Public Spending and Fertility: The Case of Rodzina 500+ in Poland

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Abstract

This paper examines the causal relationship between public cash transfers and fertility rates through the case study of the Rodzina 500+ program, implemented in Poland in 2016. The program represents one of the most ambitious pronatalist policies in Europe, providing unconditional monthly payments to families with children. Using a synthetic control combined with a difference-in-differences (Diff-in-Diff) approach and an Event Study approach, this study evaluates whether such direct financial incentives can significantly influence reproductive behavior in a developed country context. We leverage demographic and economic data across European countries to construct a credible counterfactual and assess the magnitude of the policy's effects.

Beyond fertility outcomes, we discuss the program's fiscal implications and its role in broader debates about intergenerational equity and aging societies. Our findings contribute to the literature on cash-based pronatalist policies, providing evidence on their effectiveness in a high-income, low-fertility context.

Keywords: Fertility, Public Spending, Rodzina 500+, Pronatalist Policy, Synthetic Control Method, Difference-in-Differences, Family Policy

I warmly thank Thomas Vendryes for his valuable help and for his trust.

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1 Introduction

1.1 The European Context: Demographic Challenges and Pronatalist Strategies

Pronatalist policies play a central role in the current concerns of many European countries. Hungary, Italy, Poland, and Germany, to name just a few, have implemented various initiatives aimed at ”demographically rearming” their populations, to use Emmanuel Macron’s formula, during the last decades. Indeed, fertility is a key indicator that has been significantly declining in Europe (Figure 1), a phenomenon that, coupled with increasing life expectancy, directly leads to demographic aging (Figure 2). As of 2022, the total fertility rate (TFR) in the European Union averaged 1.46 children per woman. Life expectancy in the EU reached 81.5 years, further amplifying the aging dynamic, thus, the share of Old people in the population have surge, especially during last years, reshaping the Age pyramid structure in all European countries *(Appendix A)*. These policies, diverse both in their forms and intentions, try to address multiple issues. They include financial benefits and tax advantages, improvements in early childhood care services, the extension of maternity and paternity leave, as well as gender pay equality policies. The underlying intentions of these measures are also varied: some explicitly aim to encourage fertility (pronatalist policies), while others support gender equality and/or seek to assist vulnerable families.

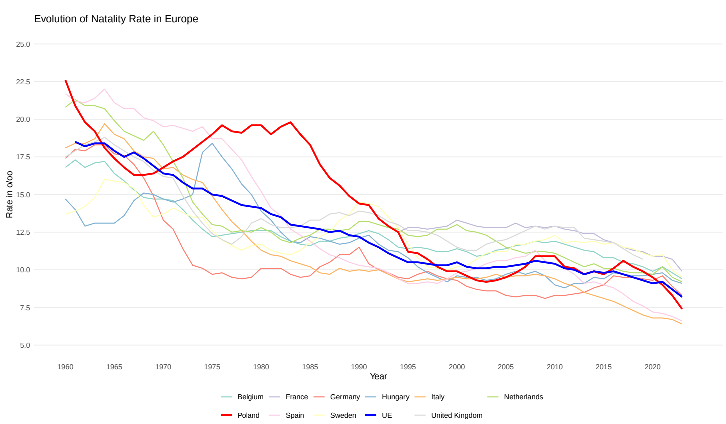

Figure 1: Evolution of Natality rate in Europe

Distribution of Age Groups in Europe

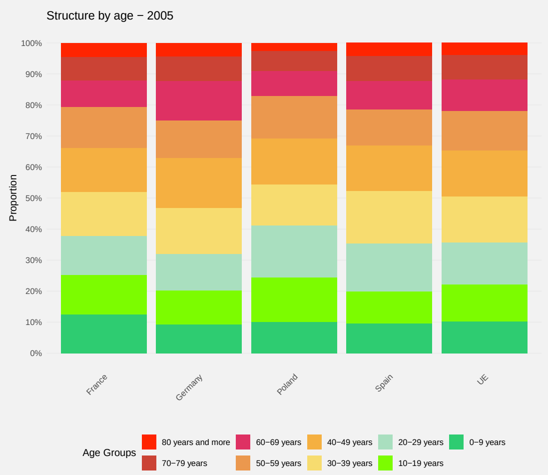

Figure 2: Distribution of Age Groups in Europe in 2005

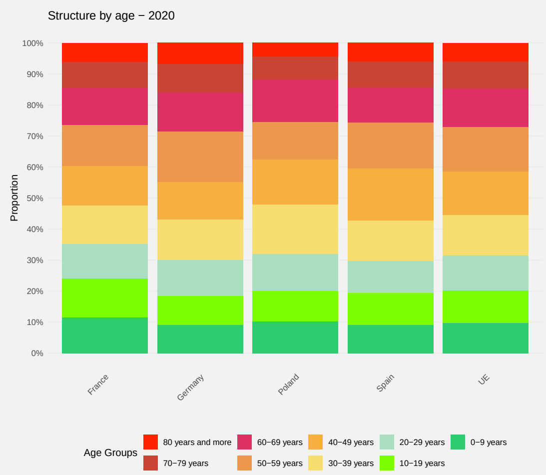

Figure 3: Distribution of Age Groups in Europe in 2020

Natalist policies primarily aim to address two key demographic issues: declining fertility rates and population aging. While both declining fertility and increased longevity contribute to aging, it is the sustained drop in fertility rates that plays the dominant role, rather than lower mortality. Indeed since approximatly the 2000s, european economies have shifted from a demographic dividend situation to a demographic burden (Bloom and Kotschy, 2003, 2025), responsible for a slowdown in per capita growth. Indeed, until recently, European countries benefited from the age structure of their populations, particularly the ratio of the working-age population to the total population, but now they are suffering from it. The share of the working-age population (15–64 years old) in the EU has fallen from 67.2% in 2000 to 64.1% in 2020 and is projected to drop below 60% by 2040, thus the Dependency ratio increase progressivly in all Europeane contries (Figure 4). With the decline of this ratio, output per capita decreases arithmetically, the labor market tightens, and productivity also slows due to the aging of the population and the inability of older workers to adapt to the digital world (Paccagnella, 2016). The Solow growth model (Solow and Swan, 1956) provides useful insights into the economic consequences of declining natality. In this framework, a reduction in the labor force N leads to a decline in total output Y, meaning that lower birth rates negatively affect aggregate economic growth. However, output per worker $y = \frac{Y}{N}$ may actually increase as a result of a smaller labor force, since fewer workers allow for greater capital accumulation per capita—a mechanism known as capital deepening.

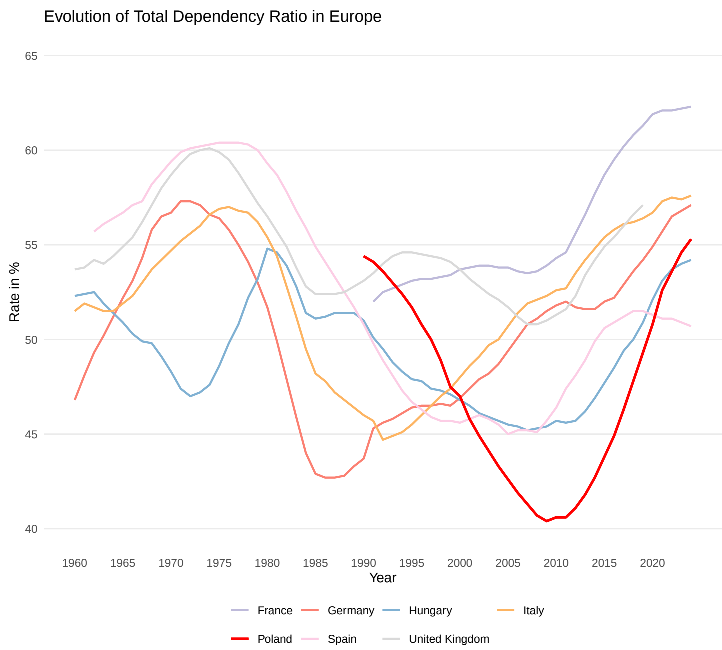

Figure 4: Evolution of Dependency ratio in Europe

Furthermore, this aging places pressure on public spending, with the constant increase in financing pensions, healthcare, and long-term care services (Rouzet, 2019), leading to an increase in the debt of European countries and/or the crowding out of public spending that stimulates innovation and growth. Public pension spending in the EU already represents 12.7% of GDP and could rise by up to 2 percentage points by 2040 (European Commission, 2021). Long-term care expenditures are also projected to increase by 1.2% of GDP on average. The effect of aging on investment is ambivalent: on the one hand, with the increase in savings volume combined with the relative rise in the price of labor compared to capital—linked to the tightening of the labor market—investment in labor-substitution technologies should increase, as well as capital per worker. However, the rate of total capital accumulation could slow down despite higher capital per worker due to the contraction of the workforce and complementary capital to workers. The shift of workers toward increasingly demanding, less automatable, and low-productivity sectors—such as healthcare and personal care—could also have a significant impact on investment, which, according to much of the literature, should decline (Lee, 2016; Goodhart and Pradhan, 2017; Aksoy et al., 2019). Thus, the ageing population caused by the slowdown in fertility rates is partly responsible for the economic slowdown and challenges to the sustainability of certain social programs (Bloom et al., 2010; Malmberg, 2010; McDonald, 2006; OECD, 2011; Werding, 2011)

Additionally, birth rates are a strategic issue. Economically, they allow for large markets and significant outlets, which disincentivizes trade wars. They also increase the tax base, thereby boosting investments in strategic infrastructure. Militarily, a young and abundant population allows for the swelling of army personnel and can enable an increase in military equipment production. Throughout history, demographics have defined the growth or decline of great powers and influenced their relative weight compared to other nations (Terranova, 2023). Thus, the "law of numbers" (Dumont, 2019) partly dictates natalist policies.

Finally, natalist policies are often used, particularly in Hungary, Italy or Poland, as a substitute for immigration. Indeed, in response to the cultural, security, and economic challenges linked to immigration, these governments have decided to tighten their immigration policies and compensate for them with proactive natalist policies (Szalma and Heers, 2024). In 2015, only 2.2% of Poland's population was foreign-born, compared to the EU average of over 12.5% (Figure 5). Meanwhile, Hungary's family support program reached 4.5% of its GDP in 2021—the highest in the OECD.

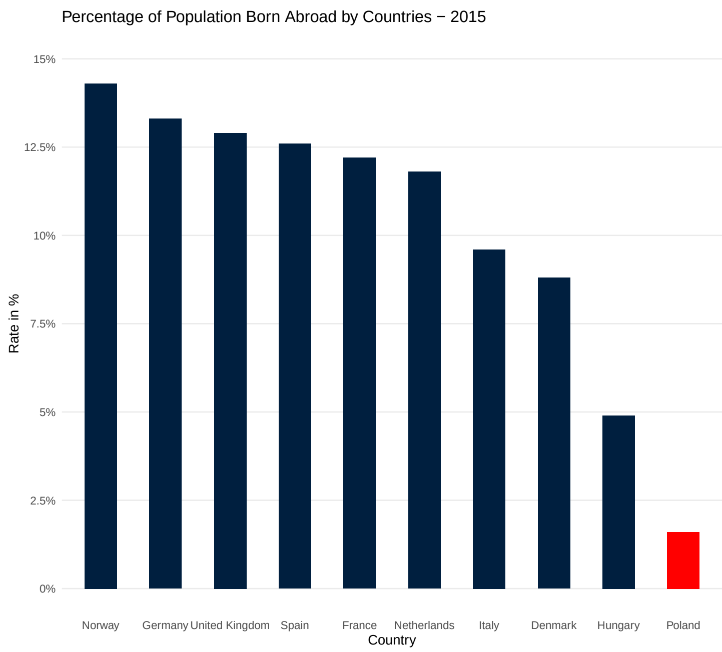

Figure 5: Percentage of Population Born Abroad by Europeen Countries in 2015

Considering all of this, it seems relevant to analyze the impact of such policies, which are multiplying across Europe and to question their overall effectiveness and relevance. The purpose of this paper is to evaluate the impact of the ”Rodzina 500+” program, implemented in Poland in 2016. This study will focus on assessing the effectiveness of this policy, while addressing the key issues identified in the economic literature. Through this analysis and the examination of the specific case, I aim to provide valuable insights into the rationale behind the implementation of pro-natalist policies through financial incentives. The paper will be structured into 4 sections.

First, I will introduce the Rodzina 500+ policy and review the existing literature on pro-natalist incentives. Next, I will outline the empirical framework used to estimate the policy's impact on birth rates. Subsequently, I will present the results, discuss the study's limitations, and finally I will conclude with key findings and implications.

1.2 The Rodzina 500+ Program: A Case of Pronatalist Policy in Poland

Even if, Natality is declining all around the European continent, the situation is not the same across countries, Poland is one of the more impacted countries *(Appendix A)*. Since the 1960s, Poland has experienced a continuous and concerning decline in birth rates. In 1960, the total fertility rate stood at 2.98 children per woman, well above the replacement level (2.1). However, shortly after the fall of the USSR, both the fertility rate and the birth rate began to drop steadily and have continued to decline to this day. By 1995, the fertility rate had fallen to 1.62, and by 2003 it had reached 1.22. In 2015, just before the introduction of the Rodzina 500+ program, the fertility rate was 1.32 and the birth rate was 9.7 ‰. Even more worrying is the annual number of births, which exceeded 700,000 at the end of the 1950s but dropped to around 370,000 in 2015. Since 2002, Poland has had a negative natural population balance, meaning that each year, the number of deaths exceeds the number of births (Figure 6).

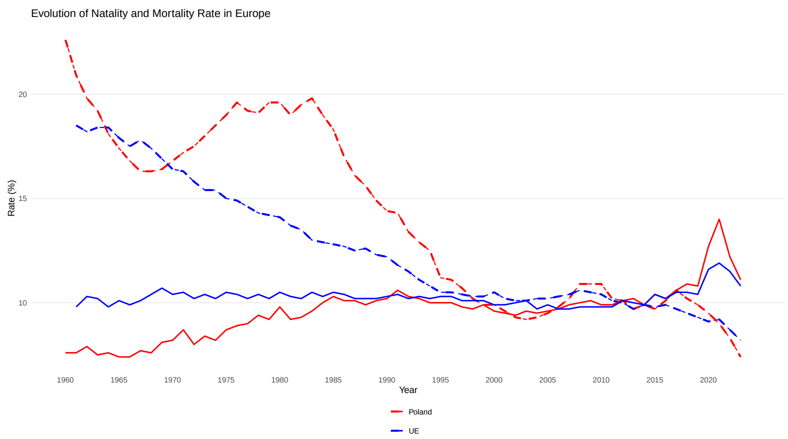

Figure 6: Evolution of Natality and Mortality Rate in Europe

In response to this alarming situation, the Polish government launched the Rodzina 500+ program on April 1, 2016. This policy aimed to support families and encourage childbirth. Initially, the program provided a monthly allowance of 500 PLN per child, unconditionally from the second child onward. For the first child, the benefit was means-tested (800 PLN per person, or 1,200 PLN in the case of a disability). This distinction was intended to prioritize larger and low-income families. However, the government gradually expanded the program: as of July 1, 2019, it became universal, meaning that every child, starting with the first, was eligible for the 500 PLN allowance, regardless of household income.

Rodzina 500+ represents one of the cornerstones of modern family policy in Poland. It marks a paradigm shift: for the first time, the Polish state offers substantial and stable support to all families, based on a logic of redistribution and direct encouragement of childbirth. In this respect, the program stands apart from earlier measures, which were often modest and income-based.

