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Impact of restrictions on the COVID-19 pandemic situation in Poland

Sergiusz Herman[1]

ABSTRACT

The COVID-19 pandemic has had a substantial impact on public health all over the world. In order to prevent the spread of the virus, the majority of countries introduced restrictions which entailed considerable economic and social costs. The main goal of the article is to study how the lockdown introduced in Poland affected the spread of the pandemic in the country. The study used synthetic control method to this end. The analysis was carried on the basis of data from the Local Data Bank and a government website on the state of the epidemic in Poland.

The results indicated that the lockdown significantly curbed the spread of the COVID-19 pandemic in Poland. Restrictions led to the substantial drop in infections – by 9500 cases – in three weeks. The results seem to stay the same despite the change of assumptions in the study. Such conclusion can be drawn from the performance of the placebo-in-space and placebo-in-time analyses.

Key words: COVID-19, coronavirus, lockdown, synthetic control method, treatment effect.

1. Introduction

The Coronavirus disease 2019 (COVID-19) is an infectious respiratory disease caused by a SARS-CoV-2 virus. The first known case was identified in Wuhan, Central China, in November 2019. The virus has rapidly spread around the world. As a result, the World Health Organization declared the outbreak of a pandemic on 11 March 2020. Until 31 June 2021, more than 182 million cases were identified around the world and 3.9 million people died from the coronavirus.

Due to the rapid spread of the virus, countries around the world introduced restrictions to stop the spread of the coronavirus. China was the first country to do so. At the beginning of March 2020, Italy was the first European country to impose

[1] Department of Econometrics, Poznań University of Economics and Business, Poland. E-mail: sergiusz.herman@ue.poznan.pl. ORCID: https://orcid.org/0000-0002-2753-1982.

a national lockdown. By the end of the month, similar actions were taken by the majority of European countries, which introduced various restrictions for their citizens.

In the literature, there are studies on COVID-19 restrictions. Some authors focus on negative impacts of a lockdown and evaluate its social and economic costs (Bonaccorsi et al., 2020; Palomino, Rodríguez and Sebastian, 2020; Coccia, 2021; Ke and Hsiao, 2021, Wu et al., 2021, Zhang et al., 2022). More applicable for this article are studies that concern a positive impact of introduced restrictions on the pace of spread of the COVID-19 pandemic in the world. For instance, the studies that demonstrated that making masks mandatory in public spaces considerably reduces the spread of the virus (Mitze et al., 2020; Zhang et al., 2020, Bo et al., 2021, Chernozhukov et al., 2021). Other authors try to study the impact of lockdown on the outbreak of the pandemic. Studies on the topic mostly concern China (Lai et al., 2020; Ruan et al., 2020; Tian, Luo, et al., 2021; Tian, Tan, et al., 2021) and US (Bayat et al., 2020, Courtemanche et al., 2020; Siedner et al., 2020; Abouk and Heydari, 2021; Li et al., 2021). There are still not many similar studies concerning Europe. Among others, there were studies on the impact of school openings in Italy (Alfano, Ercolano and Cicatiello, 2021), lockdown in Madrid or London (Goodman-Bacon and Marcus, 2020) or a lack of restrictions on the health of citizens (Cho, 2020; Born, Dietrich and Müller, 2021). Also, there are international studies (Alfano and Ercolano, 2020; Fountoulakis et al., 2020; Piovani et al., 2021). Mendez-Brito et al. (2021) presented more research connected to the discussed subject.

In their research, the authors mentioned above used diversified methods, such as: synthetic control method (Bayat et al., 2020; Cho, 2020; Mitze et al., 2020; Alfano, Ercolano and Cicatiello, 2021; Born, Dietrich and Müller, 2021; Tian, Luo, et al., 2021; Tian, Tan, et al., 2021), linear regression (Fountoulakis et al., 2020; Siedner et al., 2020; Zhang et al., 2020), event studies (Courtemanche et al., 2020; Abouk and Heydari, 2021; Li et al., 2021), structural equation model (Chernozhukov et al., 2021), SEIR model (Lai et al., 2020), difference-in-differences analyses (Goodman-Bacon and Marcus, 2020; Abouk and Heydari, 2021), panel analysis (Alfano and Ercolano, 2020; Piovani et al., 2021), generalized linear mixed model (Bo et al., 2021).

The main goal of the research is to study the impact of the lockdown in Poland on the spread of the coronavirus pandemic. The spread of this pandemic shown completely different behaviour in different regions (voivodships). In the research, therefore, a data-driven, non-parametric way to look at things is required. For this reason the synthetic control method was used in the study. It allowed the author to determine how the pandemic would have had spread in the region similar to Warmińsko-Mazurskie voivodship if it had not been for the lockdown. There is not much research on the impact of restrictions on the spread of the pandemic in European countries. It is crucial to conduct such analyses due to the risk of another wave of COVID-19. The results might be imperative for the government to determine effective actions against the spread of the pandemic. To the best knowledge of the author, there is no other analysis in the Polish literature that uses the synthetic control method.

