CHARLES UNIVERSITY
FACULTY OF SOCIAL SCIENCES
Institute of Economic Studies

The Effect of rainfall on voter turnout: Evidence from the Czech Republic

Master's thesis

Author: Ing. Kristina Kubíková
Study program: Economics and Finance
Supervisor: PhDr. Miroslav Palanský, Ph.D.
Year of defense: 2022

Declaration of Authorship

The author hereby declares that she compiled this thesis independently, using only the listed resources and literature, and the thesis has not been used to obtain any other academic title.

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Prague, August 1, 2022

Kristina Kubikova

Abstract

Existing research suggests that rainfall on election days has, at least under some circumstances, a significant negative effect on voter turnout. The purpose of this thesis is to assess whether this is also the case in the Czech Republic. The results support the hypothesis, with the preferred specification suggesting that one additional millimeter (mm) of precipitation on election day is associated with a drop in turnout rates of around 0.26 to 0.38 percentage points. We find that election type plays a key role in determining the effect of rainfall on voter's participation. For the elections to the Chamber of Deputies, we find evidence of an inverted U-shape relationship, consistent with the notion that small amounts of rain do not play a significant role in an important election, while heavy rain (around 6mm and more) decreases turnout with every additional mm of rain. For the elections to the European Parliament, which are generally perceived as less important, we find turnout to be negatively associated with even smaller amounts of rain: one additional mm of rain is associated with a 0.82 percentage point decrease in the turnout rate. Finally, we study the link between the closeness of the election results, precipitation, and turnout, and we find that for important elections, a close fight between two candidates enhances people to go to the polls even when it is raining. For unimportant elections, the effect is opposite: when the result is expected to be tight, precipitation is associated with lower turnout rates.

JEL Classification	C21, C23, D72, E10, E70
Keywords	rainfall, turnout, election, voting, Czechia
Title	The Effect of rainfall on voter turnout: Evidence from the Czech Republic

Acknowledgments

The author is grateful especially to PhDr. Miroslav Palanský, Ph.D. for his valuable advice, comments and continuous help with this thesis. Further, she would like to thank her friends, boyfriend and family for their support provided not only while writing this thesis but also throughout the whole studies. Last but not least, a big thank you goes to Ivan Novák for his endless patience during our thesis related consultations.

Typeset in LaTeXusing the IES Thesis Template.

Bibliographic Record

Kubikova, Kristina: *The Effect of rainfall on voter turnout: Evidence from the Czech Republic.* Master's thesis. Charles University, Faculty of Social Sciences, Institute of Economic Studies, Prague. 2022, pages 70. Advisor: PhDr. Miroslav Palanský, Ph.D.

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Acronyms

OLS Ordinary Least Squares

FEM Fixed Effects model

REM Random Effects model

CSO Czech Statistical Office

CHMO Czech Hydrometeorological Office

MLSA Ministery of Labor and Social Affairs

DID Difference in differences

Master's Thesis Proposal

Author	Ing. Kristina Kubíková
Supervisor	PhDr. Miroslav Palanský, Ph.D.
Proposed topic	The Effect of rainfall on voter turnout: Evidence from the Czech Republic

Motivation As previous research on US data suggests, one inch of rain decreases voter turnout per one percentage point. The main goal of this thesis is to measure, whether the precipitation has the same effect on Czech voters. According to common beliefs, as well as expert opinions, the rainfall on election day will lead to decrease in number of voters participating in the election (Franklin, 2004). However, only a few studies providing empirical evidence supporting this assumption were released so far.

Besides the already mentioned analysis conducted in the United States, measuring the effect for presidential elections, there is a paper studying elections to Swedish parliament (Persson *et al.*, 2014). This thesis will replicate these papers on Czech data. However, it will not focus only on one single type of election and will consider all elections carried out in the Czech Republic so far, which creates an opportunity to evaluate the significance of the effect compared to the importance of individual types of elections.

Voter turnout is influenced by many factors. The ones that most of the papers have in common are parameters such as income, gender, age, unemployment, education etc. One could say that those are uniform all over the world and therefore there is no need to replicate the research on data from another country. However, there are very different electoral systems across the world, with different barriers and both actual and perceived costs and benefits of voting. Therefore, it could be assumed, that for the Czech Republic the outcomes could be very different than for other countries.

Hypotheses

Hypothesis #1: The voter turnout will be lower when it is raining.

Hypothesis #2: The more important the election is, the lower will be the decrease in voter turnout caused by rain.

Hypothesis #3: The tighter the outcome of the election, the lower is the impact of precipitation on the turnout.

Methodology As this thesis aims to replicate previous research, the main resources will be the previously mentioned papers which will provide theoretical background. The data regarding voter turnout for individual elections will be provided by volby.cz and will cover the period from 2004 to 2020 for each electoral district and constituency. The historical weather data will be taken from Czech Hydrometeorological Office – institution that provides information taken from numerous weather stations situated all over the Czech Republic, describing what amount of precipitation was in the area of a specific constituency by the time the election took place. Data on other factors determining participation of voters in the election (such population size or density etc.) will be taken mostly from Czech Statistical office or other official websites focusing on the specific factor.

Voter turnout and precipitation will be put together, along with other factors affecting voter turnout, creating a dataset. This panel data will be further analyzed using Pooled OLS, as the same method was used in the related papers (but might also be FEM or REM, tbd). The final chapter of this thesis will be dedicated to the results and their interpretation.

Expected Contribution If this thesis achieves to verify the original claim that rainfall leads to decrease in voter participation, it might impact the way the elections are carried out in the Czech Republic. It will contribute to existing literature in at least 3 ways. First, it will describe whether the rainfall affects Czech voters when deciding whether to cast their ballots or not. Second, the outcomes will show whether the effect of rainfall is less significant for these types of election that are perceived as more important (such as Chamber of deputies' election). Last but not least, it will examine whether there is a link between the tightness of the election outcome and voter turnout while it is raining.