1.3 The Impacts of Natalist Policies on Fertility: A State of the Art Review

The effect of family policies on fertility has been the subject of extensive debate within the scientific literature. While several studies conclude that support measures for families have a positive—albeit moderate—effect, the precise nature of this impact often remains difficult to determine (Gauthier and Hatzius, 1997; Sleebos, 2003; OECD, 2011; Sobotka, 2011; Thévenon and Gauthier, 2011). Two theoretical concepts help to better qualify this impact: the tempo effect and the quantum effect, conceptualized by Bongaarts and Feeney (1998).

The quantum effect refers to a lasting change in the total number of children per woman—that is, a real variation in completed fertility. This effect reflects a profound shift in individual preferences or constraints, often linked to long-term social, cultural, or economic transformations. In contrast, the tempo effect denotes a mere shift in the timing of births, without altering the total number of children. It occurs when couples adjust the timing of childbirth, for instance by accelerating births to benefit from a windfall such as a birth grant or temporary financial support. This mechanism changes the temporal distribution of births without resulting in a sustained increase in fertility.

Besides, the literature highlights that the effects of pronatalist policies vary depending on the type of measure implemented, with some compelling cases being particularly well-studied:

- **Family allowances and tax credits:** These measures are generally associated with a positive but modest impact on fertility. (Gauthier, 1997) estimate that a 25% increase in family allowances could raise the total fertility rate by 0.07 across

22 industrialized countries. Long-term allowances appear to support the quantum effect more effectively than lump-sum payments at birth (Luci, 2012). However, some studies challenge these results, reporting no significant effect on either the timing or the number of births (Kalwij, 2010).

- **Birth grants and baby bonuses:** These one-time financial incentives often produce a tempo effect by encouraging earlier births, without affecting the total number of children. Their limited financial scope makes them insufficient to influence completed fertility (Thevenon, 2011).

- **Parental leave:** Effects remain ambiguous. Better-paid parental leave may affect the timing of childbirth, but not its overall quantum (Kalwij, 2010). Moreover, for women waiting for stable employment, these policies might delay parenthood and inadvertently increase infertility risks linked to age (Thevenon, 2011).

  Childcare services: Among all family policies, the availability of childcare services is the one that most consistently shows a positive effect on fertility. This is true both for direct financial support for childcare (such as childcare allowances) (Sleebos, 2003) and for the provision of institutionalized childcare services (Castles, 2003; Apps and Rees, 2004), particularly for children under the age of three (Luci and Thévenon, 2012). These services are most effective when they are affordable and of high quality. In countries such as Norway and Sweden, reductions in childcare costs have been associated with increased fertility (Mörk et al., 2009; Rindfuss et al., 2007). However, this effect is not universal. In Germany, for example, the availability of childcare has not shown a significant impact on fertility rates (Hank and Kreyenfeld, 2001).

In this context, the Rodzina 500+ program in Poland can be interpreted as a family allowance transfer policy, primarily aimed at strengthening financial support for families. As a monetary benefit paid per child, it resembles policies that tend to produce a tempo effect—encouraging parents to accelerate childbirth in order to take advantage of the program—rather than fostering a sustained increase in completed fertility. Besides, Rodzina 500+ is not a one-time payment and is designed as a permanent measure, this permanence does not necessarily ensure a quantum effect but encourage it. Moreover, in an environment where public trust in government continuity and policy stability is low, reliance on the program's long-term availability is uncertain (Premik, 2022). This skepticism regarding the benefit's durability may lead families to treat it as temporary, thereby prompting short-term fertility decisions instead of lasting changes in reproductive behavior. Consequently, despite its ongoing nature, Rodzina 500+ may operate similarly to short-term pronatalist incentives when viewed through the lens of institutional distrust.

The literature specifically examining the impact of the Rodzina 500+ program in Poland remains relatively scarce; however, several studies offer valuable insights. Anna Bokun (2024) identifies a moderate, short-term positive effect on fertility, with outcomes varying by income level, age, and broader socio-economic conditions. Likewise, Bartnicki and Alimowski (2022) report that the program led to a 4.5% monthly increase in births from its launch until the end of 2017. However, by mid-2019—when the benefits were extended to first-born children—the program no longer had a measurable effect on birth rates. (Bartnicki Alimowski, 2022)

A key limitation of the former study, as acknowledged by its author, is its inability to capture medium- and long-term effects. This constraint prevents a clear distinction between tempo effects (a shift in the timing of births) and quantum effects (an increase in the total number of births). Addressing this distinction is essential, as it directly influences the assessment of the policy's effectiveness and long-term relevance. Therefore, by analyzing the Rodzina 500+ program, my objective is to determine whether its impact was primarily tempo or quantum. In doing so, I aim to contribute to the literature by examining both short-term and long-term effects—factors that are crucial for evaluating the overall efficiency of the policy.

2 Data and Empirical Strategie

2.1 Empirical strategy

Fertility is a particularly complex demographic phenomenon, influenced by a multitude of economic, social, cultural, and psychological factors—many of which are difficult to observe or quantify. Fertility decisions can depend on individual preferences, expectations regarding economic stability, social norms about family life, the role of women in the labor market, or even perceptions of and trust in public policies (Becker, 1960).

In this context, evaluating the impact of the Rodzina 500+ policy on the fertility rate using a simple OLS regression or even a fixed effects model presents several notable limitations (Lundborg et al., 2005). A simple regression does not allow for the control of unobserved determinants that may influence both the implementation of the policy and fertility behaviors. As a result, there is a high risk of omitted variable bias, which undermines any causal interpretation. Fixed effects models, while helpful in controlling for time-invariant characteristics specific to regions or countries and for shocks common to all units at a given time, fail to account for unit-specific trends. Yet both Poland and many European countries were already experiencing a structural decline in fertility prior to the reform, and not accounting for these differentiated trends can lead to biased estimates.

In this context, the Difference-in-Differences (DiD) method emerges as a more relevant approach. By comparing changes in fertility rates before and after the reform between a treated group and a control group, DiD aims to isolate the causal effect of the policy—provided that the pre-treatment trends are parallel between the two groups. This method improves causal identification by eliminating both fixed differences between groups and common time shocks.

However, the reliability of the DiD approach depends heavily on the quality of the control group. It is often difficult to identify a single country—or even a set of countries—with fertility dynamics closely resembling those of Poland before the policy intervention. To address this challenge, the construction of a synthetic control group offers a robust alternative. This method involves creating a weighted combination of untreated countries that best replicates Poland's pre-policy fertility trend. This synthetic control thus serves as a credible counterfactual, estimating what would have happened in Poland in the absence of the policy.

Mathematically, the synthetic control method solves an optimization problem that aims to minimize the discrepancy between the pre-intervention characteristics of the treated unit (Poland) and a convex combination of control units. Specifically, it seeks a weight vector $W = (w_1, w_2, \dots, w_J)$, with $w_j \geq 0$ and $\sum_{j=1}^{J} w_j = 1$, that minimizes the squared distance:

$$\|X_1 - X_0 W\|^2,$$

where X_1 is the vector of pre-treatment characteristics of the treated unit, and X_0 is the matrix of corresponding characteristics of the control units. This approach allows for a flexible, data-driven construction of a counterfactual that better captures the underlying dynamics in the absence of treatment.

Applying a Difference-in-Differences estimation between Poland and this synthetic group then allows for the identification of the policy's net effect, while controlling for common global trends—such as broader economic or cultural shifts affecting fertility across Europe. The combination of these two approaches therefore strengthens the validity of the analysis by reducing selection bias and better satisfying the parallel trends assumption (Abadie et al., 2010).

To further explore the dynamics of the policy's effect over time, and not just a before-after contrast, an event study design provides additional analytical value. This method estimates the policy's impact at multiple time points relative to its implementation—both before and after—allowing for a visualization of the policy's temporal profile. The event study approach offers several key advantages (Kothari and Warner, 2005). First, it makes it possible to test the parallel trends assumption directly by examining whether there are significant differences in trends between treated and control units before the policy was enacted. If the pre-treatment coefficients are statistically indistinguishable from zero, it supports the credibility of the design. Second, by mapping out the evolution of the treatment effect over several years, the event study can uncover delayed or anticipatory effects, as well as duration and persistence of impact—elements that are particularly relevant when evaluating demographic behavior, which often adjusts gradually rather than abruptly.

Nonetheless, the validity of the event study approach—like DiD—rests on strong assumptions. It requires that no other major events or policies differentially affect the treatment and control groups during the window of observation. Moreover, the structure of the event study model assumes that the timing of treatment is exogenous and that no dynamic treatment effects are confounded by anticipatory behavior or selection into treatment. When implemented alongside synthetic control techniques and DiD, the event study provides a powerful complementary framework for assessing the robustness and dynamics of policy impact, while enabling rich causal inference in complex policy settings such as fertility (Ciccia, 2024).

2.2 Data

To construct a credible and robust counterfactual for Poland in evaluating the impact of the *Rodzina 500+* policy, I selected a broad set of variables primarily sourced from Eurostat, with additional indicators from the OECD and EIGE (European Institute for Gender Equality) *(Appendix B)*. The aim was to ensure that Poland could be compared to countries that are similar not only in economic and demographic terms but also in cultural, social, and institutional dimensions.

Demographic indicators such as mean age of women at childbirth, crude birth and death rates, fertility rate, age dependency ratios, and median age of the population capture the underlying population structures, which are key determinants of fertility behavior. Gender-related variables, such as the share of women in parliament and senior government positions, reflect gender norms and equality, which directly influence family formation dynamics.

From a socioeconomic perspective, variables such as median earnings, GDP per capita, male and female unemployment rates, social protection expenditure, overcrowding rate, and average household size help characterize living standards, labor market conditions, housing quality, and overall economic well-being—all of which play a significant role in fertility decisions. Measures of inequality, such as the Gini coefficient, along with educational outcomes (PISA low achievers, tertiary graduates by sex), offer insight into social stratification and future prospects for individuals and households.

Health indicators, including life expectancy, infant mortality, and health expenditure, provide a sense of healthcare system quality, which can influence decisions about having children. Immigration data disaggregated by gender accounts for population structure changes due to migratory flows.

Lastly, broader indicators such as life satisfaction, at-risk-of-poverty rates, single-parent households, and the foreign-born population share help reflect the social and cultural environment of a country.

By combining these demographic, economic, educational, social, health, and cultural dimensions, the variable selection allows for the construction of a synthetic control unit that closely mirrors Poland's pre-treatment trajectory. This multidimensional approach enhances the credibility of the counterfactual and strengthens the causal interpretation of the policy effect.

2.3 Counterfactual Construction

To credibly estimate the causal effect of the Rodzina 500+ policy on birth rates, I constructed three synthetic control groups, each using a different number of covariates: one based on 30 variables, one with 15, and one with only 5 *(Appendix C)*. This strategy allows for testing the robustness of results to the choice of predictors. Using a larger number of variables captures the complexity of fertility dynamics more thoroughly by including a wide range of economic, social, and demographic dimensions. However, the more variables included, the harder it becomes to find a synthetic control that closely mirrors Poland, as the optimization process has more constraints, potentially reducing overall similarity. On the other hand, reducing the number of predictors improves the closeness of the synthetic control to Poland's aggregate pre-treatment values, but at the cost of omitting potentially important explanatory dimensions. This trade-off between thematic coverage and proximity justifies the construction of multiple counterfactuals.

The donor pool is composed exclusively of European countries, selected for their cultural, institutional, and economic proximity to Poland, which strengthens the validity of the comparison. Hungary and Italy were excluded because they implemented similar family policies during the same period, which could bias the estimation by contaminating the control group.

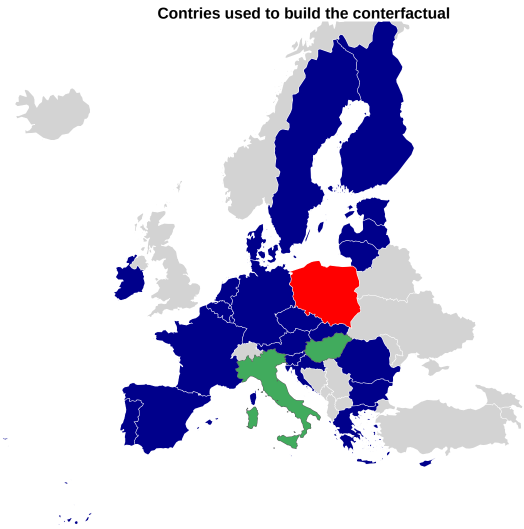

Figure 7: Countries used to Build Counterfactuals

The pre-treatment period begins in 2008, given data availability, and ends in 2014, 2015, or 2016 depending on the specification. This variation allows for robustness checks and sensitivity to the chosen time window. In addition, I conducted placebo tests for the years 2015, 2016, and 2017 to examine the presence of potential anticipation effects—households may adjust their fertility decisions in expectation of the policy—as well as the impact of the biological delay associated with gestation, which naturally creates a lag between the decision to conceive and the observable birth.

Before computing the synthetic control, I standardized the data over the pre-treatment period by subtracting the mean and dividing by the standard deviation. This z-score normalization harmonizes the scale of the data across different units, preventing any single unit with large absolute values from dominating the construction of the synthetic donor. Once the data were standardized, I applied the weights from the synthetic control model to the control units (the donor countries) to construct a synthetic trajectory. This approach allows for a more rigorous comparison of relative trends, focusing on standardized deviations rather than absolute levels.

To assess the credibility of the constructed synthetic control groups, it is essential to evaluate how closely the synthetic units replicate the pre-treatment characteristics of the treated unit (Poland). Two key metrics are commonly used for this purpose: the Root Mean Squared Prediction Error (RMSPE) and the Euclidean distance between predictor variables.

The RMSPE measures the average deviation between the observed outcome of the treated unit and that of the synthetic control during the pre-treatment period. Mathematically, if Y_{1t} denotes the observed outcome for the treated unit at time t, and $\hat{Y}_{1t}$ the corresponding synthetic control outcome, then the RMSPE over T_0 pre-treatment periods is defined as:

$$RMSPE = \sqrt{\frac{1}{T_0}\sum_{t=1}^{T_0}(Y_{1t} - \hat{Y}_{1t})^2}.$$

A lower RMSPE indicates a better fit of the synthetic control to the treated unit's trajectory before the intervention, enhancing confidence in the counterfactual's validity.

The Euclidean distance, on the other hand, quantifies the difference between the vector of pre-treatment predictors of the treated unit, X_1, and the weighted combination of predictors in the donor pool, X_0W, used to construct the synthetic control:

$$d = \|X_1 - X_0W\| = \sqrt{\sum_{k=1}^{K}\left(X_{1k} - (X_0W)_k\right)^2},$$

where K is the number of predictor variables. This distance measures the closeness of the synthetic control to Poland in terms of underlying structural characteristics.

Balancing these two measures is crucial: a synthetic control with a low RMSPE ensures a close match in outcome trajectories, while a low Euclidean distance confirms similarity in relevant covariates. However, increasing the number of predictors (30, 15, or 5) imposes stricter constraints that may raise the Euclidean distance or RMSPE, reflecting a trade-off between thematic richness and fit quality.

Year	Controls	Pre (RMSPE)	Post (RMSPE)	Ratio (RMSPE)	Euclidean Distance
	30	0.1153	0.3986	3.4580	20.8427
2015	15	0.0664	0.3379	5.0889	5.2077
	5	0.1244	0.6451	5.1860	2.7102
	30	0.4037	0.4341	1.0754	25.3105
2016	15	0.0849	0.4427	5.2166	4.7324
	5	0.1222	0.7125	5.8306	2.7306
	30	0.4535	0.4778	1.0538	25.5614
2017	15	0.0679	0.4599	6.7696	4.2949
	5	0.1651	0.6889	4.1725	2.1167

Table 1: Euclidean distance, pre-, post-, and ratio RMSPE for counterfactuals by year and control group size

The results in the table reveal that synthetic controls using an intermediate number of predictors (15 controls) offer the best compromise between statistical precision and similarity with the treated case. While models with only 5 controls do show the smallest Euclidean distances (indicating good geometric proximity), their higher pre-treatment RMSPE ratios (e.g., 0.1244 in 2015) suggest a weaker ability to accurately capture the complex dynamics of Polish fertility rates. Conversely, configurations with 30 controls, though theoretically more comprehensive, produce excessive Euclidean distances (consistently exceeding 20) and degraded predictive performance.