The article has the following structure. In the second part, the author presented statistics on the spread of the coronavirus pandemic in Poland and restrictions implemented subsequently. The third part includes a description of the methodology of the study – the synthetic control method. Next parts present a research sample and results of the empirical analysis. The article ends with the summary.

2. The spread of COVID-19 in Poland and subsequent restrictions

First cases of the coronavirus in Europe were identified at the end of January 2020. First, they were recorded in France, Germany and Italy. In Poland, a month later, on 4 March 2020, patient zero was documented in Lubuskie voivodship. Next cases on the subsequent days as well as a rapid spread of the disease in Western Europe led to first restrictions in Poland. On 10 March 2020, mass gatherings were cancelled. Two days later, schools and cultural institutions were closed. On 24 March, the movement of the population and gatherings (up to 2 people) were restricted. A week later, next restrictions were imposed; among others: hotels, restaurants and hair salons were closed, and religious gatherings were limited. On 16 April, similarly to other European countries, it became mandatory to cover nose and mouth in public spaces. Owing to the rapid introduction of restrictions as well as self-discipline of the society, a daily number of cases was stagnant in the studied period (Figure 1).

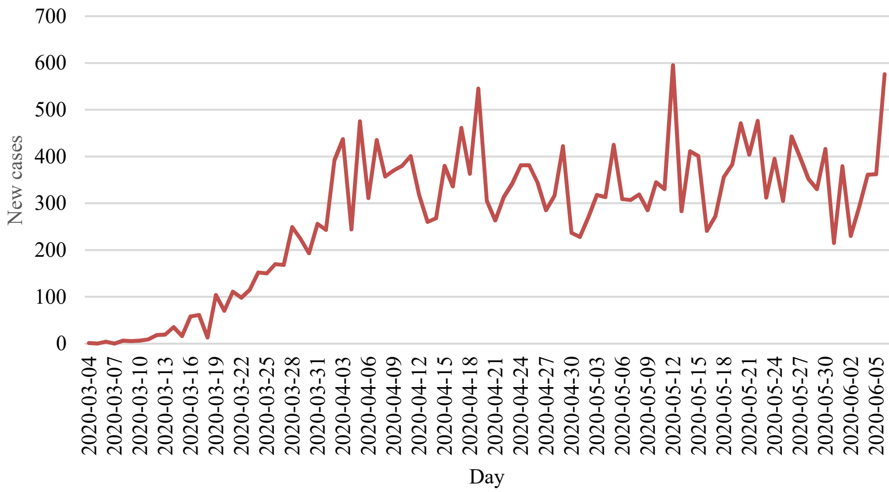

Figure 1. Daily new coronavirus cases in Poland for the period 4.03.2020 – 6.06.2020.
Source: author's work on the basis of Ritchie et al. (2021).

As a result, as of 20 April, restrictions were gradually lifted. It was divided in the 7-14-day intervals and lasted until 6 June 2020. During summertime, daily numbers of new cases were growing (reaching the maximum value of 903) but remained stable. Restrictions were implemented locally (in poviats).

The situation got considerably worse in autumn. This is well-illustrated in Figure 2. This is when the second wave of pandemic hit Poland. Due to a dramatic growth in new cases, all restrictions lifted during summertime were reintroduced. The worst situation was in November. In the subsequent months, the situation was gradually improving. Therefore, first restrictions were lifted on 18 January – schools were opened for younger kids, shopping malls, museums and art galleries were opened on 1 February, and hotels, swimming pools, cinemas and theatres were opened on 12 February.

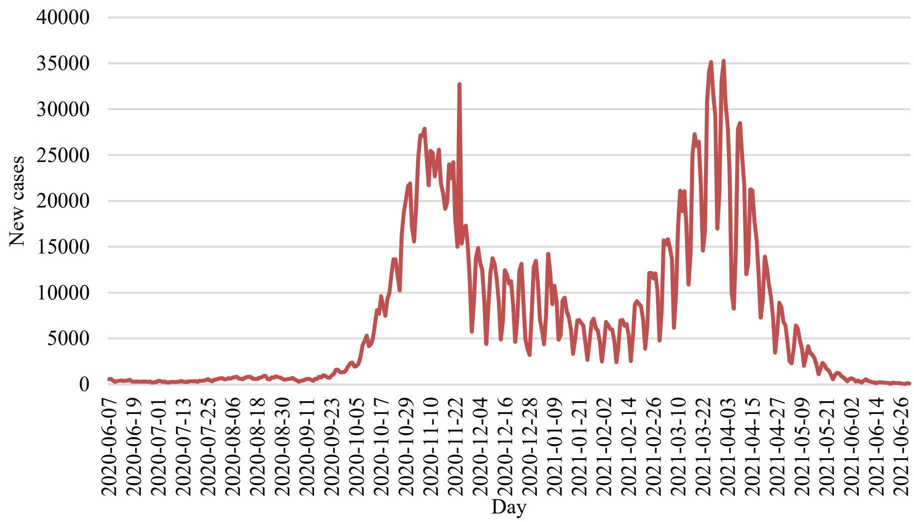

Figure 2. Daily new coronavirus cases in Poland between 7.06.2020 – 30.06.2021

Source: author's work on the basis of Ritchie et al. (2021).