If the effect of rainfall on voter turnout shows to be very significant, calls for resolving the situation are to be expected. As Gomez *et al.* (2007) show, the rainfall plays against some parties since their voters tend to stay at home when it rains. Also, the effect seems to be more significant for those elections that will not have a tight outcome – voters perceive it as their vote doesn't matter and tend to stay at home when a minor obstacle such as rain occurs. The same applies to elections with less importance where a minor difficulty might cause the voter not to participate.

In extreme cases the precipitation might cause a different outcome of the election, which should be considered and prevented.

Outline

1. Context of the Czech Republic – electoral system, division into districts, voting days, geographical division, climate conditions and weather.
2. Literature review – determinants of voting behavior on both individual and aggregate level; previous research on the effect of rainfall on voter turnout
3. Data – description of how the data is gathered and processed, basics descriptive statistics of main variables.
4. Methodology – description of the models used to analyze the data (OLS, FE, DID)
5. Results and Discussion – outcomes of the models as well as their discussion
6. Limitations and further research suggestions – discussion of the drawbacks of data and models as well as options for durther research

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Chapter 1

Introduction

The effect of rainfall on voter turnout is undoubtedly an interesting topic, leaving many researchers curious whether there is a relationship between the two or not. So far, a handful of studies and papers have been published, trying to answer this question. Most of them conclude that there is a significant negative effect of rainfall on voter turnout, however, there is no consensus in the existing literature. The results are rather different among the countries − in the US 1 inch of the rain reduces turnout by 1 percentage point (Gomez *et al.*, 2007), in the research conducted on Irish data a 2pp decrease in turnout caused by rain was found, and the analysis based on Danish data hasn't found any significant effects. Besides being interesting, this topic also introduces an important issue regarding the results of the elections. The research conducted on the US presidential election data shows, that the election day rainfall favors the Republicans which might have affected the outcomes of the presidential elections held in 1960 and 2000 (Gomez *et al.*, 2007).

As the research always covers the elections held in a certain state, and it is obvious that the effect of precifpitation on turnout is slightly different for each of them, this thesis aims to analyze whether and how the rainfall on election day influences Czech voters. Further, this research aims to answer the question, whether the impact of the rainfall differs for different types of elections. Undoubtedly, the rainfall is possessing an obstacle when it comes to decision making whether to cast the ballot or not. It is assumed that there are some election types that are perceived by the population as more (less) important than others − which are which can be determined using only such basic indicator as is the average turnout. Therefore, as intuition suggests, the will to overcome an additional cost of voting in the form of rain will be smaller when the election type is perceived as unimportant by the individual. To confirm whether this intuition is correct is one of the objectives of this thesis. Also, the tightness of the anticipated election outcome is believed to play a significant role. Intuition suggests that when a close fight is expected between two candidates, people perceive their vote as more pivotal, as only units of votes might change the outcome of the election. In such situation a minor inconvenience in the form of precipitation will not discourage them from coming to the polls. On the other hand, when it is almost clear in advance who will be the winner, people tend to abstain − the expected winner's voters might think that their candidate will definitely win and that he doesn't need their votes; on the contrary, others might assume that it is a lost cause anyway, with or without their vote. Therefore, it is believed that when an issue such as rain occurs, it might discourage people from voting. One of the goals of this research is then to confirm whether this intuition can be supported by empirical evidence.

The evidence from the Czech Republic shows that, as in most of the states, the effect of rainfall on voter turnout is significantly negative. We found that 1mm of rainfall decreases the number of voters that cast their ballots by around 0.38pp on the district level. The evidence from around 600 Czech villages confirms the negative effect, showing that with this selected sample the turnout drops by 0.26pp with every additional mm of precipitation.

Further, the election type is found to play a key role when it comes to voter's behavior related to bad weather. The research analyzes the turnout for the Chamber of Deputies elections, as it is perceived as the most important election type, and finds that at first the rain enhances voter turnout. Then, when the precipitation exceeds 6.15mm break point, the turnout tends to decrease with every mm of rainfall. On the contrary, as the European Parliament election is seen as the least important election type, the voters are not motivated enough to cast their ballots when it is raining, and every mm of rainfall lessens the electoral participation by 0.82pp.

The thesis concludes that tightness of election outcome affects the effect of precipitation on voter turnout. For the Chamber of Deputies election, when the outcome is tighter, rain is not found to have as profound effect as it would have if the difference in the number of received votes was large. Therefore, when people perceive that the election outcome will be tight and that their vote might be pivotal and change the results, they are less affected by the rain. This effect is not confirmed for the European Parliament election. On the contrary we found that the effect is quite the opposite − when the difference between two candidates is small, voters tend to be affected by the rain more and decide to stay at home rather than go to the polls even when little rain occurs.

This research contributes to existing literature in at least three ways. First, it analyzes the effect of precipitation on voter turnout on the data from the Czech Republic. Until today, no paper studying this effect on Czech data was published. Therefore, it brings an interesting insight into the situation in the country, finding that Czechs are significantly negatively affected by the precipitation. Second, it puts in relationship the tightness of the outcome, precipitation, and electoral participation. There were papers published about the impact that closeness of the results has on the voter turnout, as well as papers that analyze the effect of rainfall on the turnout, but none of them has ever studied the interaction between these three. Finally, all of the previously published papers have studied either one type of election or all of the election types in general. This paper adds to existing research in such a way that it distinguishes between types of elections and presents separate outcomes for the most and the least important of them all, as it was assumed that it plays a key role in the strength of the rainfall effect on the turnout rates.