The comparative analysis demonstrates that specifications with 15 controls—including the 2016 version with an optimal pre-treatment RMSPE (0.0849) and a moderate Euclidean distance (4.7324)—constitute the most robust counterfactuals. We note that the 5-control model also shows interesting characteristics.

These results validate the preferential use of 15-control synthetics for rigorously assessing the impact of the Rodzina 500+ program via Synthetic Control, Difference-in-Differences, and event study methods, while highlighting how sensitive the conclusions are to parametric choices.

	5 contrôles			15 contrôles			30 contrôles		
Variable	Synth.	Treat.	Gap	Synth.	Treat.	Gap	Synth.	Treat.	Gap
GDP per capita in thousand EUR	12.87	10.14	-2.72	12.43	10.00	-2.43	16.29	10.00	-6.29
Gender Equality Index	55.73	55.88	0.16	55.26	55.76	0.51	55.49	55.76	0.27
Average household size	2.75	2.80	0.05	2.77	2.80	0.03	2.69	2.80	0.11
Life expectancy at birth	77.17	77.21	0.05	77.11	77.11	0.00	76.92	77.11	0.19
Share of women in total population	51.53	51.61	0.08	51.41	51.62	0.20	51.74	51.62	-0.13
Mean age of women at childbirth	–	–	–	28.86	28.88	0.02	29.18	28.88	-0.31
Infant mortality rate	–	–	–	5.04	4.47	-0.57	4.68	4.47	-0.20
Gini coefficient of equivalised disposable income	–	–	–	32.88	32.94	0.06	30.86	32.94	2.08
Proportion of seats held by women in national parliaments	–	–	–	22.43	20.74	-1.69	21.37	20.74	-0.64
Crude marriage rate	–	–	–	4.20	5.21	1.02	5.20	5.21	0.02
Unemployment rate – Males	–	–	–	62.97	64.45	1.48	64.49	64.45	-0.04
Current health expenditure by financing scheme (in thousand)	–	–	–	0.96	0.67	-0.29	1.31	0.67	-0.64
Tertiary education graduates – Males (levels 5–8)	–	–	–	0.80	1.07	0.27	0.94	1.07	0.13
Share of women aged 15–40 in total population	–	–	–	33.87	36.98	3.10	35.68	36.98	1.29
Overcrowding rate	–	–	–	–	–	–	32.92	44.55	11.63
At-risk-of-poverty rate	–	–	–	–	–	–	15.49	17.30	1.81
Social protection expenditure	–	–	–	–	–	–	18.62	19.07	0.45
Low achievers in reading – Males (PISA)	–	–	–	–	–	–	30.66	19.35	-11.31
Low achievers in reading – Females (PISA)	–	–	–	–	–	–	14.78	7.10	-7.68
Low achievers in mathematics – Males (PISA)	–	–	–	–	–	–	24.99	17.57	-7.41
Low achievers in mathematics – Females (PISA)	–	–	–	–	–	–	24.76	17.26	-7.50
Overall life satisfaction	–	–	–	–	–	–	6.95	7.33	0.38
Women in senior ministerial positions	–	–	–	–	–	–	16.54	24.15	7.61
Median hourly earnings in PPS by sex, public sector	–	–	–	–	–	–	7.42	7.17	-0.25
Unemployment rate – Females	–	–	–	–	–	–	57.25	52.29	-4.96
Single-parent households by number of children	–	–	–	-	-	-	0.00	0.00	0.00
Immigrants by sex – female	–	–	–	–	–	–	0.34	0.35	0.01
Immigrants by sex – male	–	–	–	–	–	–	0.41	0.57	0.16
Live births outside marriage per 1,000 population	–	–	–	–	–	–	30.68	22.05	-8.63
Tertiary education graduates – Females (levels 5–8)	–	–	–	–	–	–	0.21	0.28	0.07

Table 2: Average Difference during the Pre-treatment period between Poland and its 2016 Counterfactuals

Nonetheless, it is important to emphasize that while these metrics provide valuable information about the goodness of fit and covariate similarity, they do not guarantee the validity of the crucial parallel trends assumption underlying Difference-in-Differences analyses. The parallel trends assumption requires that, absent the treatment, the treated and control units would have followed similar trajectories over time. Thus, additional tests—such as examining pre-treatment trends graphically and through placebo or event study analyses—remain necessary to reinforce causal inference.

Pays	30 controls	15 controls	5 controls
Austria	0.00	0.00	0.00
Belgium	0.00	0.00	0.00
Bulgaria	0.00	0.00	0.33
Croatia	0.57	0.06	0.46
Cyprus	0.00	0.00	0.00
Czechia	0.00	0.01	0.00
Denmark	0.00	0.00	0.00
Estonia	0.00	0.00	0.00
Finland	0.07	0.00	0.00
France	0.00	0.00	0.00
Germany	0.00	0.00	0.00
Greece	0.00	0.00	0.00
Ireland	0.04	0.00	0.08
Latvia	0.08	0.00	0.02
Lithuania	0.00	0.00	0.00
Luxembourg	0.00	0.00	0.00
Malta	0.00	0.00	0.00
Netherlands	0.00	0.00	0.00
Portugal	0.00	0.00	0.00
Romania	0.00	0.44	0.00
Slovakia	0.24	0.27	0.02
Slovenia	0.00	0.13	0.00
Spain	0.00	0.08	0.07
Sweden	0.00	0.00	0.00

Table 3: Weights of countries in synthetic control groups of 2016

2.4 The Difference-in-Difference and the Event Study

The constructed synthetic counterfactuals, particularly the 2016 version based, show satisfactory characteristics for analysis: they faithfully reproduce Poland's pre-treatment trends (low pre-2016 RMSPE) and rely mainly on Eastern European countries like Croatia, Slovenia, Slovakia, Romania and Bulgaria, which is consistent with their socio-cultural and economic similarity to Poland. The slightly weaker performance of the 2015 counterfactual (post/pre RMSPE ratio close to 1) could be explained by an adjustment lag in reproductive behaviors following the policy announcement. Morover, The research design incorporates several robust features to ensure causal identification:

- **No other idiosyncratic shocks**: Systematic exclusion of countries with concurrent family policies (Hungary, Italy) eliminates spillover effects
- **Stable comparison group**: The synthetic control weights Eastern European countries with similar socioeconomic profiles
- **Independent interventions**: The nationally focused Rodzina 500+ design minimizes cross-country dependencies

But in order to confirm the validity of the DiD approach, it remains essential to graphically and statistically verify the parallel trends assumption before 2016, and to examine the sensitivity of results to different time windows.

Evolution of Natality Rate in Poland and its Counterfactual

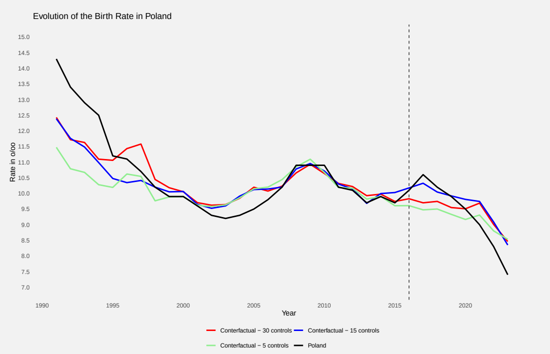

Figure 8: Evolution Since 1990

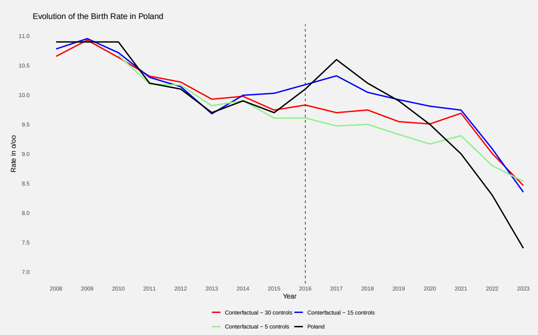

Figure 9: Evolution Since 2008

To empirically test this assumption, we estimated a linear regression model for each Poland–control group pair using only the pre-treatment period, including an interaction term between country and year. The interaction term (Poland $\times$ Year) is used to detect any potential divergence in trends between the two groups prior to treatment. The absence of statistical significance for this term suggests that there is no systematic difference in the slope between the two series before the intervention, indicating that the parallel trends assumption is reasonably satisfied.

	30 controls	15 controls	5 controls
Poland	88.940	89.993	-3.244
	(80.084)	(99.402)	(86.830)
Year	-0.159***	-0.159***	-0.205***
	(0.028)	(0.035)	(0.031)
Poland X Year	-0.044	-0.045	0.002
	(0.040)	(0.049)	(0.043)
Constant	330.832***	329.778***	423.015***
	(56.628)	(70.288)	(61.398)
R^2	0.875	0.820	0.882
Adjusted R^2	0.844	0.775	0.852
Residual Std. Error	0.182	0.226	0.198
F Statistic	28.117***	18.235***	29.889***

Note: $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

Table 4: Pre-trend Analysis of Birth Rate Determinants: Poland vs 2016 Counterfactual Groups

The results show that, for all nine synthetic control groups tested, none of the interaction terms are statistically significant, which strengthens the credibility of the subsequent DID estimates. This pattern is also confirmed visually: when plotting the pre-treatment trajectories of Poland and its synthetic controls, the trends appear to evolve in parallel prior to the treatment year.

However, it is important to note that this remains a weak test, as it relies on historical data and cannot guarantee that the trends would have remained parallel in the absence of treatment. Nevertheless, in practice, this verification—both statistical and visual—is widely accepted as a minimal requirement for the validity of DID models.

The relatively high R^2 and adjusted R^2 values suggest a good explanatory power without signs of overfitting, confirming that the model fits the pre-treatment data well while penalizing unnecessary complexity.

Difference-in-Differences and Event Study Specification with an Observed Control Group (Synthetic Control) To evaluate the impact of the policy, I estimated two difference-in-differences (DiD) models over different time horizons: the first covering the period 2010–2019 to capture short-term effects, and the second spanning 2010–2022 to assess medium/long-term effects. Besides, my event study analysis also covers the 2010–2022 period, allowing for an examination of the dynamic evolution of the effects around the policy implementation. The estimated models are:

$$Y_{it} = \alpha + \theta \cdot (Treated_i \times Post_t) + \mu_i + \lambda_t + \varepsilon_{it},$$

where Y_{it} denotes the birth rate for unit i at time t, $Treated_i$ equals 1 for Poland and 0 for its synthetic control, and $Post_t$ equals 1 from 2016 onward (post-treatment). The terms μ_i and λ_t are unit and year fixed effects, respectively, controlling for time-invariant differences between units and common shocks over time. The error term is ε_{it}, and θ captures the average treatment effect.

To examine dynamic effects surrounding the policy introduction, an Event Study specification is used:

$$Y_{it} = \alpha + \sum_{k \neq -1} \theta_k \cdot D_{it}^k + \mu_i + \varepsilon_{it},$$

where D_{it}^k indicates whether year t is k periods relative to treatment (2016) for unit i, with $k = -1$ omitted as the baseline. This setup allows treatment effects to vary over time and enables testing for pre-treatment trends and post-treatment dynamics.

Justification of the Specification Unit fixed effects μ_i absorb all time-invariant heterogeneity across units, including any baseline differences not perfectly captured by the synthetic control weights. Meanwhile, year fixed effects λ_t control for common time shocks, such as macroeconomic or demographic trends affecting all units.

Together, these fixed effects isolate the causal effect θ by removing confounding factors that are constant across units or over time.

Methodological Choice for Statistical Inference in the Synthetic Control Method Although Difference-in-Differences (DID) and Event Study estimations may appear straightforward, their application in a context with only one treated unit—Poland—raises significant challenges for statistical inference. Conventional p-values and standard errors reported from fixed-effects regressions rely on large-sample approximations, which are valid only when multiple treated and control units are present. In this case, those assumptions are violated: treatment assignment is neither random nor replicated, which likely leads to underestimated standard errors and inflated statistical significance. This issue is particularly pronounced for clustered standard errors over time or units, which tend to be unreliable when there are few clusters or limited variation in treatment status.

To overcome these limitations, I follow recent recommendations (e.g., Abadie et al., 2010; Roth, 2022) and adopt an empirical inference strategy based on placebo tests, applied to both the DID and Event Study frameworks. This method involves re-estimating the same model under placebo treatments, by shifting the treatment pretending that other control units were treated. The resulting placebo effects form a reference distribution under the null hypothesis of no treatment effect. The empirical p-value is then calculated as the proportion of placebo estimates that are as large or larger than the observed one. This approach better accounts for uncertainty in the estimation process and provides robust inference without relying on asymptotic assumptions. I apply this methodology to assess the robustness of both average and dynamic treatment effects.

Formally, this approach compares the estimated treatment effect for the treated unit, denoted $\hat{\tau}_{treated}$, to a distribution of placebo estimates $\hat{\tau}_j$ obtained from units that were not actually treated ($j \neq treated$) or from periods where treatment is artificially reassigned (e.g., leads or lags in treatment timing). The empirical inference relies on constructing a **non-parametric p-value** defined as:

$$\hat{p} = \frac{1}{J} \sum_{j=1}^{J} 1\left(|\hat{\tau}_j| \geq |\hat{\tau}_{treated}|\right)$$

where:

- $1(\cdot)$ is the indicator function,
- J is the number of placebo estimates considered,
- $\hat{\tau}_j$ denotes the estimated effect under a placebo treatment assignment for unit j.

To ensure the credibility of the placebo distribution, I exclude control units whose synthetic control poorly fits the treated unit during the pre-treatment period. Specifically, any unit with a pre-treatment Root Mean Squared Prediction Error (RMSPE) exceeding three times that of Poland—the treated unit—is removed. This step avoids distortions caused by poorly matched synthetic controls and ensures that empirical p-values more accurately reflect the uncertainty around the estimated effects.

3 Results

3.1 Results

First, the event plots provide valuable insights into the impact of the Rodzina 500+ policy on the birth rate in Poland. These plots allow us to track the evolution of the differences between Poland and a synthetic control group composed of 15 countries, both before and after the implementation of the policy in 2016. A key observation is the parallel trend between Poland and the control group during the pre-treatment period (from year -6 to -1). The coefficients during this interval are small and statistically insignificant, which strengthens the credibility of the analytical framework and the validity of the constructed counterfactual.

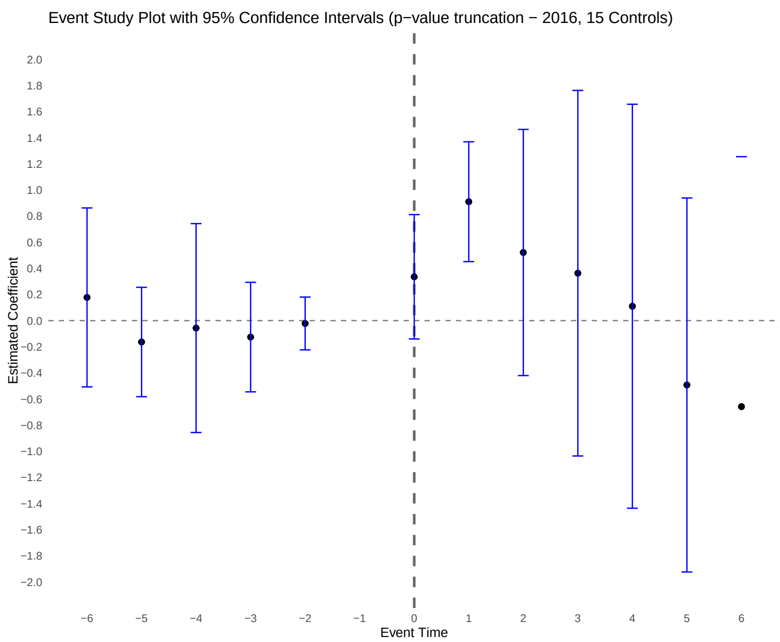

Figure 10: Event Study Plot with 95% Confidence Intervals (pvalue truncation 2016, 15 Controls)

Regarding the policy's impact, the plot reveals that the main effect materializes in

2017, one year after its official implementation. The absence of a significant effect in 2016 (year 0) suggests no anticipation of births, aligning with the natural biological delay between policy announcement and actual births. In 2017 (year 1), the effect is clearly positive and statistically significant, with a coefficient of approximately 0.91. This suggests that the policy may have led to nearly one additional birth per 1,000 inhabitants—a notable effect at the national level, indicative of a short-term increase likely driven by a temporary acceleration of birth plans.