It was not long before another lockdown was introduced. The third, most serious, wave of pandemic hit Poland. From the beginning of March, the daily number of new cases was rapidly growing reaching the maximum of 35000 cases a day. The hospitals were overwhelmed with COVID-19 patients. To reduce the strain on healthcare system, temporary hospitals were opened around Poland. The pandemic was spreading at different pace around the country. Therefore, first, the government introduced lockdown only in some regions. First, it was introduced in Warmińsko-Mazurskie (27.02), then Pomorskie (13.03), and Mazowieckie and Lubuskie (15.03). Figure 2 illustrates that the daily number of new coronavirus cases was growing in the studied period. Therefore, the lockdown was introduced in the entire country on 20 March. After the peak of new cases at the turn of March and April, the situation began to improve. From 20 April, the introduced restrictions were being lifted.

3. Research methodology

The synthetic control method, proposed by Abadie and Gardeazabal (Abadie and Gardeazabal, 2003) and further developed by Abadie, Diamond and Hainueller (Abadie, Diamond and Hainmueller, 2010, 2011, 2015; Abadie, 2021) was used in the study. This method is used in comparative case study research. In this kind of research, authors compare the outcome of one or multiple units affected by the treatment or intervention with the outcome of one or multiple units not affected by them. In the synthetic control method, the assumption is that only one unit was affected by the intervention. The goal of the research is to identify the impact of the treatment on the outcome of the research subject.

The assumption is that gathered data included J+1 units ($j = 1,2, \dots, J + 1$), where the first unit ($j = 1$) is a treated unit, whereas remaining units $j = 2, \dots . J + 1$ belong to the donor pool and constitute a set of potential comparative units not affected by the treatment. The data were gathered from T periods, where first T_0 are periods prior to the treatment (periods $1,2, \dots, T_0$) . The Y_{jt} outcome of interest can be observed for each j unit and t period. For each j unit, there is k set of $X_{1j,} \dots, X_{kj}$ predictors of the outcome that may include outcomes before the Y_{jt} treatment. Vectors with $(kx1)\boldsymbol{X_1}, \dots . \boldsymbol{X_{J+1}}$ dimensions include components for $j = 1, \dots . J + 1$ units. The $\boldsymbol{X}_0 = [X_2 \dots X_{J+1}]$ matrix with (kxJ) dimensions includes predictors of J untreated units. The outcome of interest for $t > T_0$ and for the studied ($j = 1$) unit may be defined with the equation:

$$\tau_{1t} = Y_{1t}^I - Y_{1t}^N \tag{1}$$

where Y_{1t}^I and Y_{1t}^N are denoted as the outcome for the unit affected by the intervention or in the absence of the intervention respectively. The (1) equation allows for the fact that the impact of the political intervention may vary over time. The intervention might not have an immediate effect – it can be accumulated over time. The Y_{1t}^I values are known. The purpose of the synthetic control method is to estimate the outcome for the studied unit in the absence of the Y_{1t}^N intervention. The method is based on the assumption that the linear combination of units not affected by the intervention will better illustrate how the unit reacts to the intervention. In order to construe the synthetic control unit, the author defined the $(Jx1)$ weights vector where weights are denoted as $W = (w_2, \dots, w_{J+1})'$. When the W weights vector is known, the Y_{1t}^N and τ_{1t} estimators are respectively:

$$\hat{Y}_{1t}^N = \sum_{j=1}^{J+1} w_j Y_{jt} \tag{2}$$

$$\hat{\tau}_{1t} = Y_{1t}^I - \hat{Y}_{1t}^N \tag{3}$$

The weights meet the assumptions: $w_j \geq 0 \ j = 2,, \dots J$ and $w_2 + \cdots + w_{J+1} = 1$. The main challenge is to estimate the $w_2, \dots, w_{J+1}$ weights. Abadie and Gardeazabal (2003) as well as Abadie *et al.* (2010) suggest choosing weights in such a way that characteristics of the synthetic control unit were best illustrating characteristics of the unit affected by the intervention $(j = 1)$. It means that, taking into account non-negative $v_1, \dots v_k$ values, they suggest choosing $W^* = (w_2^*, \dots, w_{J+1}^*)$ synthetic control that minimizes the distance defined as:

$$\|\boldsymbol{X_1} - \boldsymbol{X_0 W}\| = \sqrt{(\boldsymbol{X_1} - \boldsymbol{X_0 W})' \boldsymbol{V} (\boldsymbol{X_1} - \boldsymbol{X_0 W})} = \left(\sum_{h=1}^{k} v_h (X_{h1} - w_2 X_{h2} - \cdots - w_{J+1} X_{hJ+1})^2\right)^{\frac{1}{2}} \quad (4)$$

under conditions:

$$0 \leq w_j \quad j = 2,, \dots J \quad w_2 + \cdots + w_{J+1} = 1$$

Positive $v_1, \dots v_k$ values illustrate validity of each $X_{11}, \dots X_{k1}$ predictive variable. For a given set of $v_1, \dots v_k$ values, the minimizing of the (4) equation constitutes the problem of the square optimization. The question is how to choose the $\boldsymbol{V}$ vector. Abadie and Gardeazabal (2003) as well as Abadie *et al.* (2010) suggest choosing the $\boldsymbol{V}$ vector that minimizes the mean squared prediction error (MSPE) for the outcome over some set of pre-intervention periods. In other words, the $Z_1(T_P x 1)$ is a vector of the outcome for the treated unit over some set of pre-intervention periods and $Z_0(T_P x J)$ is a matrix of corresponding values for units from the donor pool, where T_P $(1 \leq T_P \leq T_0)$ is a number of pre-intervention periods for which the mean squared prediction error (MSPE) is minimized. Then, the V^* is chosen to minimize:

$$arg\min_{V \in \gamma}(Z_1 - Z_0 W^*(V))'(Z_1 - Z_0 W^*(V)) \quad (5)$$

where γ is a set of all positive (KxK) diagonal matrices. In the end, the embedded optimization problem is solved, which minimized the above (5) equation for $W^*(V^*)$ defined by the (4) equation.

4. Research sample

The goal of the research is to study the impact of restrictions imposed in Poland on the spread of the COVID-19 pandemic. For this purpose, the author used Warmińsko-Mazurskie region (voivodship), where lockdown was introduced on 27 February 2021. As mentioned before, this is the first region in Poland where the lockdown was introduced during the third wave of the coronavirus pandemic. The research covers the period of 36 days, which is period of two weeks prior to restrictions and three weeks after they were introduced. It is the period between the lifting of restrictions in Poland (12 February 2021) and their reintroduction in the entire country (20 March 2021).

It was assumed that restrictions introduced on 13 and 15 March in three regions had not shown the desired effect – to curb the spread of the pandemic. The assumption was based on the fact that according to the literature, the average period between the infection and a positive test result is 11.7 days (Mitze et al., 2020).

Apart from Warmińsko-Mazurskie region, all 15 voivodships in Poland constituted the set of potential comparative units – the donor pool. The Y_{jt} outcome variable responsible for the spread of the pandemic in every voivodships was the accumulated number of new infections from 12 February 2021 until 20 march 2021 (36 observations for each region). The predictive variables were:

- accumulated number of cases a day and seven days prior to the restrictions (2 observations for each voivodship),
- average daily number of cases in the last 7 days prior to the restrictions (1 observation for each voivodship),
- young-age dependency ratio (ratio of people aged 14 and younger to the 15–64 age group) in 2020 (1 observation for each voivodship),
- share of people living in cities in 2020 (1 observation for each voivodship),
- doctors per 10 thousand citizens in 2020 (1 observation for each voivodship),
- pharmacies per 10 thousand citizens in 2020 (1 observation for each voivodship),
- number of people vaccinated per 10 thousand citizens on a day prior to restrictions in 2020 (1 observation for each voivodship),
- number of recoveries per 10 thousand citizens on a day prior to restrictions in 2020 (1 observation for each voivodship).

They were chosen based on the literature review and the availability of data. Data on the spread of the pandemic in Poland were taken from the government website on the pandemic in Poland (Ministry of Health 2021), whereas data on demographics and healthcare were taken from the Local Data Bank (GUS 2021). Calculations were made in the R statistical environment.

5. Results of the empirical study

Using the methodology and data described in previous parts, based on the two-week period prior to restrictions (13.02.2021-26.02.2021), the author construed the synthetic control unit – synthetic Warmińsko-Mazurskie region (voivodship). Table 1 includes weights created for this purpose. Based on that, it is safe to say that the synthetic region is the combination of three regions: Kujawsko-Pomorskie, Śląskie and Mazowieckie.

Table 1. Synthetic weights for Warmińsko-Mazurskie

Region	Synthetic control weight	Region	Synthetic control weight
Dolnośląskie	0.001	Podkarpackie	0.001
Kujawsko-Pomorskie	0.745	Podlaskie	0.000
Łódzkie	0.001	Pomorskie	0.000
Lubelskie	0.000	Śląskie	0.196
Lubuskie	0.000	Świętokrzyskie	0.000
Małopolskie	0.000	Wielkopolskie	0.000
Mazowieckie	0.055	Zachodniopomorskie	0.001
Opolskie	0.000		

Source: own calculation based on GUS (2021) and Ministry of Health (2021).

Table 2 presents values of predictive variables used in the study for two units, that is Warmińsko-Mazurskie and synthetic Warmińsko-Mazurskie regions as well as an average value for the 15 remaining regions.

Table 2. Averages for predictive variables of accumulated number of cases

Variable	Warmińsko-Mazurskie		Average of 15 control voivodships
	Real	Synthetic	
Accumulated number of cases a day prior to the restrictions	8944.0	8878.1	6808.4
Accumulated number of cases seven days prior to the restrictions	4378.0	4414.2	3306.9
Average daily number of cases in the last 7 days prior to the restrictions	704.3	715.8	562.1
Young-age dependency ratio (persons aged 14 years and below per 100 of population aged 15-64 years)	22.5	22.8	22.8
Doctors per 10 thousand citizens	42.4	58.5	55.7
Pharmacies per 10 thousand citizens	2.9	2.9	3.1
Share of people living in cities	59.0	62.4	58.3
Number of people vaccinated per 10 thousand citizens on a day prior to restrictions	799.1	785.9	848.3
Number of recoveries per 10 thousand citizens on a day prior to restrictions	575.6	534.8	432.0
	RMSPE	126.6	

Source: own calculation based on GUS (2021) and Ministry of Health (2021).