The thesis is divided into 6 chapters. The first chapter aims to introduce the context of the Czech Republic − the types of elections and methods of their evaluation and overall rules of voting, as the previous research finds all of the above mentioned important when the voters are deciding whether to cast the ballot or abstain. Further, it describes the climatic conditions of the country, as this might be a crucial factor for eventual inter−country comparison. The second chapter aims to describe the background of voting behavior. Firstly, the costs and benefits of voting are described on the individual level, as well as the rational choice model of each voter. Then, the determinants of voter turnout are presented on the aggregate level, highlighting groups of important variables. The third chapter is dedicated to data and variables. It is described how the observations are obtained and put together, as well as some basic descriptive statistics about the variables. Treatment of missing values and outliers is also specified. Chapter four focuses on the methodology and the description of the methods used to analyze the obtained data, as well as reasoning of why they are chosen. The fifth chapter brings up the results of used models and related discussion, as well as the hypotheses evaluation. Finally, the main drawbacks of this research are addressed, and further research options are discussed.

Chapter 2

Context of the Czech Republic

Voter turnout differs in every country, state, city, and municipality. There are many factors affecting people's behavior on the election day – some of them are empirically supported, some are only based on intuition, some haven't been identified yet. Based on previous research it is known that demographics, electoral system, institutional context and local legislation play significant roles in the decision-making process that voters make while choosing whether to cast their votes or not (Blais, 2006). For that reason, the next chapter introduces the way elections are held in the Czech Republic, describing both organization on general level and the system of each specific kind of elections, as well as some basic demographic factors that might affect the turnout.

In the Czech Republic, the system is based on general suffrage, meaning that people over certain age who in all other ways meet the conditions set by law have the right to express their opinion by casting their ballots. Every person who has attained the age of 18, no matter their gender, race, religion, income etc., has the right to vote[1]. Based on the Constitution of the Czech Republic Act No. 1/1993 Coll. adopted on 16 December 1992[2], every election is subject to 4 main principles. The first one, generality, was described above. The principle of equality suggests that each citizen has one vote, and the weight of all votes is the same. The principle of the secret ballot ensures, that it will not be possible to link specific person to their vote and their identity remains anonymous. Finally, the principle of directness guarantees that the selection is made by the voter specifically and the right to vote may not be transferred to another

[1]Except some minor exceptions e.g., when the person is deprived of their right to vote by court due to mental illness etc.

[2]As amended by Constitutional Acts No. 347/1997 Coll., No. 300/2000 Coll., No. 395/2001 Coll., No. 448/2001 Coll., No. 515/2002 Coll., No. 319/2009 Coll., No 71/2012 Coll. and No 98/2013 Coll.

person in any way. This principle is the newest one, since before the year 2013 presidential elections were held in an indirect form − the president was elected by the parliament (the Senate and the Chamber of Deputies). The link between voter turnout and the switch from indirect to direct presidential election can be seen since the participation of citizens in the Senate and Chamber of deputies' elections significantly decreased after the year 2013 when the direct election was established[3].

As written in the Constitution (1992), the election day is always set to Friday between 2 pm and 10 pm, and Saturday between 8 am and 2 pm, no matter the type of election. Unlike most of the countries that only have one election day, two election days are held in the Czech Republic. The voter is assigned a polling station based on his permanent address where he must cast the ballot. There are approximately 1,000 citizens per one polling place (Ministry of the Interior, 2021). It is necessary that the voter comes in person to the correct polling station with his ID card to be able to vote. It is possible to arrange a special permit that allows the citizen to vote outside the allocated polling station.

To evaluate the election, different types of methods are used based on the election type. Generally, two main systems are employed − proportional representation and plurality voting. In the plurality voting process, the candidate who obtains more votes than any other counterpart gets elected − winner-takes-all system. The method of proportional representation reflects the real distribution of votes. This method is further divided into two categories − the election number and election quotient. Election number is used to convert the number of votes acquired by a party into mandates. Its value represents the minimal number of votes that a party needs to obtain to receive a seat. The other group works with quotients. This method is based on the idea that no party shall receive a mandate before another party with greater number of votes at the time of the distribution process.

The most important general regulations were listed above, however, the specific requirements differ for each election type. Also, the basic classification of methods used to evaluate the election was described. Other rules and regulations, as well as the specific evaluation systems differ for each election type and will be described below.

[3]This assumption was made based on the data provided by volby.cz

2.1 Summary of election types

The most discussed type is undoubtedly the presidential election. Between the years 1993 and 2012 the election was indirect, and the president was elected by the Parliament. After that the direct election was introduced where each voter that meets legal conditions gets one vote to decide about the future president. The president is elected for a period of 5 years and can only be elected twice. Plurality voting system is used to evaluate the votes, meaning that the candidate who receives more than 50% of votes wins the election. Generally, there are two rounds of presidential election since no candidate usually receives plurality of votes in the first round. In that case, two most successful candidates advance to the next round where the one with majority of votes wins and becomes the president of the Republic. Anyone with the right to vote who accedes the age of 40 can run for president if they comply with conditions set by law. For the candidacy, it is necessary to get support of at least 20 members of parliament, 10 senators, or 50 000 citizens who sign related petition. If a person meets at least one of these conditions no less than 66 days before the election they are added to the list of candidates (Constitution Act No. 1/1993 Coll., 1992). Voter turnout for presidential election is usually a little over 60%. Minimal turnout was in the second round of presidential election held in 2013 – 59.11% (Czech Statistical Office, 2013), the highest turnout was also in the second round but in 2018 when 66.6% of voters cast their ballots (Czech Statistical Office, 2018).