However, this effect diminishes in subsequent years. From 2018 to 2020 (years 2 to 4), the coefficients remain positive but gradually decline and lose statistical significance. In the longer term (years 5 and 6), the coefficients turn slightly negative (down to -0.66), though without statistical significance. This pattern is characteristic of a tempo effect, indicating a shift in the timing of births rather than a permanent increase in the total number of children. Such dynamics are well documented in the literature on cash-based pronatalist policies, which often influence birth timing more than completed fertility.

These findings are further corroborated by event plots centered on 2015 and 2017, presented in the appendix. These additional plots reflect the same temporal dynamics, with a peak effect in 2017 and a reversion to negligible or negative differences in subsequent years. This consistency reinforces the robustness of the observed pattern.

Consistent with the event study results, the DID (Difference-in-Differences) estimates also confirm the absence of a long-term effect of the Rodzina 500+ policy on birth rates. Over the full 2016–2022 period, although the estimated coefficients are positive, they remain modest (ranging from 0.14 to 0.30 depending on the number of control countries) and, crucially, statistically insignificant, as reflected by high empirical p-values. Short-term estimates (2016–2019) show slightly higher values (around 0.5 to 0.56), yet they too fall short of statistical significance, indicating a limited and transient impact.

Table 5: Estimations 2016 DID in long term (2016–2022)

Controls	Estimate	Pr(|t| >)	Empiric p-value	Signif.	Adj. R^2
5	0.140991	6.7188e-15	0.90909091	.	0.739577
15	0.187376	1.2792e-15	0.8333333	.	0.717191
30	0.295821	7.5478e-16	0.65217391	.	0.850322

Several factors may explain this lack of statistical significance. First, the policy was not universal until 2019, potentially limiting uptake and impact on the broader population. Second, the inference method—particularly the empirical distribution of test statistics—may lack sufficient power to detect moderate effects over a short period. Finally, these results may reflect a dilution of the effect, initially concentrated in the very short term, as supported by the peak around 2017.

Table 6: Estimations 2016 DID in short term (2016–2019)

Controls	Estimate	Pr(|t| >)	Empiric p-value	Signif.	Adj. R^2
5	0.496179	1.82e-15	0.45454545	.	0.879784
15	0.564337	6.09e-16	0.2777778	.	0.879304
30	0.568590	2.2e-16	0.26086957	.	0.856484

3.2 Limits

While this paper makes important contributions to evaluating the Rodzina 500+ policy—notably by identifying short- and medium-term effects on fertility and presenting evidence of a tempo effect—it also suffers from several methodological and analytical limitations. One concern is the use of empirical p-values for statistical inference. Despite their common use in synthetic control and related designs, these p-values are sensitive to the donor pool selection and the number of possible permutations (Abadie, Diamond, Hainmueller, 2010; Chernozhukov, Kasahara, Schrimpf, 2021), which can reduce statistical power and produce conservative estimates. Additionally, the synthetic control analysis would benefit from a longer pre-treatment period to better assess the parallel trends assumption and strengthen the reliability of the counterfactual. Nonetheless, within the limits of the available data, the bias risk remains relatively low.

Substantively, the paper's focus on aggregate temporal trends does not allow for exploration of the policy's heterogeneity—a crucial aspect in the pronatalist policy literature. For instance, (Bokun, 2023) shows that the Rodzina 500+ policy has heterogeneous effects depending on women's characteristics. Age plays a key role: women aged 35 to 44 respond more strongly, likely due to nearing the end of their reproductive window. Education also matters, though the results are mixed: less-educated women tend to respond earlier, while more educated women often delay childbirth but may later catch up.

Moreover, the paper infers a tempo effect based only on the timing of births, without considering changes in first-birth transitions—a vital approach in distinguishing timing effects from quantum effects. (Laroque Salanié, 2014) emphasize that analyzing first births is essential to determine whether a policy increases long-term fertility or simply accelerates existing plans.

Finally, the paper does not address other key dimensions of the policy's impact, particularly regarding gender equality and women's labor market participation. A growing literature highlights that Rodzina 500+ has led to a decline in female labor force participation, especially among lower-income women (Golinowska Sowa-Kofta, 2017; Magda, Kiełczewska Brandt, 2018; Myck Trzciński, 2019; Bartosik, 2023; Bargu Morgandi, 2018; Premik, 2022). These findings point to a reinforcement of the male breadwinner model, undermining women's economic independence and exacerbating gender inequalities in the labor market. Such side effects are essential to consider in a comprehensive assessment of the Rodzina 500+ policy's effectiveness and equity.

In sum, while the paper offers a valuable empirical contribution by documenting a temporary increase in birth rates—especially around 2017—and signals of decline in the medium term, the findings remain partial and exploratory. Further research is necessary to uncover underlying mechanisms, assess heterogeneous effects across socioeconomic groups, and evaluate broader societal implications in order to form a more comprehensive evaluation of the policy.

4 Conclusion

This study evaluates the causal impact of Poland's Rodzina 500+ program, one of Europe's most ambitious pronatalist policies, on fertility rates. By combining synthetic control methods with difference-in-differences and event study approaches, we provide robust evidence on the policy's short- and medium-term effects. Our findings indicate that the program led to a temporary increase in birth rates, peaking one year after implementation (2017), but this effect diminished over time, with no statistically significant long-term impact observed by 2022. This pattern is consistent with a tempo effect—where births are accelerated in response to the policy—rather than a sustained quantum effect that would raise completed fertility.

This study confirms that the Rodzina 500+ program, despite its scale and significant cost, primarily had a temporary effect on increasing births in Poland, with a notable rise in the early years followed by a return to more normal levels. These results are consistent with the existing literature, notably the work of Błaszczyk Sawicka (2018), Ruzik-Sierdzińska (2018), and Śmigielska (2020), which also show a strong initial effect followed by a rapid decline .Moreover, thanks to the necessary time lag and the availability of data that other searcher do not have, our paper successfully identifies the policy's effect as a tempo effect, thus making a significant contribution to the literature.

Nonetheless, our analysis has several limitations, including reliance on aggregate data, which prevents exploration of heterogeneous effects across socioeconomic groups, and the inability to fully disentangle tempo from quantum effects due to data constraints. Future research could extend this work by examining micro-level data to assess how the policy's impact varies by income, education, and region.

From a policy perspective, these findings suggest that standalone cash transfer programs may not be sufficient to reverse long-term fertility declines in high-income countries. Other complementary measures—such as affordable childcare, flexible work arrangements, and policies promoting gender equity and paternity leave —are more likely to encourage higher birth rates. These structural changes help reduce the burden of caregiving primarily borne by mothers, shifting the pressure from financial earnings to greater autonomy and support (Matthieu , 2013). By creating a more supportive and enabling environment, such policies foster a landscape conducive to childbearing and family growth.

To conclude, if European countries want to effectively encourage higher fertility rates—a key demographic challenge—they must take into account all the factors discussed in this paper: financial incentives alone are not enough. Policies need to address broader structural issues such as affordable childcare, labor market conditions, and gender equality to create a supportive environment for families.

However, this effort takes place amid growing ecological concerns and resource limitations. Beyond questions of economic growth and productivity, there is an important debate about whether societies should aim to increase the number of births at all, given environmental sustainability challenges. This tension highlights the need for demographic policies that are carefully balanced with environmental and social considerations.

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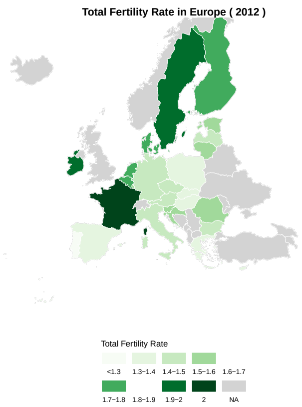
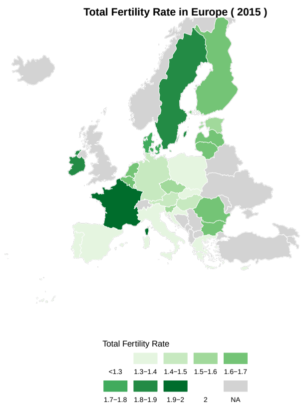
Appendicies

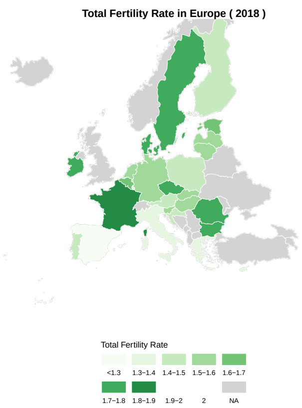
.1 Appendix A: Descriptive Statistics on Europe Demographic composition



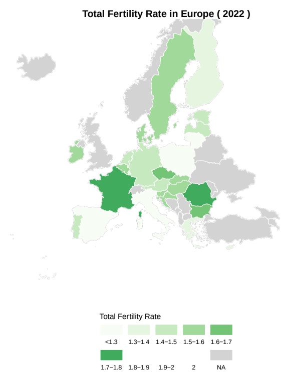
(a) Fertility rate in 2012 by European Countries



(b) Fertility rate in 2015 by European Countries

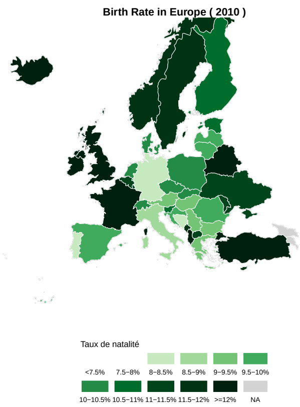


(c) Fertility rate in 2018 by European Countries

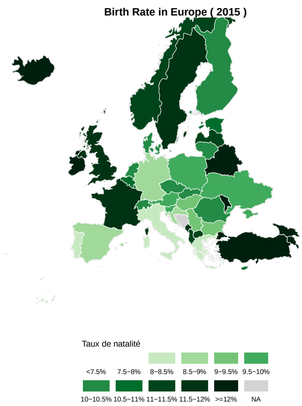


(d) Fertility rate in 2022 by European Countries

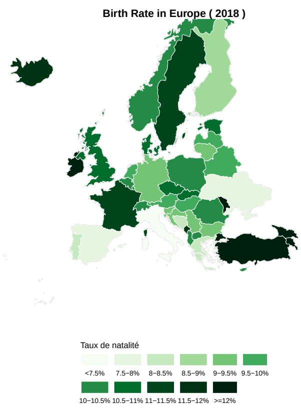
Figure 11: Evolution of fertility rate across years and countries



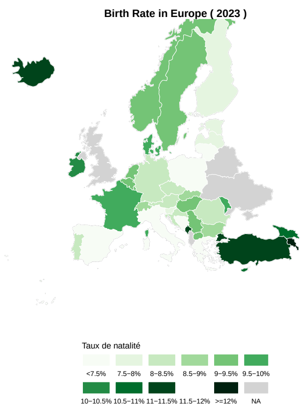
(a) Natality rate in 2010 by European Countries



(b) Natality rate in 2015 by European Countries

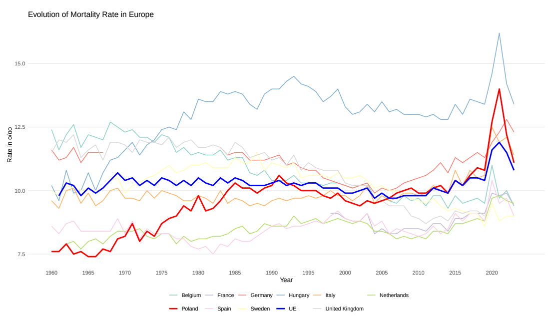


(c) Natality rate in 2018 by European Countries

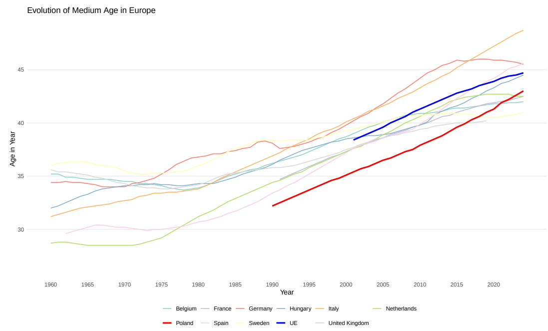


(d) Natality rate in 2023 by European Countries

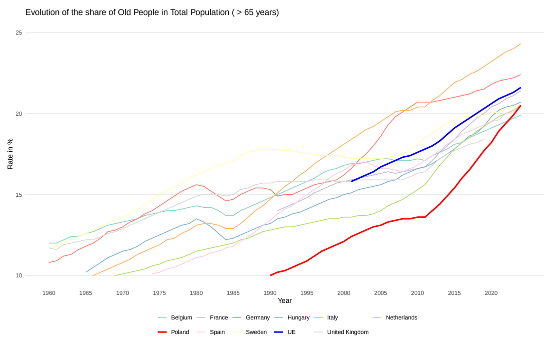
Figure 12: Evolution of Natality rate across years and countries



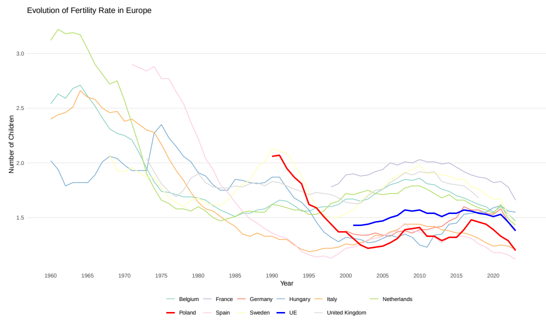
(a) Evolution of Mortality Rate in Europe (1960–2023)



(b) Evolution of Medium Age in Europe (1960–2023)

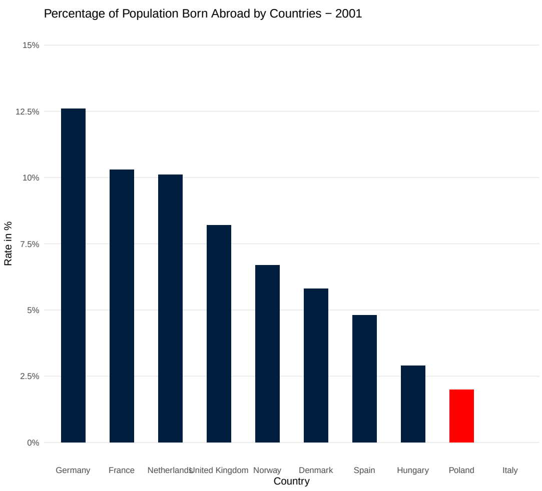


(c) Evolution of the share of Old People in Total Population ($\geq$ 65 years) (1960–2023)

