktu interesów.

Funding / Finansowanie: The author declares no institutional funding. / Autor oświadczył, że nie korzystał z finansowania instytucjonalnego.

The use of AI tools / Wykorzystanie narzędzi AI: The author declares no use of AI tools. / Autor oświadczył, że nie korzystał z narzędzi AI.

Data availability / Dostępność danych: The data is available on request. / Dane dostępne na życzenie.

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