According to the results, for the vast majority of predictive variables, the synthetic Warmińsko-Mazurskie region is more similar to the actual region than to all other studied regions. In other words, the determined linear combination of regions better reflects characteristics of the studied unit than the average of the donor pool. The table also presents the root mean square prediction error (RMSPE). It measures the difference between outcome variables (accumulated number of cases) for Warmińsko-Mazurskie region and its synthetic equivalent for the period prior to restrictions. Figure 3 presents slight differences. Trajectories of the pandemic for both analysed units are aligned in the studied period. The synthetic region almost perfectly illustrates outcome variables for the actual Warmińsko-Mazurskie region.

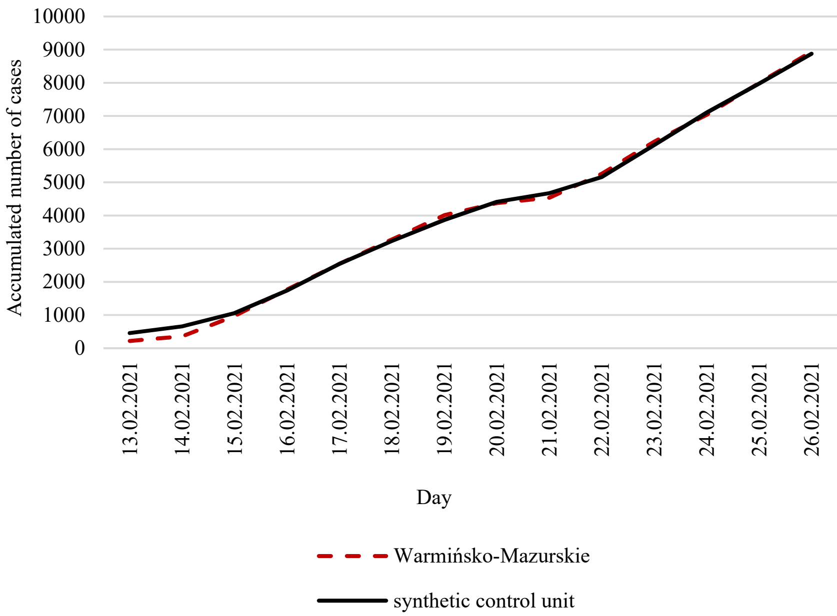

Figure 3. Accumulated number of cases for Warmińsko-Mazurskie region and synthetic Warmińsko-Mazurskie region in the period prior to restrictions

Source: own calculation based on GUS (2021) and Ministry of Health (2021).

For the goal of the research, it is crucial how the variable responsible for the accumulated number of new cases for the synthetic unit changes after restrictions were introduced. The figure presents data on the spread of the pandemic in the studied period.

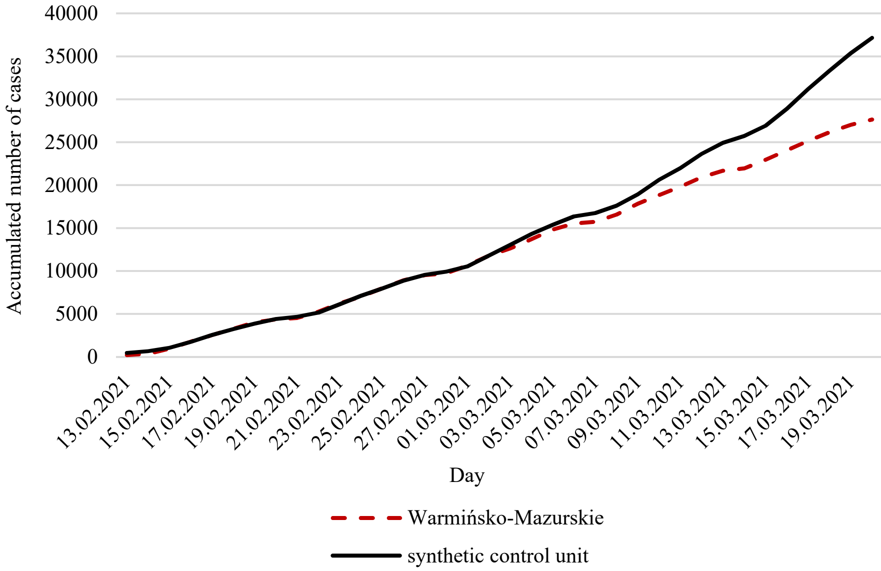

Figure 4. Accumulated number of cases in Warmińsko-Mazurskie region and for the synthetic control unit in the studied period

Source: own calculation based on GUS (2021) and Ministry of Health (2021).