The second type of election is the Chamber of Deputies' election. Chamber of Deputies is the lower house of the Parliament and consists of 200 seats. The main activity of the Chamber is to negotiate and approve laws. As written in the Constitution (1992) the deputies are elected for 4 years and every citizen older than 21 years with the right to vote is eligible to be elected as a deputy. The seats are allocated using the party-list proportional representation and the D'Hondt method. Each party makes a list of candidates and citizens vote either for the party (meaning that they don't care who specifically will the deputy be) or for specific deputies within the party. Every voter can give away up to 4 preferential votes choosing the potential deputies. The mandates are then assigned based on the number of preferential votes each candidate obtained, assuming they received more than 5% of the preferential votes (Ministry of the Interior, 1995). Thanks to the party-list proportional representation system, the ratio of mandates each party obtains is close to the ratio of votes the party acquired from voters. To be eligible to obtain mandates the parties need to pass the electoral threshold. The threshold is set to 5% of votes per party, 10% of votes per two-parties coalition, 15% per three-parties coalition and 20% per four-and-more-parties coalition (Chamber of Deputies, 2022). The distribution of mandates itself was historically done using multiple methods. First, the mandates were redistributed using the Sainte−Lägue method, that is very similar to the D'Hondt method described below, only using a series of odd numbers as a divisor. After 2002 the D'Hondt method was used. When the election ended, all the votes were tallied and then the seats were distributed based on a simple formula:

$$Quotient = \frac{V}{(s+1)} \tag{2.1}$$

Where V is total number of votes obtained, and s is the number of mandates the party has received so far (initially 0 for all the parties). In every round, the party with the highest quotient received the seat and the quotient was recalculated again until all the mandates were distributed (Cortona *et al.*, 1999). This method was valid until 2021 when it was replaced by Imperiali quota as an election number combined with the Hagenbach−Bischoff system but giving the same result as the D'Hondt method. The highest voter turnout was in the 1996 when it reached 76.41%. On the contrary, the lowest turnout was in 2002 when only 58.0% of eligible voters cast their ballots (Czech Statistical Office, 2022b).

The second chamber of the Parliament is the Senate. The Senate also proposes and negotiates laws but has less competence than the Chamber of Deputies. When the Chamber of Deputies is dissolved, the Senate takes over most of its competences and can even approve new laws (Office of the Senate of the Czech Parliament, 2012). There are 81 senators in the Senate, elected for 6 years. Every 2 years, one third of the senators is replaced by new candidates. Every person eligible to vote who accedes the age of 40 can become a senator. The Senate elections work differently than the elections for Chamber of Deputies, where all the citizens vote at the same time. In this system, there are 81 constituencies, and each constituency gets to choose one senator. First 27 constituencies choose one third of senators, then 2 years later, another third of constituencies chooses another third of senators and so on. After 6 years, this cycle repeats itself and the first third of voters chooses new senators. In most cases, this election has two rounds (Ministry of the Interior, 1995). The system is the same as in the case of presidential election – if no candidate receives over 50% of votes in the first round, two most successful candidates advance to the next round and the one with majority of votes wins the election and becomes senator. Voter turnout is typically quite low for the Senate elections. The highest turnout in the first round was in the year 2010 – 44.59%, the lowest was in 2002 when only 24.10% of voters showed at the polling stations. Surprisingly, the highest turnout in the second round was also in 2002 when 32.55% of voters cast their ballots. The lowest turnout in the second round was in 2016 when only 15.38% of voters showed up. On average, the turnout in the first round is higher than in the second round – 37% and 22%, respectively (Czech Statistical Office, 2022b). Generally, the turnout for Senate elections is lower than for Presidential and Chamber of deputies' elections, probably because Senate has less competences than the other two.

Another election type to be introduced is election to Regional Council. There are 13 Councils that copy the distribution of Czech regions. Interesting fact is that the capital, Prague, is not considered a region nor a municipality and has its special election – Prague City Council election that always takes place two years after the Regional Council elections. Besides that, the Prague City Council is basically the same as the Regional Councils. As per the responsibilities, Councils submit drafts of laws to the Chamber of Deputies, provide subsidies to municipalities from the regional budget, menage land and real estates owned by the region and effectuate many other things on regional level. Anyone who has reached the age of 18, has the right to vote and has his permanent address in the area of the district can become a counselor (Ministry of the Interior of the Czech Republic, 2020). Each of the 13 Councils has between 45 and 65 members, based on the number of citizens. Evaluation of this election is similar to the one of Chamber of Deputies. The system of proportional representation is used, as well as the D'Hondt's method, and the voter also gets to choose up to 4 candidates of the party they voted for. The only difference between the Chamber of Deputies' election and election of Regional Council is, that the threshold the party has to cross to obtain mandates is set to 5%, which applies even for coalitions, no matter the number of parties in it (Ministry of the Interior of the Czech Republic, 2000). On average, the turnout is a little over 35% (Czech Statistical Office, 2022b).

The election of Municipal Council is usually held every 4 years. Sometimes there may be an exceptional election in a municipality when the number of

Council members falls below certain threshold. The threshold is different for every municipality and is based on the number of citizens – ranging from 5 to 70 members. Main responsibility of the Council is to independently administer the municipality – menage the budget and owned properties, adhere to the development plan or resolve various issues on local level (Ministry of the Interior of the Czech Republic, 2001). Just like in the Regional Council election, the system of proportional representation is used, and the Municipal Council election is evaluated using the D'Hondt method. The threshold for obtaining mandates is also set to 5%, no matter if it is a party or a coalition of parties. The voter chooses either a party, specific candidates, or both a party and certain candidates (Balíik, 2009). Only residents of the specific municipality are eligible to vote for the Municipal Council members. Unlike in some other types of elections, the voter's permit cannot be used, and the voter has to vote at the assigned poll station. Average turnout is a little over 43%, which is quite high compared to other election types (Czech Statistical Office, 2022b). The turnout is higher in small municipalities rather than bigger cities – probably due to closer interpersonal relationships since the voters vote for somebody they actually know, not just some politician they have only heard of from the media.

As the Czech Republic entered the European Union in 2004, Czech citizens get to elect members of the European Parliament that will represent their beliefs. The election is held once every 5 years in all of the member countries. Currently there are 705 members of the Parliament, out of which 21 were elected by Czech citizens. There is no unified system to evaluate the results. Just like most of the other election types, proportional representation system and D'Hondt method are used (Czech Statistical Office, 2021a). Main responsibility of the European Parliament is adaptation of Union legislation and political control over other EU institutions. The voting rules are different in every member country, but in the Czech Republic, every citizen over the age of 18 with no other obstacles to the right to vote is eligible to cast their ballot (Ministry of the Interior of the Czech Republic, 2003). Czech Republic was also the only member country that had two-days election. The voter turnout tends to be very low – only around 25.9% on average, which puts Czech Republic among 5 EU member states with the lowest voter turnout (European Parliament, 2020).