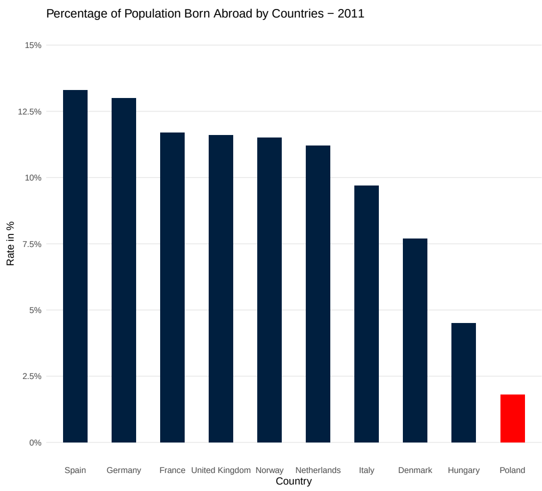


(d) Evolution of Fertility Rate in Europe (1960–2023)

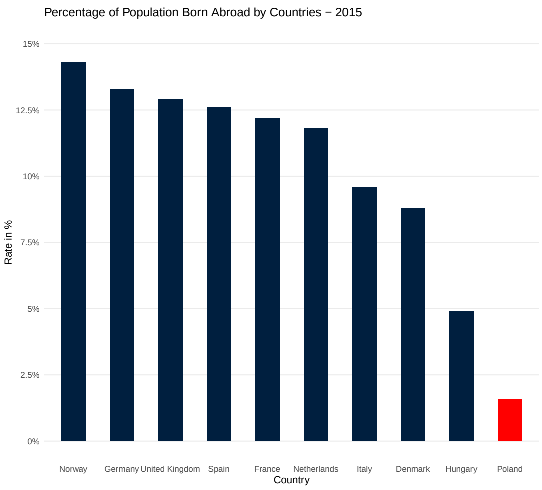
Figure 13



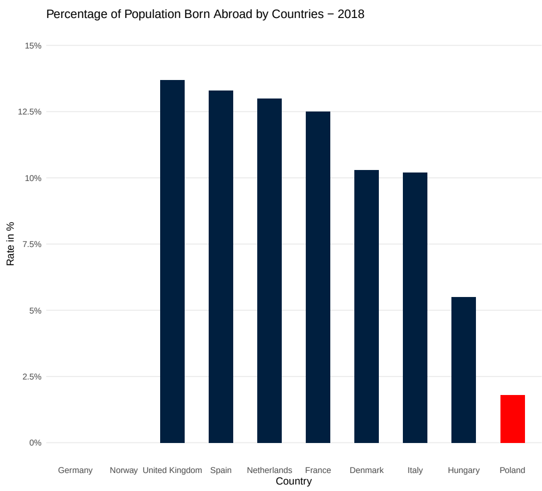
(a) Share of foreign-born population in 2001



(b) Share of foreign-born population in 2011

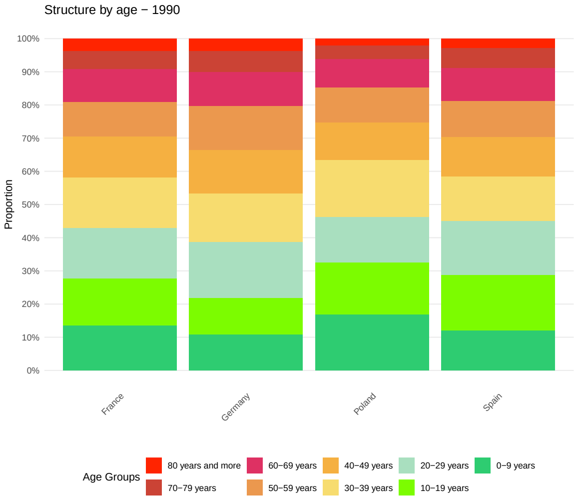


(c) Share of foreign-born population in 2015

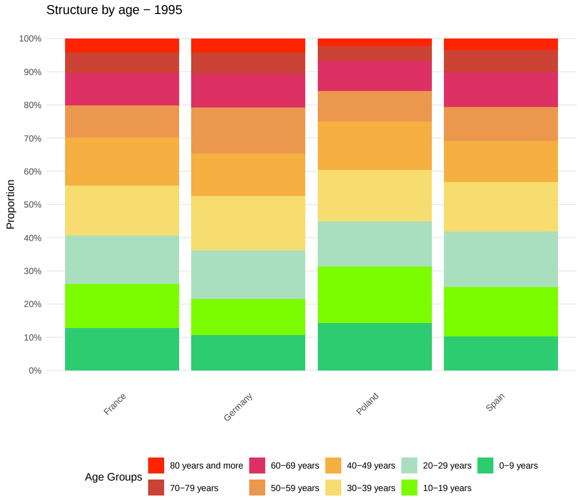


(d) Share of foreign-born population in 2018

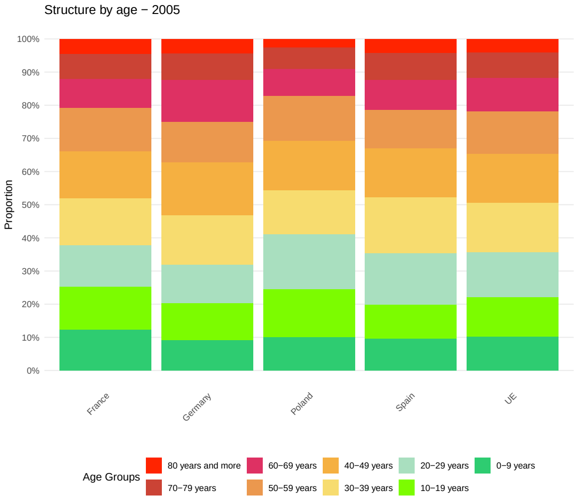
Figure 14: Evolution of the share of foreign-born population in Europe (2001–2018)



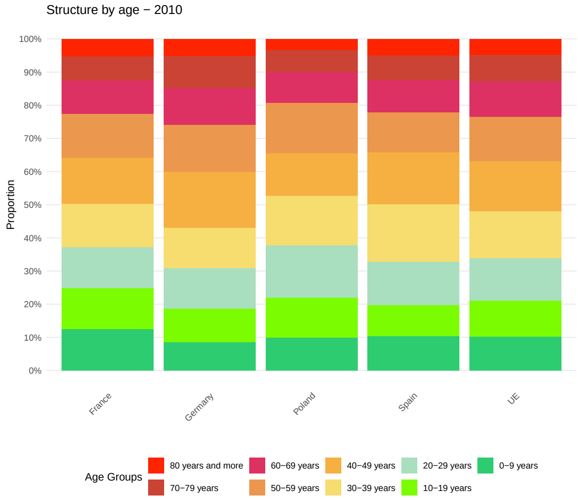
(a) Distribution of Age Groups in Europe in 1990



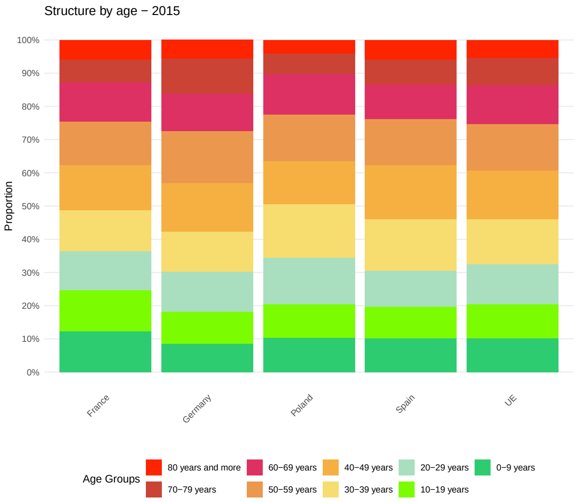
(b) Distribution of Age Groups in Europe in 1995



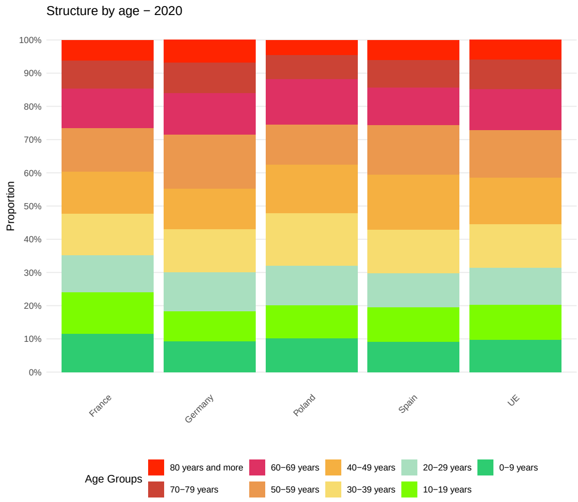
(c) Distribution of Age Groups in Europe in 2005



(d) Distribution of Age Groups in Europe in 2010

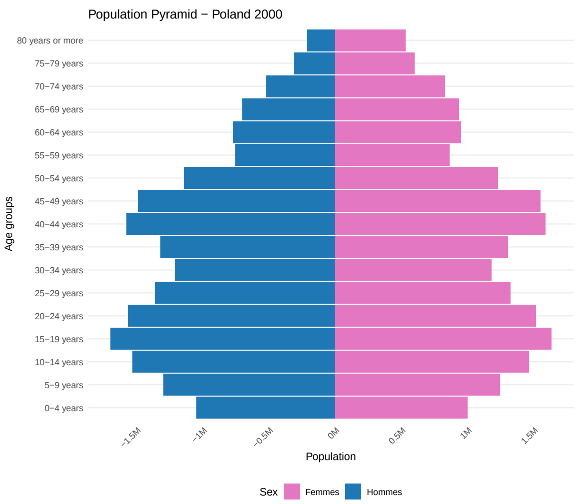


(e) Distribution of Age Groups in Europe in 2015

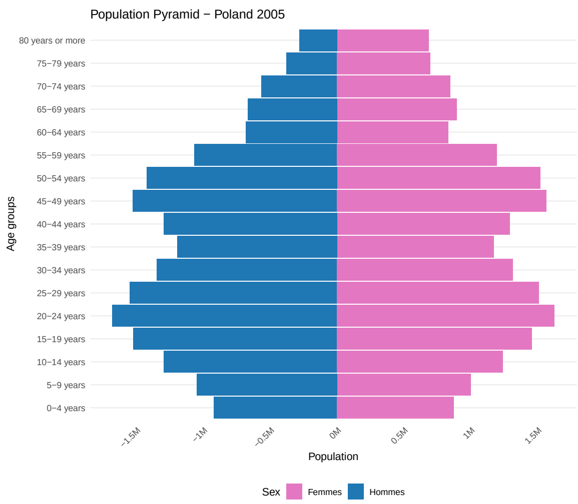


(f) Distribution of Age Groups in Europe in 2020

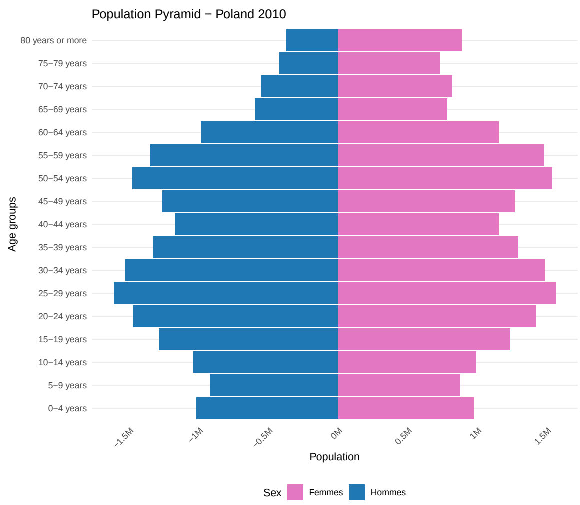
Figure 15: Evolution of the distribution of age groups in Europe (1990–2020)



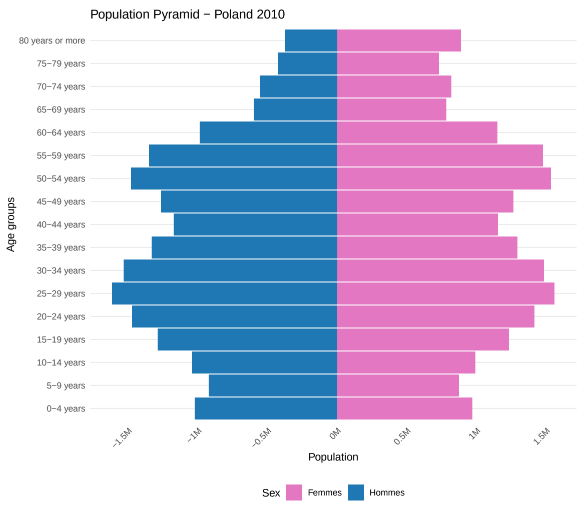
(a) Age Pyramid in Poland in 2000



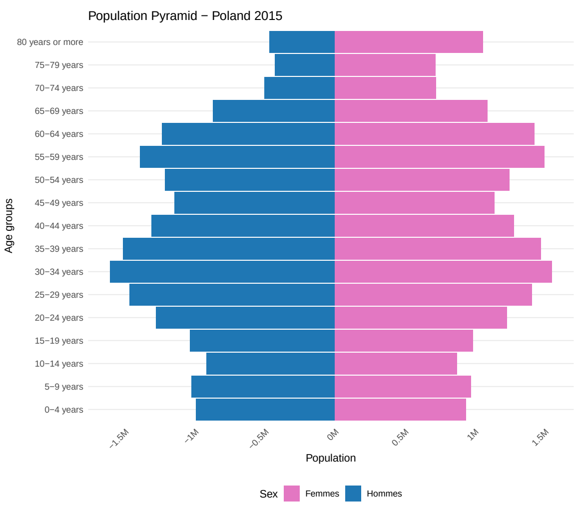
(b) Age Pyramid in Poland in 2005



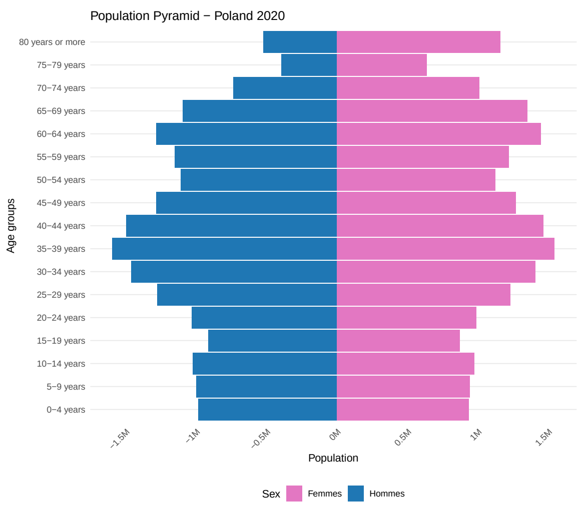
¡ (c) Age Pyramid in Poland in 2010



(d) Age Pyramid in Poland in 2010 (duplicate)