The figure shows that after 27 February there is a growing discrepancy between presented trajectories that are responsible for the spread of the pandemic. Over time, values for the synthetic unit are more and more different compared to actual numbers in the studied region in Poland. It is worth reminding that the synthetic unit is responsible for the situation with an absence of the studied intervention; that is if the lockdown had not been introduced. According to the results, only 10 days after the restrictions were imposed, the accumulated number of cases for the Warmińsko-Mazurskie region would have been lower by 1100 compared to the synthetic unit. On the last studied day, the difference grew to more than 9500 cases. Thus, the conclusion is that if it had not been for the lockdown introduced in the Warmińsko-Mazurskie region, on 20 March 2020 the number of new cases would have been higher by 34% compared to the reality.

To assess the validity of the results, placebo studies were conducted. As a result, it was verified whether differences visible in Figure 4 stem from the introduced restrictions or lack of prognostic abilities of the adopted method. Placebo studies were conducted in two dimensions: time and space. In the first scenario, the entire analysis was repeated assuming that the restrictions were introduced earlier, e.g. on 22 January 2020. Figure 5 presents accumulated number of cases.

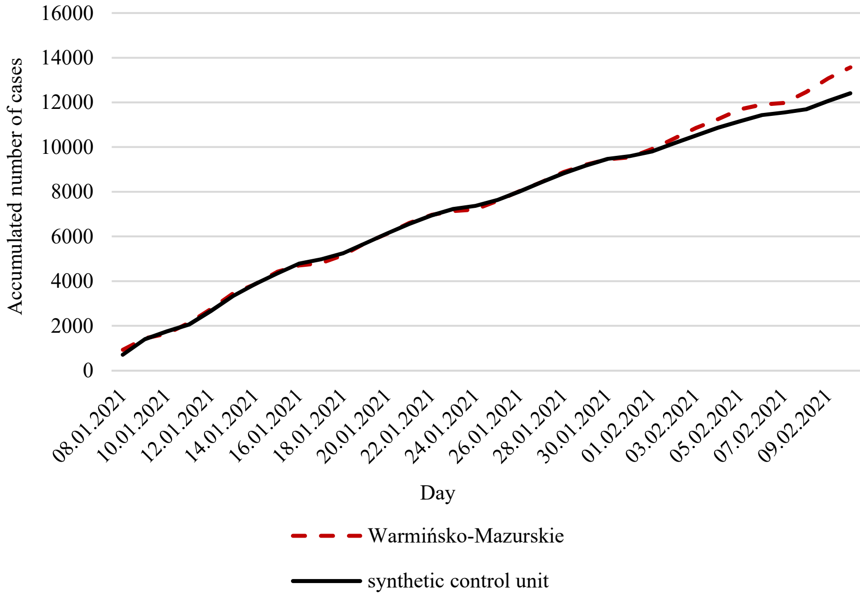

Figure 5. Placebo-in-time tests for (pseudo) treatment effects in the period 22 January to 12 February

Source: own calculation based on GUS (2021) and Ministry of Health (2021).

According to the figure, the dynamics of the pandemic evolution in Warmińsko-Mazurskie region and its synthetic equivalent is similar. Only the last 4 days show slightly higher discrepancies between the curves presented on the figure. Most importantly, unlike in the case of Figure 4, values for the synthetic unit are lower compared to the Warmińsko-Mazurskie region.

In the second placebo study, analyses are redone assuming that units affected by the intervention (lockdown) are all 15 regions from the donor pool. As a result, it was possible to compare the estimated outcome of restrictions for the Warmińsko-Mazurskie region with the distribution of placebo outcomes for other regions. The assumption is that the studied outcome for the Warmińsko-Mazurskie region is relevant if the gap (defined as the difference between the accumulated number of cases for the actual region and the synthetic one) for the Warmińsko-Mazurskie is high in comparison with the gaps from the donor pool. The results are shown in Figure 6. The figure presents the distribution of the gaps. It is clear that Warmińsko-Mazurskie voivodship is one of the regions for which the studied difference is negative. Most importantly, it is the highest (absolute value) on the last day of the studied period. Results of the placebo studies show that the outcome presented in Figure 4 is the actual outcome of restrictions introduced in Warmińsko-Mazurskie voivodship.