2.2 Basic statistics about the Czech Republic

Previous research shows that demographic and economic factors, such as age, education, income, or unemployment rate, may affect voter turnout (McDonald, 2020). Therefore, it is crucial to introduce some basic statistics describing Czech Republic. The area is 78 871 km^2 divided into 13 regions and the capital, Prague. As per 31.12.2020 there were 10 700 thousand citizens, out of which 5,426 thousand were females. Almost 30% of people lived in one of the 10 biggest cities. Life expectancy was 79.3 years, fertility rate was at 1.7 children per woman. The GDP was 5,694.6 bn CZK, inflation rate 3.2%. General unemployment rate was 2,6% and average gross wage at 38,525 CZK. There were 1,762.3 thousand people with completed higher education. Around 35% of the population are believers, typically people after 60 years of age. The net migration rate is 2.3 migrants per 1,000 people (Czech Statistical Office, 2022a).

Since this thesis aims to examine the effect of rainfall on voter turnout, something about the climate conditions should be said. The Czech Republic is placed in central Europe, surrounded by mountains by its boarders. There are quite big differences between winters and summers. In 2020, the lowest average temperature was in January – +0.3°C, the warmest month was August when the average daily temperature was +18.8°C. Most rain falls in the summer months; those are usually big and heavy rains. Rainfall is common until early November but can be sporadically seen throughout the whole year. In 2020, the month with the highest precipitation rate was June where the level of rainfall reached the average of 152mm per day. On the other hand, January is the month with the lowest precipitation rates – the average of only 19mm of precipitation per day was observed (Czech Hydrometeorological Office, 2020).

There are quite big differences between the regions regarding both demographic and economic factors, as well as the weather. A little over 10% of the whole population live in the capital, where the levels of education, income and employment are higher than in other regions. Also, there are districts that are far behind the average, such as Ústí and Labem Region or Karlovy Vary Region. The weather conditions are also very different – the temperature in the mountains can be even more than 15°C lower than in the warmest parts of the Czech Republic – such as Southern Moravia. Therefore, it can be expected that the effect of precipitation will vary for different parts of Czechia.

Chapter 3

Literature Review

Undoubtedly, voter turnout is affected by many different factors. Previous research shows that determinants such as education, income, age or even home ownership have positive effect on voter turnout. On the other hand, costs of voting, such as the need to acquire necessary information to be able to make the decision, were found to have negative effect on turnout rates (Smets & van Ham, 2013). Basically, anything can influence whether the voter decides to cast the ballot or not. To simplify the case, the factors have been divided into two levels – individual and aggregate, and will be described below.

3.1 Individual level

Finding people's motivations behind the decision whether to go to the polls or abstain is a quite tricky task. In the Czech Republic, along with absolute majority of other countries, the election is anonymous. Indeed, this is an indispensable rule of voting in the modern world established to protect the voters. On the other hand, it makes it incredibly hard for people studying the motivations behind casting a ballot. By its very nature it is impossible to link a certain voter to their ballot, therefore almost impossible to draw conclusions on what such a voter's characteristics look like. When trying to examine the reasons on individual level, science has to rely on surveys. A meta-analysis of individual-level research on voter turnout was published in 2013, introducing multiple models summarizing the main ideas behind people's decision-making processes (Smets & van Ham, 2013).

The first model to be discussed is the rational choice model. It stresses out that each voter is creating his own cost-benefit formula while making the decision. When the benefits outweigh the costs, the person chooses to cast the ballot. Otherwise he chooses to abstain (Downs, 1957). The paper found that people who voted in prior elections are more likely to go to the polls again, as well as the ones with stronger sense of civic duty. On the other hand, the country's national economic situation along with voter's own economic situation were not found to have significant effect on the voter's personal decision about casting the ballot (Smets & van Ham, 2013). There are also some shortcomings of the model – the most famous one is called The Down's Paradox. It emphasizes that for a rational voter the costs will always exceed the expected benefits. The chances that the voter's ballot will be pivotal are minimal and compared to his personal sacrifices he has to make to vote, the expected benefits will always be smaller than the costs.

Another discussed model is the resource model. The main idea behind it is, that the participation in elections is driven by resources – especially time, skills, and money. People with better jobs, higher incomes, education, and socio-economic status are more likely to have more resources and therefore are more likely to vote (Brady *et al.*, 1995). There are many factors that can be considered subordinate to the three main resources. The ones that are repeated throughout most of the studies are age, education, gender, race, income, marital status, home ownership, unemployment, and citizenship. On the other hand, some of the variables are insignificant in some of the models and general conclusions cannot be made. The strengths of the effects of listed variables also differs from one study to another, but most of the studies consent on at least whether the effect is negative or positive. One of the strongest predictors in many papers is education, having a strong positive effect on voter turnout. Age is also highly relevant – young voters typically tend to abstain, as well as elderly people that start to withdraw from social life. The highest voter turnout is typically between the middle-aged citizens. On the other hand, studies show that the turnout gap between females and males has basically disappeared, and that gender hardly has any effect on the turnout (Smets & van Ham, 2013).

Mobilization model considers the impact that external bodies have on the voter's decisions. The core theory behind it states that the interest groups, social movements, parties, and candidates themselves sort of mobilize the citizens, forming their opinions and trying to get their votes. They also minimize the information asymmetries, informing voters about the electoral process, specific candidates or even the party's program itself. This reduces people's costs of voting since they don't have to look up the information on their own and it simply gets to them from the outside (Rosenstone & Hansen, 1993). Nowadays, it is becoming more and more clear which practices and campaigns boost voter turnout and even alter citizen's opinions and points of view so that the interest groups can benefit from it, and voting is changing into a special kind of social behavior (Green & Schwam-Baird, 2016).