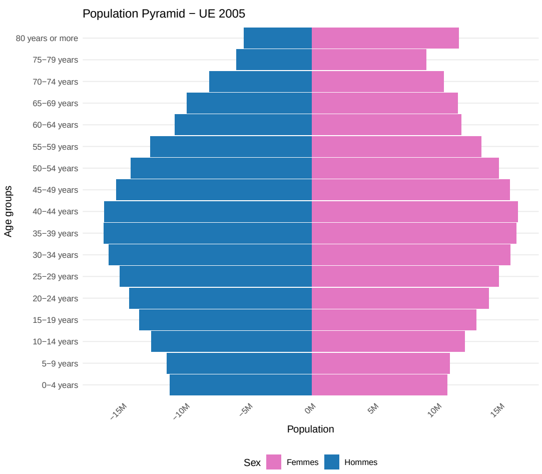


(e) Age Pyramid in Poland in 2015

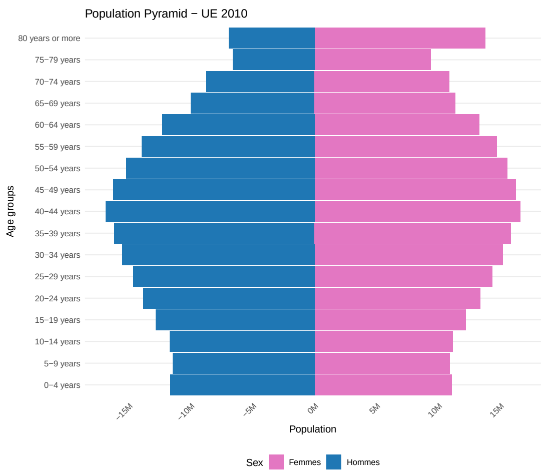


(f) Age Pyramid in Poland in 2020

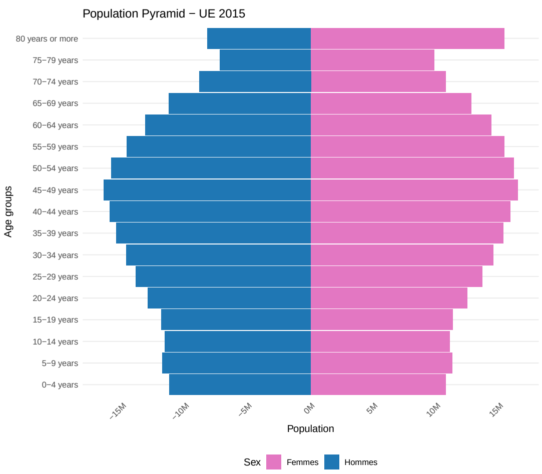
Figure 16: Evolution of age pyramids in Poland (2000–2020)



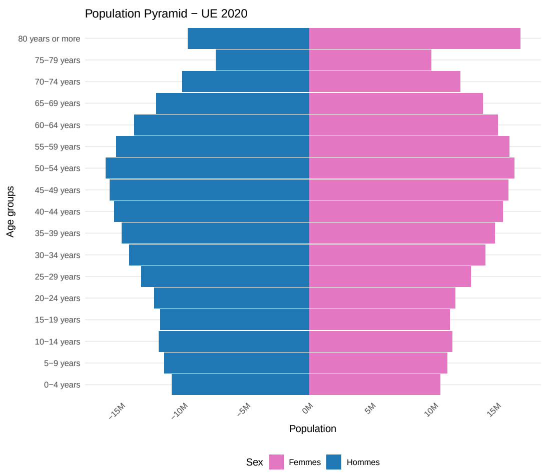
(a) Age Pyramid in Europe in 2005



(b) Age Pyramid in Europe in 2010



(c) Age Pyramid in Europe in 2015



(d) Age Pyramid in Europe in 2020

Figure 17: Evolution of age pyramids in Europe (2000–2020)

.2 Appendix B: Data

Table 7: Socio-economic variables from Eurostat (1/2)

Indicator	Code	Source
Population au 1er janvier par âge et sexe	demo_r_pjangroup	Eurostat
Âge moyen des femmes à la naissance	demo_find	Eurostat
Taux brut de natalité	demo_gind	Eurostat
Taux brut de mortalité	demo_gind	Eurostat
Indice synthétique de fécondité	demo_frate	Eurostat
Part des femmes au parlement national	sdg_05_49	Eurostat
Femmes aux postes ministériels supérieurs	sdg_05_50	Eurostat
Salaire horaire médian (PPS, secteur public)	earn_ses_pub2s	Eurostat
Ratio de dépendance démographique totale	demo_pjanind	Eurostat
Ratio de dépendance des personnes âgées	demo_pjanind	Eurostat
Âge médian de la population	demo_pjanind	Eurostat
Satisfaction globale de vie	ilc_pw01	Eurostat
Faibles résultats en maths (PISA, 15 ans)	educ_outc_pisa	Eurostat
Faibles résultats en lecture (PISA, 15 ans)	educ_outc_pisa	Eurostat
Dépenses de santé par régime de financement	hlth_sha11_hf	Eurostat
Immigrants par sexe – femmes	migr_imm8	Eurostat
Immigrants par sexe – hommes	migr_imm8	Eurostat
Coefficient de Gini	tessi190	Eurostat

Table 8: Complementary Variables (2/2)

Indicator	**Code**	**Source**
Diplômés de l'enseignement supérieur – hommes	educ_uoe_grad01	Eurostat
Diplômés de l'enseignement supérieur – femmes	educ_uoe_grad01	Eurostat
Taux de surpeuplement des logements	tessi171	Eurostat
Âge moyen au premier mariage	tps00014	Eurostat
Taux de risque de pauvreté	tespm010	Eurostat
Familles monoparentales par nombre d'enfants	lfst_hhnhtych	Eurostat
Espérance de vie à la naissance	tps00205	Eurostat
Taux de mortalité infantile	tps00027	Eurostat
Taux brut de nuptialité	tps00206	Eurostat
Taux de chômage – hommes	une_rt_a	Eurostat
Taux de chômage – femmes	une_rt_a	Eurostat
Dépenses de protection sociale	tps00098	Eurostat
Taille moyenne des ménages	ilc_lvph01	Eurostat
PIB aux prix du marché	nama_10_gdp	Eurostat
Population née à l'étranger	—	OCDE
Indice d'égalité de genre	—	EIGE

.3 Appendix C: Synthetic Controls

	5 contrôles			15 contrôles			30 contrôles		
Variable	Synth.	Treat.	Gap	Synth.	Treat.	Gap	Synth.	Treat.	Gap
GDP per capita in thousand EUR	12.80	9.80	-3.00	11.71	9.80	-1.90	14.03	9.80	-4.23
Gender Equality Index	55.38	55.60	0.22	54.50	55.60	1.10	54.62	55.60	0.98
Average household size	2.75	2.80	0.05	2.73	2.80	0.07	2.73	2.80	0.07
Life expectancy at birth	77.11	77.06	-0.05	76.78	77.06	0.28	77.31	77.06	-0.25
Share of women in total population	51.55	51.62	0.07	51.17	51.62	0.45	51.77	51.62	-0.15
Mean age of women at childbirth	–	–	–	28.44	28.83	0.39	29.23	28.83	-0.40
Infant mortality rate	–	–	–	6.20	4.54	-1.66	4.35	4.54	0.19
Gini coefficient of equivalised disposable income	–	–	–	30.82	30.80	-0.02	29.36	30.80	1.45
Proportion of seats held by women in national parliaments	–	–	–	16.51	20.19	3.68	23.50	20.19	-3.32
Crude marriage rate	–	–	–	4.77	5.24	0.48	4.84	5.24	0.41
Unemployment rate – Males	–	–	–	63.16	64.00	0.84	62.59	64.00	1.41
Current health expenditure by financing scheme (in thousand)	–	–	–	0.86	0.66	-0.19	1.06	0.66	-0.40
Tertiary education graduates – Males (levels 5–8)	–	–	–	0.78	1.08	0.30	0.81	1.08	0.27
Share of women aged 15–40 in total population	–	–	–	35.03	37.17	2.14	33.87	37.17	3.30
Overcrowding rate	–	–	–	–	–	–	37.67	44.71	7.05
At-risk-of-poverty rate	–	–	–	–	–	–	17.23	17.26	0.03
Social protection expenditure	–	–	–	–	–	–	19.66	19.08	-0.58
Low achievers in reading – Males (PISA)	–	–	–	–	–	–	28.57	19.37	-9.20
Low achievers in reading – Females (PISA)	–	–	–	–	–	–	12.24	6.76	-5.48
Low achievers in mathematics – Males (PISA)	–	–	–	–	–	–	26.63	17.80	-8.83
Low achievers in mathematics – Females (PISA)	–	–	–	–	–	–	27.80	17.09	-10.71
Overall life satisfaction	–	–	–	–	–	–	6.70	7.31	0.61
Women in senior ministerial positions	–	–	–	–	–	–	19.04	23.44	4.40
Median hourly earnings in PPS by sex, public sector	–	–	–	–	–	–	7.37	7.07	-0.29
Unemployment rate – Females	–	–	–	–	–	–	54.08	51.81	-2.26
Single-parent households by number of children	–	–	–	–	–	–	0.00	0.00	0.00
Immigrants by sex – female	–	–	–	–	–	–	0.26	0.33	0.07
Immigrants by sex – male	–	–	–	–	–	–	0.33	0.56	0.23
Live births outside marriage per 1,000 population	–	–	–	–	–	–	24.26	21.69	-2.57
Tertiary education graduates – Females (levels 5–8)	–	–	–	–	–	–	0.19	0.28	0.10

Table 9: Average Difference during the Pre-treatment period between Poland and its 2015 Counterfactuals

	5 contrôles			15 contrôles			30 contrôles		
Variable	Synth.	Traité	Écart	Synth.	Traité	Écart	Synth.	Traité	Écart
GDP per capita in thousand EUR	12.12	10.14	-1.98	11.78	10.14	-1.64	16.59	10.14	-6.45
Gender Equality Index	55.37	55.88	0.51	53.95	55.88	1.93	55.29	55.88	0.59
Average household size	2.76	2.80	0.04	2.63	2.80	0.17	2.69	2.80	0.11
Life expectancy at birth	76.74	77.21	0.47	77.03	77.21	0.18	76.94	77.21	0.27
Share of women in total population	51.36	51.61	0.26	51.68	51.61	-0.06	51.78	51.61	-0.16
Mean age of women at childbirth	–	–	–	28.94	28.93	-0.01	29.24	28.93	-0.30
Infant mortality rate	–	–	–	4.45	4.42	-0.03	4.69	4.42	-0.27
Gini coefficient of equivalised disposable income	–	–	–	34.45	34.47	0.02	32.71	34.47	1.76
Proportion of seats held by women in national parliaments	–	–	–	21.17	21.27	0.10	20.87	21.27	0.40
Crude marriage rate	–	–	–	4.38	5.20	0.82	5.28	5.20	-0.08
Unemployment rate – Males	–	–	–	66.31	65.02	-1.28	64.91	65.02	0.11
Current health expenditure by financing scheme (in thousand)	–	–	–	0.82	0.68	-0.14	1.31	0.68	-0.64
Tertiary education graduates – Males (levels 5–8)	–	–	–	0.73	1.05	0.32	0.94	1.05	0.11
Share of women aged 15–40 in total population	–	–	–	33.68	36.77	3.09	35.57	36.77	1.20
Overcrowding rate	–	–	–	–	–	–	32.58	44.12	11.54
At-risk-of-poverty rate	–	–	–	–	–	–	15.71	17.30	1.60
Social protection expenditure	–	–	–	–	–	–	18.31	19.22	0.90
Low achievers in reading – Males (PISA)	–	–	–	–	–	–	30.94	19.35	-11.59
Low achievers in reading – Females (PISA)	–	–	–	–	–	–	15.42	7.37	-8.05
Low achievers in mathematics – Males (PISA)	–	–	–	–	–	–	25.24	17.38	-7.86
Low achievers in mathematics – Females (PISA)	–	–	–	–	–	–	25.06	17.24	-7.82
Overall life satisfaction	–	–	–	–	–	–	6.94	7.35	0.42
Women in senior ministerial positions	–	–	–	–	–	–	16.22	23.42	7.21
Median hourly earnings in PPS by sex, public sector	–	–	–	–	–	–	7.45	7.27	-0.18
Unemployment rate – Females	–	–	–	–	–	–	57.67	52.84	-4.82
Single-parent households by number of children	–	–	–	–	–	–	0.00	0.00	0.00
Immigrants by sex – female	–	–	–	–	–	–	0.38	0.36	-0.01
Immigrants by sex – male	–	–	–	–	–	–	0.46	0.58	0.12
Live births outside marriage per 1,000 population	–	–	–	–	–	–	30.85	22.38	-8.47
Tertiary education graduates – Females (levels 5–8)	–	–	–	–	–	–	0.21	0.28	0.07

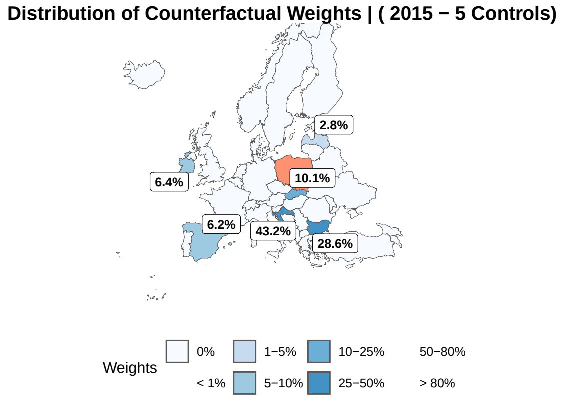
Table 10: Average Difference during the Pre-treatment period between Poland and its 2017 Counterfactuals

Table 11: Country weights in synthetic Poland (2015)

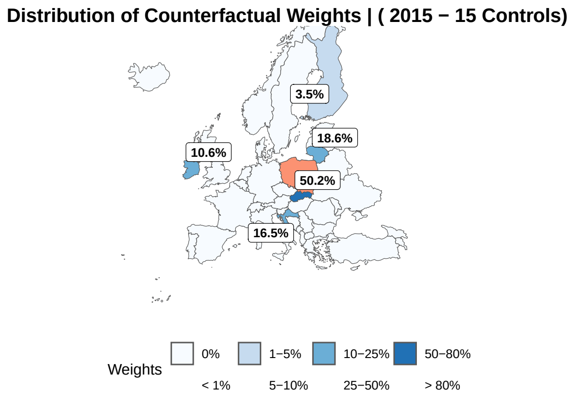
	Number of predictors		
Country	30	15	5
Austria	0.00	0.00	0.00
Belgium	0.00	0.00	0.00
Bulgaria	0.35	0.00	0.29
Croatia	0.20	0.17	0.43
Cyprus	0.00	0.00	0.00
Czechia	0.00	0.00	0.00
Denmark	0.00	0.00	0.00
Estonia	0.00	0.00	0.00
Finland	0.00	0.04	0.00
France	0.00	0.00	0.00
Germany	0.00	0.00	0.00
Greece	0.00	0.00	0.00
Ireland	0.04	0.11	0.06
Latvia	0.00	0.01	0.03
Lithuania	0.00	0.19	0.00
Luxembourg	0.00	0.00	0.00
Malta	0.00	0.00	0.00
Netherlands	0.00	0.00	0.00
Portugal	0.00	0.00	0.01
Romania	0.00	0.00	0.00
Slovakia	0.32	0.50	0.10
Slovenia	0.00	0.00	0.00
Spain	0.08	0.00	0.06
Sweden	0.00	0.00	0.00

Table 12: Country weights in synthetic Poland (2017)

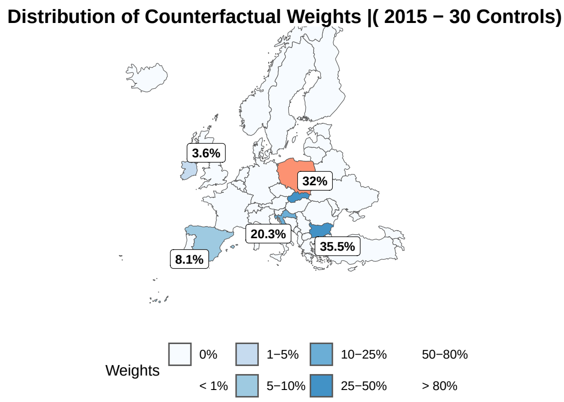
	Number of predictors		
Country	30	15	5
Austria	0.00	0.00	0.00
Belgium	0.00	0.00	0.00
Bulgaria	0.00	0.26	0.35
Croatia	0.17	0.36	0.20
Cyprus	0.00	0.01	0.00
Czechia	0.00	0.00	0.00
Denmark	0.00	0.00	0.00
Estonia	0.00	0.00	0.00
Finland	0.06	0.00	0.00
France	0.00	0.00	0.00
Germany	0.00	0.00	0.00
Greece	0.00	0.00	0.00
Ireland	0.09	0.04	0.04
Latvia	0.01	0.01	0.00
Lithuania	0.16	0.00	0.00
Luxembourg	0.00	0.00	0.00
Malta	0.00	0.00	0.00
Netherlands	0.00	0.00	0.00
Portugal	0.00	0.00	0.00
Romania	0.00	0.00	0.00
Slovakia	0.51	0.21	0.32
Slovenia	0.00	0.06	0.00
Spain	0.00	0.06	0.08
Sweden	0.00	0.00	0.00