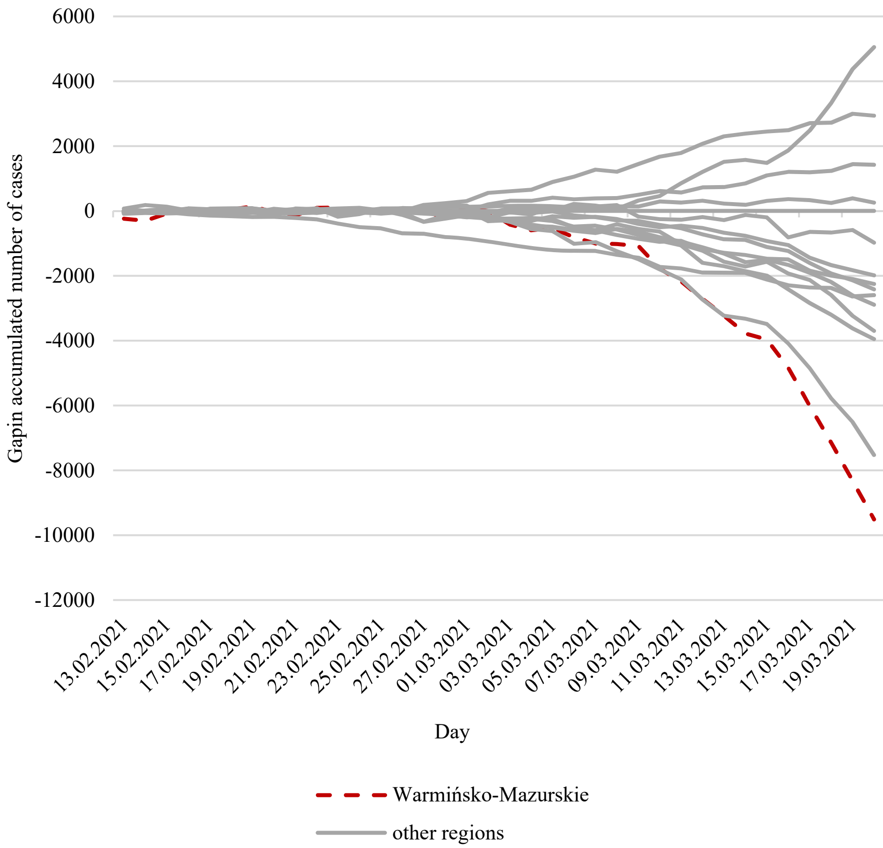

Figure 6. Placebo-in-space tests (all voivodships)

Source: own calculation based on GUS (2021) and Ministry of Health (2021).

The last part of the study includes robustness tests and is connected with the sensitivity analysis determining how the adopted method is affected by the change of the research sample. First, it was studied how the outcomes would be changing if different regions were taken to the donor pool. Table 1 shows that three regions (Kujawsko-Pomorskie, Śląskie and Mazowieckie) are crucial for the construction of the synthetic Warmińsko-Mazurskie region. Using variables presented earlier, the methodology was used three more times and one of the above-mentioned regions was left out from the donor pool in next iterations. The outcomes on the accumulated number of cases in Warmińsko-Mazurskie region and its synthetic equivalents are presented in Figure 7.

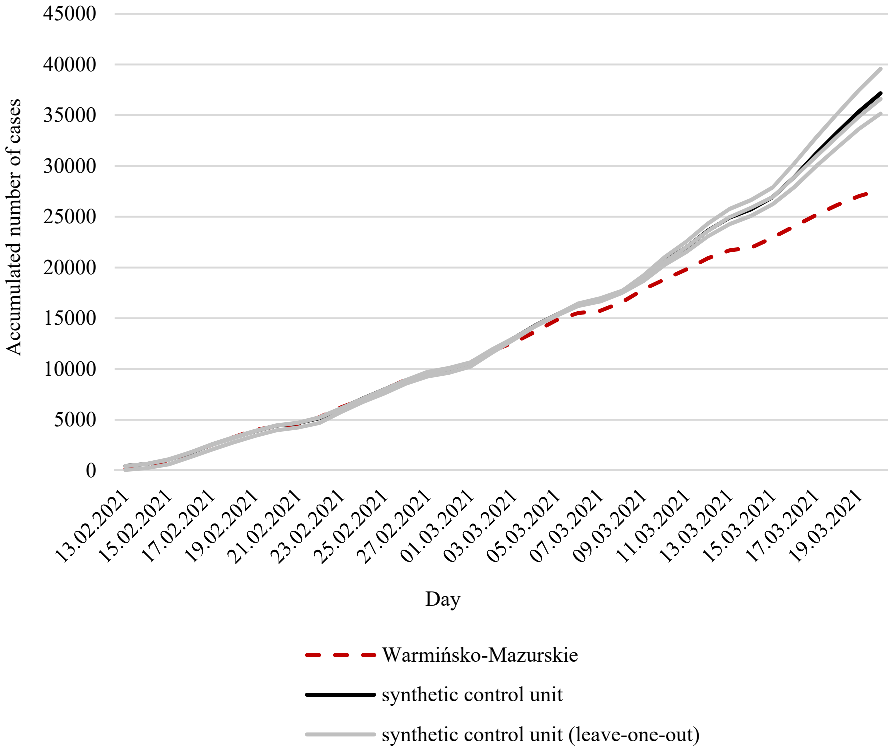

Figure 7. Leave-One-Out Distribution of the Synthetic Control for Warmińsko-Mazurskie

Source: own calculation based on GUS (2021) and Ministry of Health (2021).

The figure shows that outcomes obtained at the beginning of the research are quite resistant to leaving out the most important regions from the donor pool. The leave-one-out synthetic controls produce a very similar effect of restrictions introduced in Warmińsko-Mazurskie. In all three cases introducing lockdown causes decrease in the number of cases. Only in one case (after deleting the Mazowieckie region) the effect of lockdown would be higher than for whole quota of donors. The second robustness test included the change of predictive variables. To conduct the test, calculations were repeated twice. First, not taking into account demographics and healthcare data in Poland, then, not including variables on the dynamics of the pandemic in Poland. Table 3 shows weights for particular variables in presented calculations and root mean square prediction errors.