Individual's childhood and his parent's attitude to politics is also a predictor of his voting behavior. The socialization model stresses out that voter's social group has a key role in forming his political opinions. Throughout life the person gets information from different channels that are influencing him − such as parents, school, media etc. This impacts not only his political opinions but also the decision whether to even cast the ballot or not (Gidengil *et al.*, 2016). Some studies even show that the education of parents and their socio-economic status are predictors of the child's turnout, having a positive effect on it (Sandell & Plutzer, 2005).

The model considering the political aspect on the individual's level is called the political−institutional model. The base idea of this model is that the decision to participate in politics is the result of the political system in the first place. Also, that person's decision whether to vote or abstain is affected by the importance of the election, as well as by the expected tightness of election outcome (Dubois & Leprince, 2017). The legal system of elections undoubtedly plays a significant role as well. In the systems with compulsory voting, the turnout is, of course, higher since the cost of non-voting is typically higher than the cost of voting. Boosting voter turnout by motivating people to vote, rather than forcing them to, seems like a better approach. Many countries put incentives in place, such as weekend voting, postal or e−voting, special polling booths placed in convenient spots or multi-day elections. Research shows some of those stimulus effective, some as inconclusive but no negative effect on voter turnout was ever found (Smets & van Ham, 2013). Effective number of parties shows out to be an important element in this model, since too many parties are causing the cost of gaining enough information about all of the parties too high. On the contrary, when there are too little parties to choose from it might cause the voter not to identify himself with any of the proposed parties and abstaining.

Last of the models on the individual level is the psychological model, which focuses on the psychological determinants of voter turnout. This model considers variables such as political knowledge, political interest, party identification or ideology. Internal efficacy (meaning how much does the voter think he can influence the election result) is positively correlated with voter turnout. Also, people who have more confidence in the political system are more likely to cast their ballots (Belanger & Nadeau, 2005). Ideological self-placement is an indispensable component of the psychological model as well. Some papers state that right−wing and conservative voters tend to perceive going to the polling stations and casting the ballot as their civic duty. On the contrary, some papers haven't found any significant effect of the ideology on the turnout. Last but not least, the voter's personality also affects the turnout. Prior research shows that a hard−working personality can boost voter turnout. Further, hardworking people and those who are mentally healthy often tend to be more involved in politics (Denny & Doyle, 2008).

3.2 Aggregate level

As the previous part discussed the voter's decision-making on his personal level, trying to reveal what specific inner factors are motivating him to get to the polls or dissuading him from voting, this chapter will rather analyze the problem from more general perspective. The next part is divided into three sets of variables grouping multiple factors affecting citizens' behavior − socio-economic variables, political variables, and institutional variables.

The first group of variables to be analyzed are the socio-economic variables. To begin with, population size was found to have a significant effect on voter turnout. With increasing population size, the voter turnout tends to decrease. This is simply the result of Down's Cost-Benefit model each voter makes. The more voters, the lower is the chance that one single vote will change the outcome of the election; therefore, the citizens are less motivated to cast their ballots (Blais & Dobrzynska, 1998). Another factor linked to population thought to affect turnout was population concentration (density). Some studies show that population density is negatively affecting voter turnout as people in rural areas have higher civic duty then in urban areas (Preuss, 1981). Others show the effect as positive, saying that living in areas with higher population density might increase the effect of word-of-mouth and the people might encourage each other to go and cast their ballots. Also, the polling stations are usually concentrated in urban locations, usually in a bigger city or town. The cost of voting is therefore higher for citizens living in rural areas since they often have to travel to get to the polling station. Some studies also show that this effect is not significant (Cancela & Geys, 2016).

Another factor in the group of socio-economic variables is population stability. From this perspective, there are three main reasons for which this has an effect on voter turnout. First of all, stability in the population increases group solidarity and feeling of identification, therefore the citizen is more motivated to cast his ballot. Further, when the resident lives in the same area for longer period of time, he gains knowledge about local issues and the candidates; therefore, the cost of acquiring information prior the election is reduced. Finally, higher out-migration rates might suggest that the residents don't intend to stay in the area for longer time, therefore they don't care about the local policy (Geys, 2006).

Unemployment is a factor that was found to have a positive effect on voter turnout by some studies (Cebula, 2017), but also a significantly negative effect by others (Kroh & Könnecke, 2014). Based on the research conducted on the psychological level that was introduced earlier, it was found that hard-working people tend to participate in politics more (Denny & Doyle, 2008), supporting the negative effect of unemployment on the turnout. On the other hand, the effect can be even significantly positive stating that unemployed people benefit from casting the ballots more, as the outcome of the election might change their life situation (Cebula, 2017).

Previous voting behavior can also effectively predict voter turnout. Studies show that voting can become a habit, and that people who have voted in the previous election might do so again. On the other hand, non−voters are believed to stay idle. This is amplified if the voter is reinforced by the election result − when their favorite candidate wins, they tend to come to the election again (Gerber *et al.*, 2003).

The second set of determinants to be discussed are the political ones. First, there is the closeness − this variable reflects the difference in obtained votes between the first and the second candidate. As was said earlier, voters need to perceive that their vote is pivotal and can change the outcome of the election. If they feel like voting for their candidate is a lost cost, they are less motivated to cast their ballots and any additional inconvenience, such as rain, might discourage them from going to the polls. On the other hand, when the result of the election is expected to be tight, voters believe that their vote may influence the outcome and they are less susceptible to negative effects (Matsusaka, 1993). Campaign expenditures were also found to have significant positive effect on voter turnout. Running a campaign undoubtedly reduces the cost of acquiring information and increases levels of awareness (Holbrook & Weinschenk, 2014). Last but not least, political fragmentation is affecting voter turnout as well − only the effect differs from one study to another. Some of them explain that the more parties there are, the bigger is the cost of obtaining information. Also that it is harder for the voter to decide between the parties (Blais & Dobrzynska, 1998). Others show that the more candidates the better the chances of voters actually identifying themselves with one of the candidates, making less compromises (Hansen, 1994).