(a) Weights repartition – 2015, 5 controls

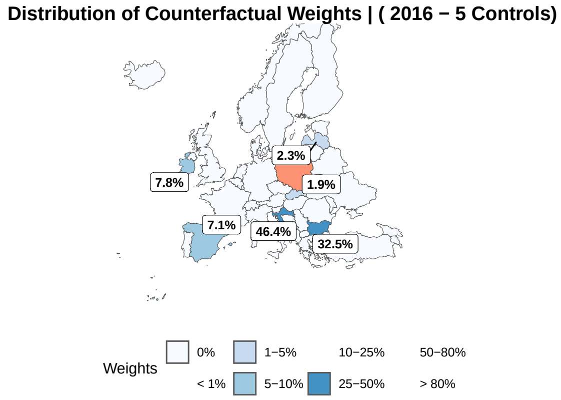


(b) Weights repartition – 2015, 15 controls

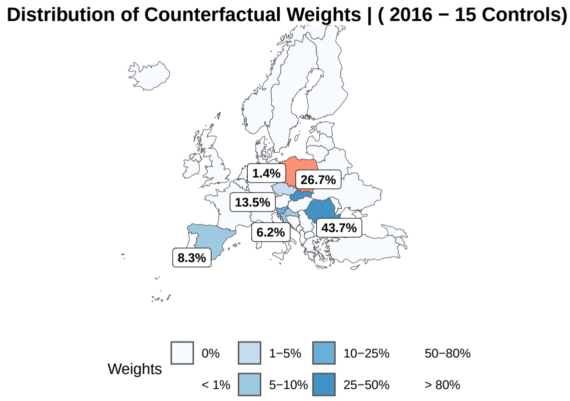


(c) Weights repartition – 2015, 30 controls

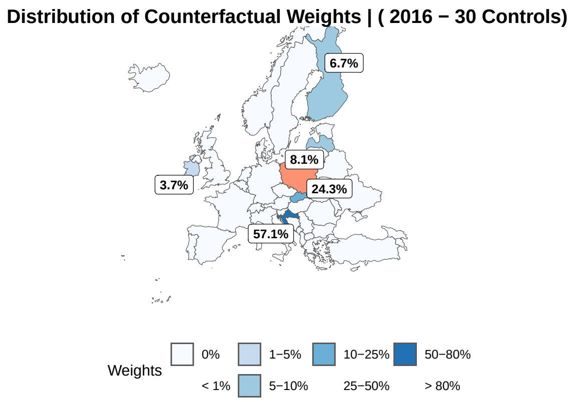
Figure 18: Synthetic control weights repartition for different controls pool sizes (2015)



(a) Weights repartition – 2016, 5 controls

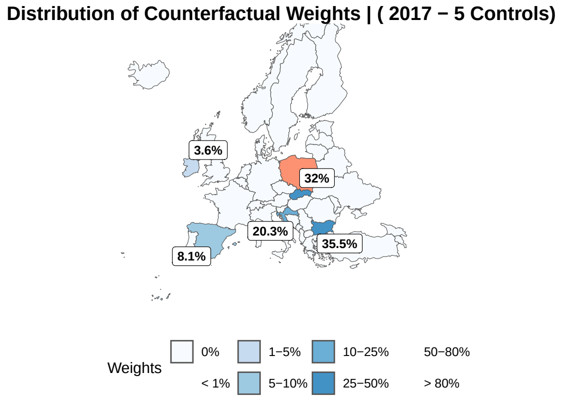


(b) Weights repartition – 2016, 15 controls

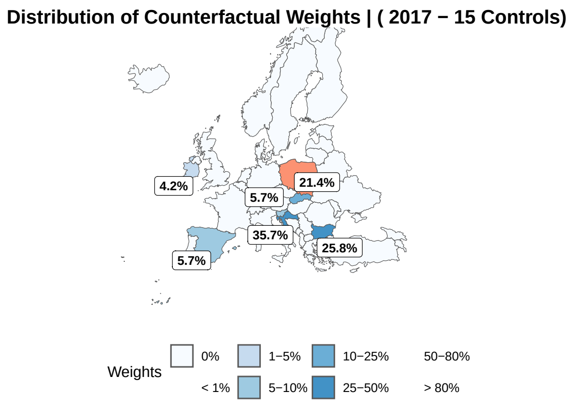


(c) Weights repartition – 2016, 30 controls

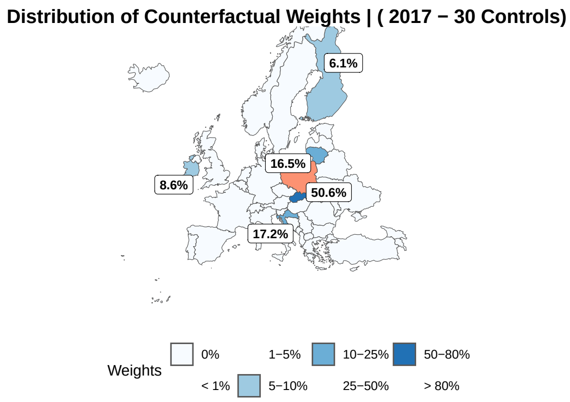
Figure 19: Synthetic control weights repartition for different controls pool sizes (2016)



(a) Weights repartition – 2017, 5 controls



(b) Weights repartition – 2017, 15 controls



(c) Weights repartition – 2017, 30 controls

Figure 20: Synthetic control weights repartition for different controls pool sizes (2017)

.4 Appendix D: Diff-in-Diff and Event Study

Table 13: Pre-trend Analysis of Birth Rate Determinants : Poland vs 2015 Counterfactual Groups

	30 controls	15 controls	5 controls
Poland	34.709	107.668	16.578
	(111.548)	(132.850)	(123.588)
Year	-0.204***	-0.168***	-0.213***
	(0.039)	(0.047)	(0.043)
Poland × Year	-0.017	-0.054	-0.008
	(0.055)	(0.066)	(0.061)
Constant	420.955***	347.996***	439.086***
	(78.877)	(93.939)	(87.390)
R^2	0.855	0.852	0.834
Adjusted R^2	0.812	0.807	0.784
Residual Std. Error	0.208	0.247	0.230
F Statistic	19.657***	19.166***	16.688***

Note: $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

Table 14: Pre-trend Analysis of Birth Rate Determinants : Poland vs 2017 Counterfactual Groups

	30 controls	15 controls	5 controls
Poland	-31.048	-28.233	46.403
	(98.434)	(91.321)	(99.912)
Year	-0.170***	-0.169***	-0.132***
	(0.035)	(0.032)	(0.035)
Poland × Year	0.015	0.014	-0.023
	(0.049)	(0.045)	(0.050)
Constant	353.175***	350.359***	275.723***
	(69.604)	(64.574)	(70.648)
R^2	0.760	0.785	0.784
Adjusted R^2	0.709	0.739	0.738
Residual Std. Error	0.268	0.249	0.272
F Statistic	14.784***	17.064***	16.979***

Note: $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

Evolution of Natality Rate in Poland and its 2015 Counterfactual

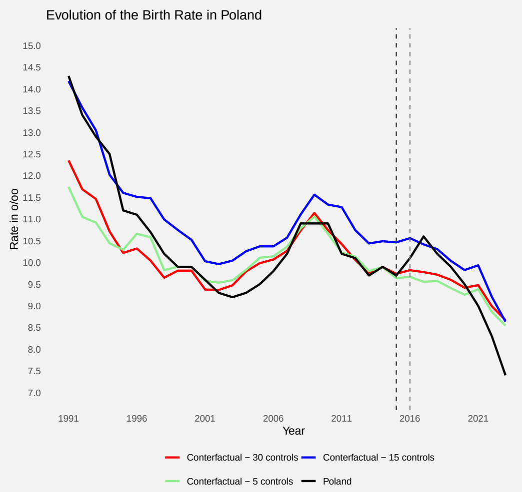


Figure 21: Evolution Since 1990

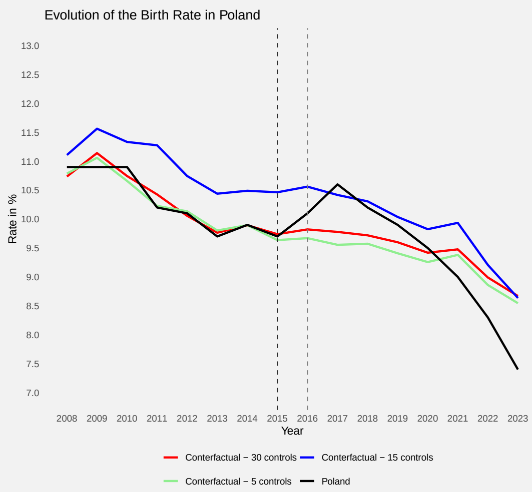


Figure 22: Evolution Since 2008

Evolution of Natality Rate in Poland and its 2017 Counterfactual

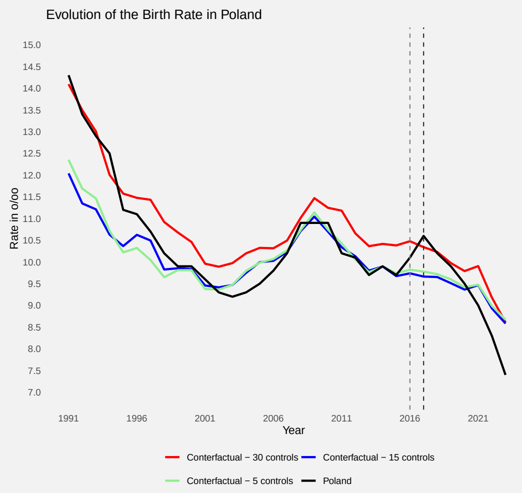


Figure 23: Evolution Since 1990

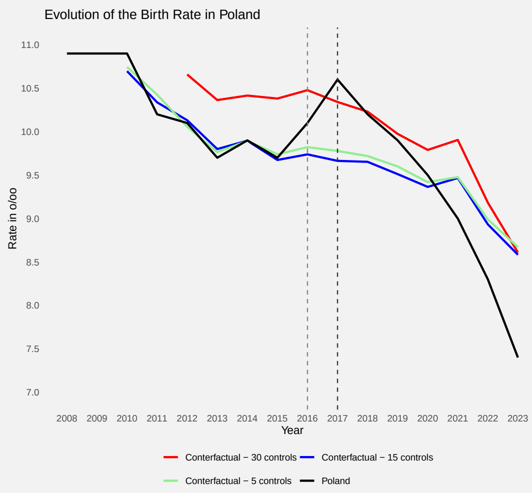


Figure 24: Evolution Since 2008

.5 Appendix E: Results

Table 15: Estimations 2017 DID in short term (2017–2019)

Controls	Estimate	Pr(|t| >)	Empiric p-value	Signif.	Adj. R^2
5	0.517582	6.947e-16	0.3636364	.	0.867099
15	0.299210	4.482e-15	0.28571429	.	0.840939
30	0.652024	1.9195e-15	0.1739130	.	0.895490

Table 16: Estimations 2017 DID in long term (2017–2022)

Controls	**Estimate**	**Pr(|t| >)**	**Empiric p-value**	**Signif.**	**Adj. R^2**
5	0.070896	7.9065e-15	0.9090909	.	0.732497
15	-0.148750	1.3363e-15	0.71428571	.	0.717416
30	0.300906	3.654e-16	0.6521739	.	0.864266

Table 17: Estimations 2015 DID in short term (2015–2019)

Controls	**Estimate**	**Pr(|t| >)**	**Empiric p-value**	**Signif.**	**Adj. R^2**
5	0.558980	1.1758e-15	0.2222222	.	0.796867
15	0.007948	1.0499e-15	1.0000000	.	0.840644
30	0.443184	2.2264e-15	0.3125	.	0.704369

Table 18: Estimations 2015 DID in long term (2015–2022)

Controls	**Estimate**	**Pr(|t| >)**	**Empiric p-value**	**Signif.**	**Adj. R^2**
5	0.260629	2.8686e-15	0.5555556	.	0.708002
15	-0.222469	7.9256e-16	0.8421053	.	0.825791
30	0.122482	7.5988e-15	0.8125	.	0.643523

Table 19: Event Study Estimates – Year 2017

Event Time	**5 Controls**		**15 Controls**		**30 Controls**	
	Coef.	**Emp. p-val**	**Coef.**	**Emp. p-val**	**Coef.**	**Emp. p-val**
-7	-0.128603	1.000	-0.029710	0.786	0.026753	0.957
-6	-0.507104	0.455	-0.170571	0.286	-0.615291	0.261
-5	-0.237278	0.818	-0.113158	0.571	-0.183501	0.609
-4	-0.345201	0.636	-0.240883	0.357	-0.278725	0.478
-3	-0.275809	0.545	-0.159766	0.643	-0.128895	0.565
-2	-0.320279	0.182	-0.271738	0.143	-0.302941	0.217
0	0.544148***	0.000	0.532459*	0.072	0.643485***	0.000
1	0.206041	0.273	0.047083	0.857	0.353529	0.348
2	0.025010	1.000	-0.104410	0.786	0.323659	0.565
3	-0.191084	0.728	-0.320618	0.643	0.135254	0.783
4	-0.747963	0.364	-0.964468	0.214	-0.474218	0.522
5	-0.965870	0.273	-0.927537	0.143	-0.447071	0.696

Table 20: Event Study Estimates – Year 2015

Event Time	**5 Controls**		**15 Controls**		**30 Controls**	
	Coef.	**Emp. p-val**	**Coef.**	**Emp. p-val**	**Coef.**	**Emp. p-val**
-5	0.181263	0.222	0.277769	0.316	0.339885	0.313
-4	-0.058727	1.000	-0.004296	1.000	-0.042818	0.813
-3	-0.064060	1.000	0.054328	0.842	-0.042022	0.875
-2	-0.115855	0.556	0.114203	0.474	-0.151023	0.500
0	0.084428	0.889	-0.233504	0.474	0.033516	0.938
1	0.464302	0.444	0.020063	1.000	0.347685	0.438
2	1.067649***	0.000	0.370052	0.526	0.977324***	0.000
3	0.632254***	0.000	0.250527	0.842	0.531997	0.313
4	0.488887	0.333	0.074604	1.000	0.429418	0.563
5	0.238903	0.667	-0.214310	0.842	0.068533	0.938

Table 21: Event Study Estimates – Year 2016

Event Time	5 Controls		15 Controls		30 Controls	
	Coef.	Emp. p-val	Coef.	Emp. p-val	Coef.	Emp. p-val
-6	0.191676	0.545	0.177734	0.611	0.333964	0.478
-5	-0.186825	0.818	-0.163479	0.444	-0.299974	0.435
-4	0.083001	0.909	-0.056934	0.889	0.122784	0.652
-3	-0.024922	1.000	-0.125923	0.556	0.017170	0.913
-2	0.044470	0.909	-0.021742	0.833	0.165624	0.435
0	0.320279	0.182	0.335665	0.167	0.303506	0.304
1	0.864427	0.091*	0.910253	0.000***	0.939505	0.043**
2	0.526320	0.091*	0.521462	0.278	0.650925	0.174
3	0.345289	0.455	0.363072	0.611	0.606802	0.391
4	0.129195	0.818	0.110101	0.889	0.391184	0.609
5	-0.427684	0.727	-0.492583	0.500	-0.223610	0.696
6	-0.645591	0.455	-0.658404	0.500	-0.201404	0.696