Table 3. Weights for analysed predictive variables

Variable	Synthetic control unit	Synthetic control unit (without variables on demographics and healthcare)	Synthetic control unit (without variables on the dynamics of the pandemic)
Accumulated number of cases a day prior to the restrictions	0.624	0.870	-
Accumulated number of cases seven days prior to the restrictions	0.195	0.096	-
Average daily number of cases in the last 7 days prior to the restrictions	0.177	0.030	-
Young-age dependency ratio (persons aged 14 years and below per 100 of population aged 15-64 years)	0.004	-	0.000
Doctors per 10 thousand citizens	0.000	-	0.840
Pharmacies per 10 thousand citizens	0.000	-	0.005
Share of people living in cities	0.000	-	0.107
Number of people vaccinated per 10 thousand citizens on a day prior to restrictions	0.000	0.004	0.000
Number of recoveries per 10 thousand citizens on a day prior to restrictions	0.001	0.000	0.048
RMSPE	126.600	126.352	158.691

Source: own calculation based on GUS (2021) and Ministry of Health (2021)

The results show that leaving out variables on demographics and healthcare does not have much impact on the alignment of the synthetic unit to the actual one. More significant impact (higher RMSPE value) can be observed if variables on the dynamics of the pandemic are excluded from the study. However, the value of the error is not very high. The same conclusion can be drawn from analysing the figure on the accumulated number of cases in the studied period (Figure 8).

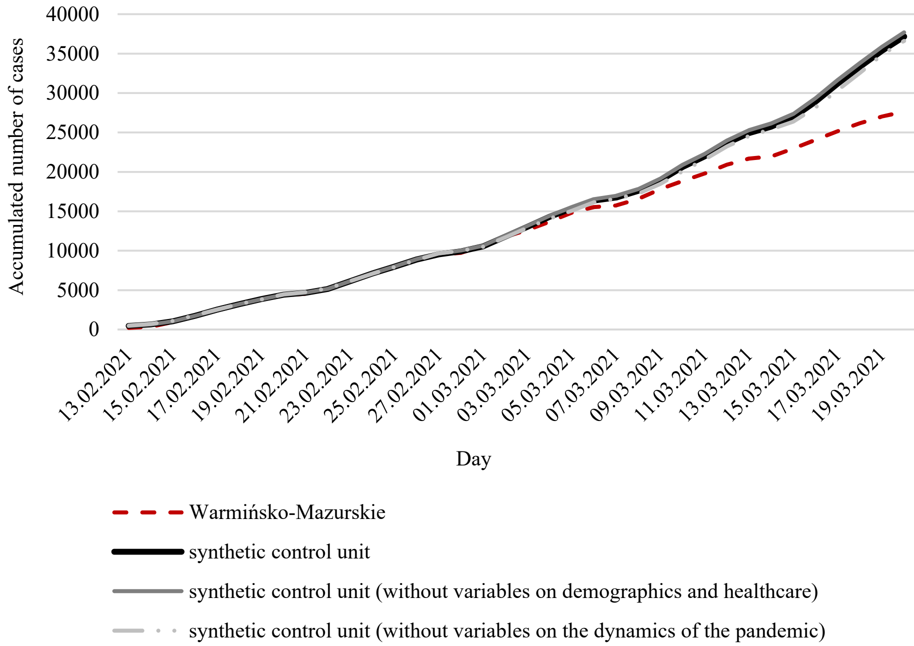

Figure 8. Accumulated number of cases for Warmińsko-Mazurskie and synthetic regions with a different set of predictive variables

Source: own calculation based on GUS (2021) and Ministry of Health (2021).

It is clear that a day before the restrictions were introduced, all curves have a very similar position. What is more, after the restrictions were implemented, their dynamics are not changing significantly. Therefore, the synthetic control method and its results are resistant to the change of assumptions made at the beginning of the study.

6. Conclusions

Due to the rapid spread of the pandemic, governments in many countries decided to introduce various restrictions. Their main goal was to reduce contact between people, which is how the virus transmits. Closing of shopping malls, cinemas, schools, hotels involves high economic and social costs. Since lockdowns are put in place repeatedly and for a longer period, the society has been rebelling against them more and more often. Therefore, before the next pandemic wave, it is essential to estimate the validity of restriction on life and health of citizens.

The main goal of the research was to study the impact of lockdown on the spread of COVID-19 in Poland. Results show that lockdown is an efficient tool that curbs the spread of the COVID-19 pandemic. Its introduction has significantly limited the number of new cases in the analysed region in Poland. The research included the construction of the synthetic region that well illustrated the tendency of the pandemic development in the Warmińsko-Mazurskie region before the lockdown. After that, with time, the virus spread trajectories started to differ considerably. Results indicate that imposed restrictions decreased the number of coronavirus cases by 9500 people in 21 days. Placebo-in-space and placebo-in-time studies proved that results are reliable and resistant to the change of research assumptions.

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