Last group of variables are the institutional ones. Electoral system, meaning the way that votes are converted into seats, plays a significant role in determining voter turnout. When the system is more proportional people tend to perceive it as "fairer" and turn out at the polls (Ladner & Milner, 1999). Clearly, registration requirements, meaning the need to go and sign up to be eligible to vote, are decreasing the turnout as it increases the individual costs of voting (Ansolabehere & Konisky, 2006). On the other hand, compulsory voting undeniably increases voter turnout as the cost of not not−voting is higher than the cost of going to the polls (Hirczy, 1994).

3.3 Precipitation and voter turnout

Several studies have already tried to provide some insight on whether the rainfall affects voter turnout. Some of them succeeded, some of them found no significant effect of precipitation on the turnout. Below, the most known analyses and their findings are introduced.

The first paper studying such topic is analyzing how the rainfall influences turnout on the US presidential elections (Gomez *et al.*, 2007). Data from over 22 thousand meteorological stations were gathered on the county level, covering the period of 14 presidential elections. It was found that 1 additional inch of precipitation reduces voter turnout by almost 1pp, and 1 inch of snow reduces turnout by 0,5pp. Also, the research shows that the rainfall on election day tends to benefit the Republicans, which might have changed the outcome of the 1960 and 2000 presidential elections.

Second, evidence from the Swedish Parliament elections are introduced (Persson *et al.*, 2014). Gathering aggregate data from 290 municipalities, individual data from the National Election Study and survey-based data on voter turnout, covering 11 elections and almost 140 thousand individuals, no robust negative effect of rainfall was found.

Further, a research conducted on Danish national parliament elections held between the years 1971 and 2010 was introduced (Eisinga *et al.*, 2012). Unlike other studies it wasn't focused entirely on the precipitation, but also on the election day temperatures and sunshine duration. It was found that whether affects the turnout rates, supporting the findings of the research held in the US (Gomez *et al.*, 2007) that 1 inch of rain decreases turnout by approximately 1 percentage point. Further, when the daily temperature increases by 10°C it enhances the turnout rate by almost 1pp. Also, when the sunshine coverage is at 100%, the turnout is 1,5pp higher than when the overage is 0%.

Another research on the effects of rainfall on the turnout was conducted on Irish data, covering general elections between the years 1989 and 2016 (Garcia-Rodriguez & Redmond, 2020). The authors have found that when the election days is classified as rainy (30mm of rain in 24 hours), it reduces voter turnout by 2pp. The research also puts the rainfall in relationship with the population density observing, that the decrease in voter turnout due to rain is greater in densely populated areas, attaining almost 3pp decrease in voter turnout on a rainy day.

Even though most of the studies show a negative effect of precipitation on the turnout od some extent, there is no clear consensus in the existing literature regarding whether, and how much does the rainfall affect voter turnout.

3.4 Hypotheses

The chapters covering the context of the Czech Republic and the Literature review have provided the necessary basics for the research. In combination with previous research conducted in other countries, main hypothesizes were set up.

Hypothesis #1: Voter turnout decreases with increasing precipitation.

Hypothesis #2: The effect of precipitation on voter turnout will be smaller the more important the election is.

Hypothesis #3: The tighter the outcome of the election, the smaller the impact of precipitation on the turnout.

Intuition behind the first hypothesis is rather obvious − when it rains, people would rather stay at home then going to the polls, as previous research shows (Gomez *et al.*, 2007; Knack, 1994; Persson *et al.*, 2014). The aim of second hypothesis is to show that perceived benefits of different election types may vary, and therefore the effect of rainfall will not be the same for all kinds of elections. For example, when it rains for Chamber of Deputies election, an inconvenience such as rain is less likely to make people abstain because this election "matters". On the other hand, raining on the day of EU Parliament elections may cause the turnout to decrease as the outcome doesn't have such direct effect on people's everyday lives as does the outcome of Chamber of Deputies' election, and a minor inconvenience such as precipitation may cause people to abstain even when they planned on casting their ballots. The third hypothesis reflects the importance of each individual's vote. When the outcome is expected to be tight it is more likely that one vote will be pivotal and will have the power to change the result. Therefore, people are more motivated to show up at the polling station and rainfall is less likely to make them change their minds.

Chapter 4

Data

This chapter aims to describe how the datasets for the research were prepared, showing how the data were obtained and processed to form the final datasets. It will introduce all of the independent variables, as well as the dependent variable used in the empirical analysis. Further, it will provide and discuss the descriptive statistics of selected variables.

To begin with, it is important to stress that two master datasets are being used in the research − one on the level of districts and one on the level of municipalities. First of them puts together all observations acquired for all the variables throughout the election types and available years on the district level. Basically, for each election type specifically, a panel dataset is formed. In the master dataset, all of the 6 panel datasets are merged into one. The advantage of this district-level approach is that there are no missing values that need to be treated, as all the necessary data for this level of granularity are available. Also, merging everything into one dataset increases the number of observations and as different methods and data levels are used further in the research, no informational value will be lost in the general point of view.

On the other hand, the districts are somewhat wide, and relatively large degree of variability within each unit can be observed. Therefore, the second dataset on the municipality level was put together. It combines all relevant data available throughout the years and election types on the level of cities and villages, removing the bias of averaging on the level of districts. Unfortunately, the data was available only for a handful of municipalities covering only something around 10% of the population.

4.1 Variables

The choice of variables aims to copy the ones that were already used in some kind of analysis studying either the effect of rainfall on voter turnout or just turnout in general and are described in the literature review above.

From the first group – socio economic variables – the dataset contains population size, population density, population stability, and average unemployment. Population size is a pretty straight forward variable, capturing the number of people living (having their permanent address registered) in the district. The data for relevant years and districts were downloaded from Czech Statistical Office (2022c). Population density is a calculated variable combining the number of citizens per area of the district and was also obtained from the Czech Statistical Office (2022c). Population stability is also a calculated variable characterizing the movements of citizens between the districts and the values are obtained as a difference between the number of people that have moved in and the number of people that have moved out of the district, respectively. The data is also obtained from the public database run by Czech Statistical Office Czech Statistical Office (2021b). Last but not least, there is the unemployment variable. This variable represents the percentage of unemployed people actively looking for a paid job on the total labor force in the district, and it was obtained from Ministry of Labor and Social Affairs (Ministry of Labor and Social Affairs, 2022).