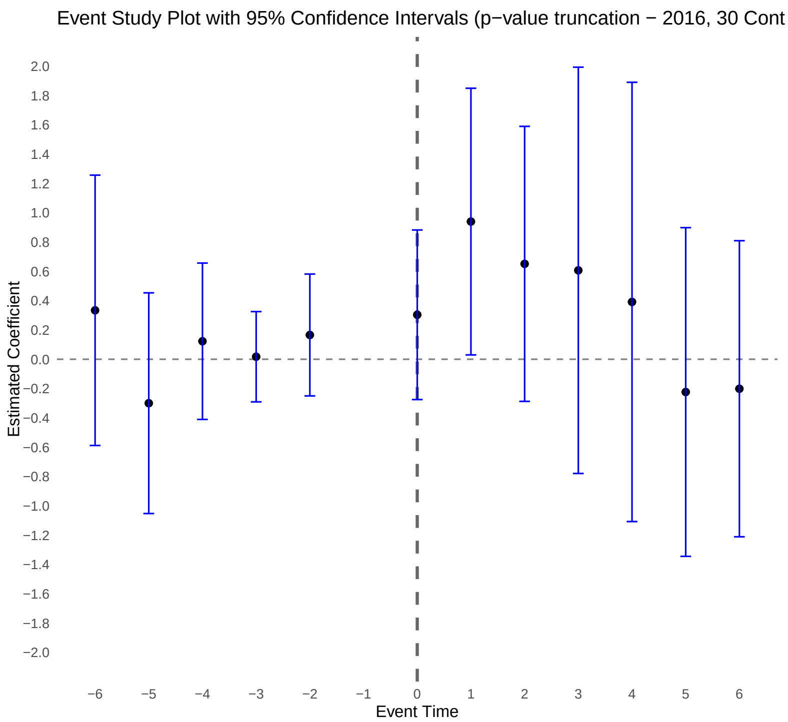


Figure 25: Event Study Plot with 95% Confidence Intervals (pvalue truncation 2016, 30 Controls)

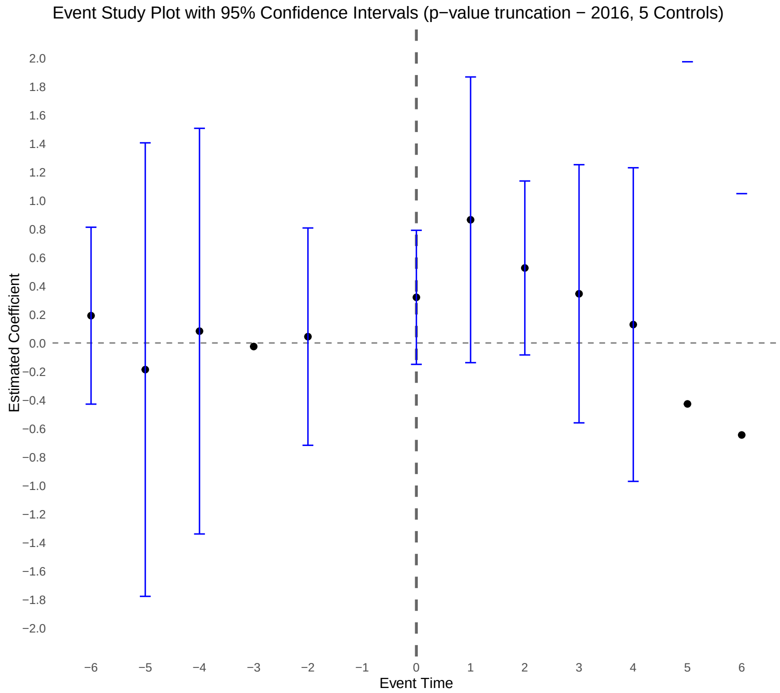


Figure 26: Event Study Plot with 95% Confidence Intervals (pvalue truncation 2016, 5 Controls)

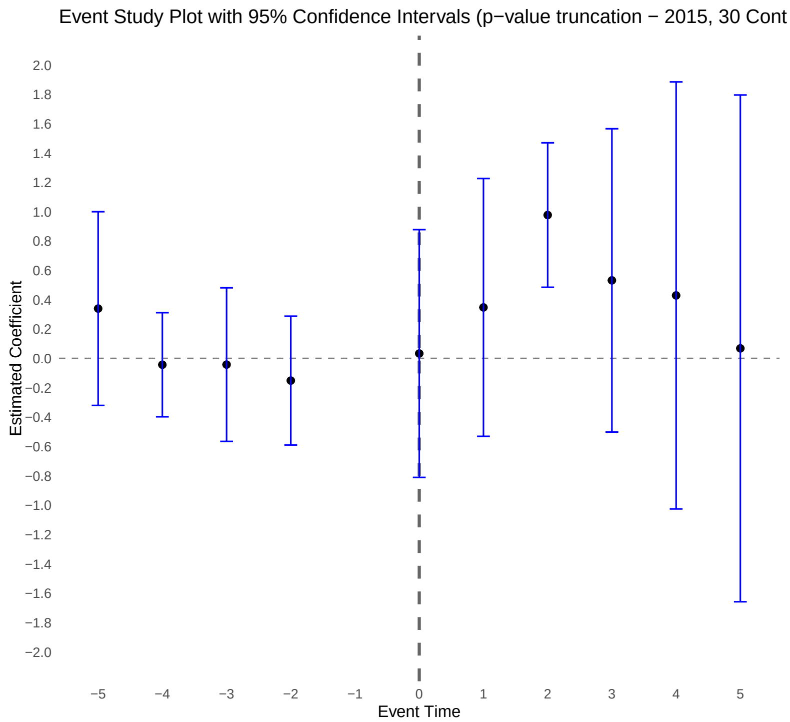


Figure 27: Event Study Plot with 95% Confidence Intervals (pvalue truncation 2015, 30 Controls)

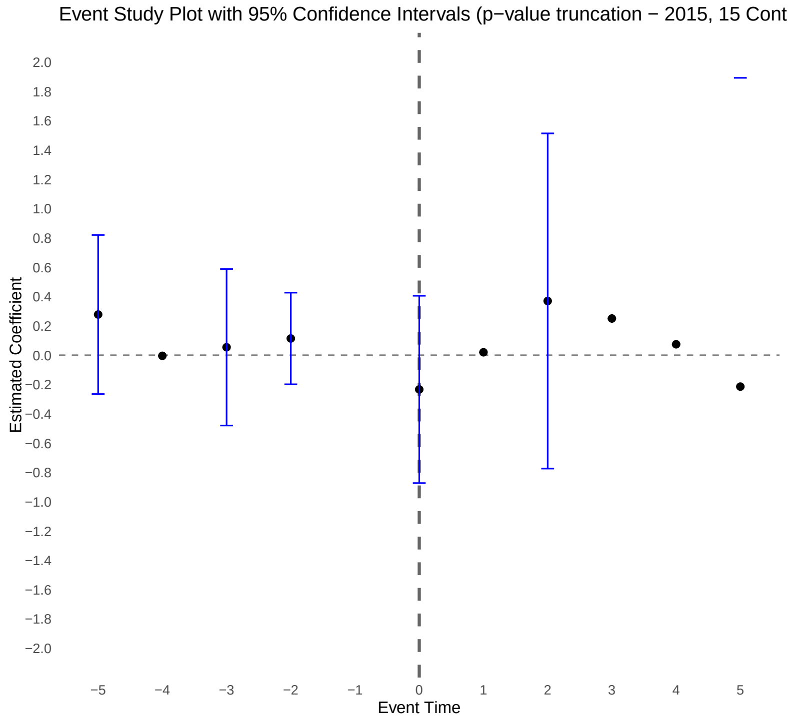


Figure 28: Event Study Plot with 95% Confidence Intervals (pvalue truncation 2015, 15 Controls)

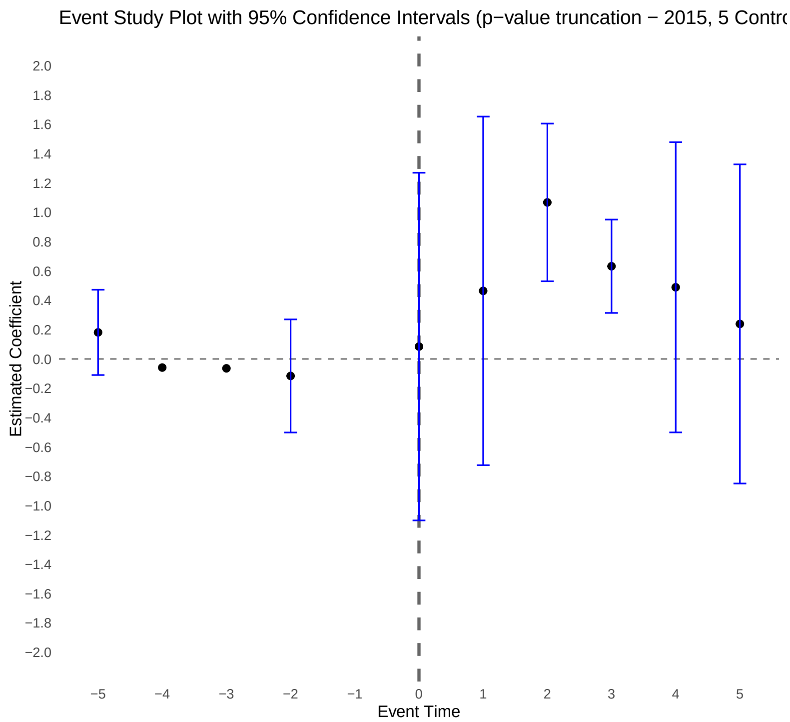


Figure 29: Event Study Plot with 95% Confidence Intervals (pvalue truncation 2015, 5 Controls)

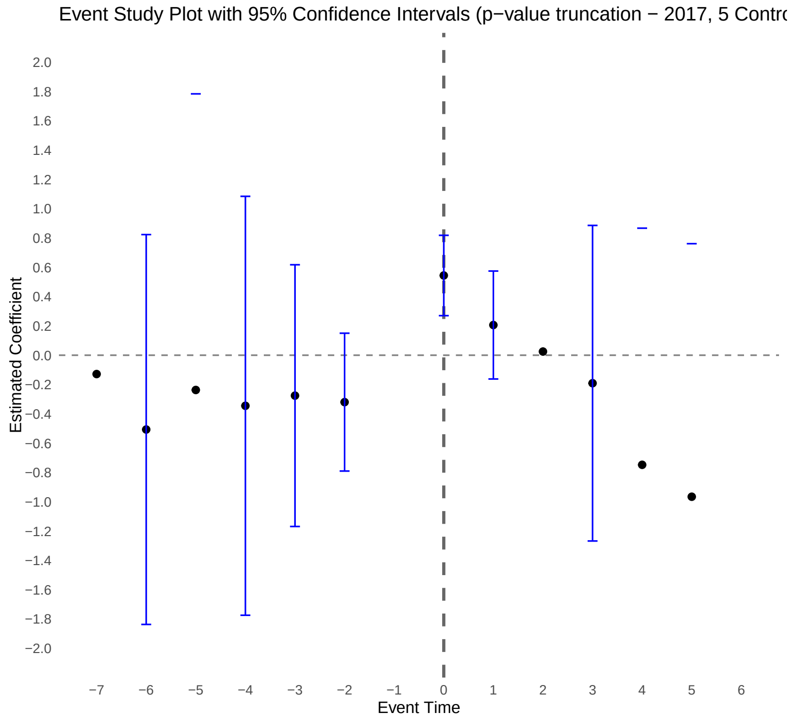


Figure 30: Event Study Plot with 95% Confidence Intervals (pvalue truncation 2017, 5 Controls)

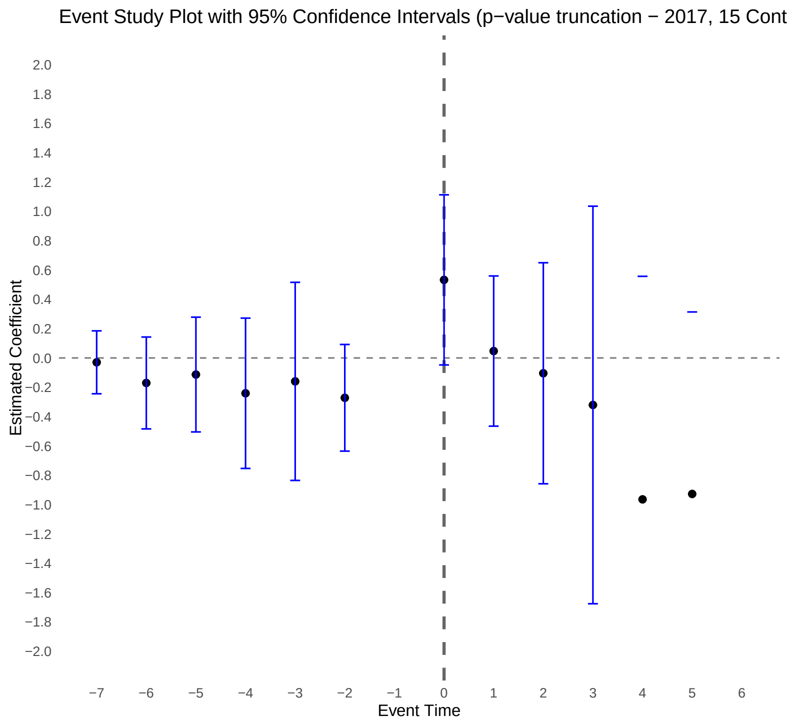


Figure 31: Event Study Plot with 95% Confidence Intervals (pvalue truncation 2017, 15 Controls)

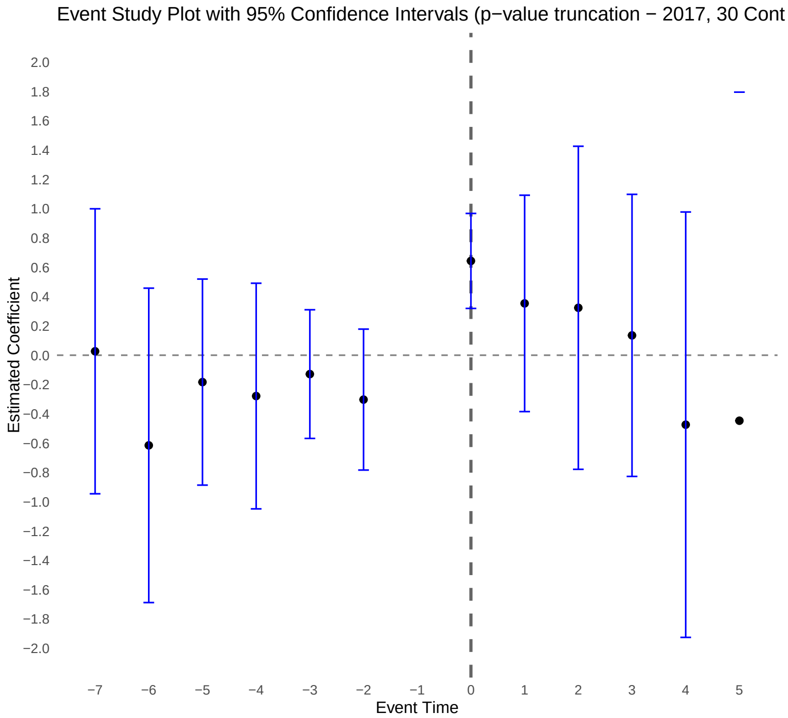


Figure 32: Event Study Plot with 95% Confidence Intervals (pvalue truncation 2017, 30 Controls)