From the group of political variables, the only variable used is the closeness. It aims to capture the mood in the society and the rivalry of parties in the district. Initially, this variable was supposed to be based on prognosis and the expected outcome of the elections. But as this data is not available on the level of districts, it is approximated as an ex-post difference between the competitors. It is computed as a difference between the candidate with the most and the second most obtained votes in the district, which was computed from the related datasets downloaded from open data portal (Czech Statistical Office, 2021c).

Also, the closeness variable is not considered in the master dataset, but only after it is divided into smaller panel datasets for specific election types. This is due to the intuition behind – the variable doesn't make sense for all of the election types. The closeness of the outcome will not matter for example for the presidential election where people do not decide up on the perceived closeness in their district, but rather on the national level. Also, closeness steps into the model in combination with precipitation as an interaction variable to see how it affects the turnout when put together.

The other two variables – political fragmentation and capital expenditures will not be used in this research. They are both only available on the level of the Czech Republic as a whole, not reflecting the local situation enough to capture the differences in turnout between the districts. It might be interesting to analyze the effect on the national level as well, following the development in time rather than on the geographical level, but as per now there is not enough observations to do so.

The institutional variables are undoubtedly very important for comparing the effect of rainfall on voter turnout between countries but have no effect on the voter's behavior analysis on the level of the Czech Republic. The rules for every citizen and every district are the same, therefore there is no point in including electoral system or the registration rules into the model.

The most important independent variable for this thesis is the precipitation variable. The historical data from Czech Hydrometeorological Office (2020) were gathered, documenting millimeters of precipitation that fell on each election day. Unfortunately, as the dependent variable, voter turnout, is only available as a total of both election days, the precipitation had to be averaged. Therefore, this variable provides the information about the average daily precipitation on both election days. This creates a certain bias in the result that, sadly, can't be overcome (for further elaboration please refer to Chapter 7). The data are available on the district level, but there is also information about precipitation for approximately 600 municipalities available, allowing for some sort of deeper analysis than on the district level. Also, a squared precipitation variable is added to the model to determine what happens when the effect of rain exponentially increases.

The dependent variable in this research is the voter turnout. The turnout was downloaded from the datasets available at volby.cz (Czech Statistical Office, 2021c), where the data can be found on the level of electoral districts – even smaller units than cities. The turnout was calculated as a quotient of issued envelopes (as each voter receives one after being identified at the polls) and the number of citizens eligible to vote, giving the final turnout rate. As was said before, there are no reliable information about the ongoing turnout rates, therefore the turnout comes as a total per both of the election days. Further, for simplification purposes only the turnout rates from the first rounds of elections are taken into account.

4.2 Descriptive statistics

The table below shows the basic descriptive statistics of all the variables in the master dataset.

Table 4.1: Descriptive statistics – Variables

Variable	Min	Max	Mean	St.Dev.
Turnout	0.12	0.72	0.44	0.13
Precipitation	0.00	17.57	1.62	2.54
Population Size	37 968	381 436	121 825	58 275
Population Stability	-2 239	7 676	224	786.65
Population Density	36.76	1 656	164,40	227.75
Unemployment	1.10	14.78	5.80	2.66

There are 1,858 observations throughout the years 2004 to 2020 and all election types. Unfortunately, Czech Republic is a relatively small and young country, with very little history of elections of all kinds . This is making the number of observations relatively low, compared to other countries for which similar kind of analysis was conducted.

The lowest turnout was measured in the European Parliament elections held in 2014 in Chomutov district. On the other hand, the highest turnout was measured in Praha–Západ district for the election to Chamber of Deputies in 2006. As per the precipitation, there were 318 observations with no rain at all. Then, the highest precipitation on election day was measured for the European Parliament election in 2014 in Liberec district. The population size maximum was measured was recorded in Brno–Město in 2020, and the lowest in Jeseník district also in 2020. The highest net in-migration was registered in 2008 for the Praha–Východ district, on the other hand the highest net out-migration was measured in Karviná, 2020. The highest population density was marked in Brno–město in 2020, the lowest in 2014 in Prachatice district. The highest unemployment was measured in 2006 in Most district, on the other hand the highest employment rate was in 2019 in Praha–Východ district.

Tables below show basic descriptive statistics for the two most important variables – voter turnout and precipitation; for each election type, as well as the number of observations and years throughout which the inputs were gathered. For further elaboration on basic statistics of the rest of the variables, or basic statistics of the districts, please refer to Appendix A.

Table 4.2: Descriptive statistics – Election types and Turnout

Election type	Years	Obs.	Min	Max	Mean	St.Dev
European Parliament	2004-2019	304	0.12	0.39	0.25	0.05
Regional Council	2008-2020	304	0.25	0.48	0.37	0.04
President	2013-2018	152	0.48	0.71	0.61	0.05
Chamber of Deputies	2006-2017	304	0.48	0.72	0.61	0.05
Senate	2008-2020	490	0.20	0.72	0.41	0.08
Municipal Council	2006-2018	304	0.30	0.59	0.48	0.06

Table 4.3: Descriptive statistics – Election types and Precipitation

Election type	Years	Obs.	Min	Max	Mean	St.Dev
European Parliament	2004-2019	304	0.00	17.57	3.79	3.78
Regional Council	2008-2020	304	0.00	14.60	1.48	2.20
President	2013-2018	152	0.00	4.03	0.45	0.81
Chamber of Deputies	2006-2017	304	0.00	10.49	2.15	2.44
Senate	2008-2020	490	0.00	14.60	1.09	1.87
Municipal Council	2006-2018	304	0.00	5.67	0.50	1.03

The number of observations for the Presidential elections is quite limited, as the election was not direct before the year 2013, and therefore there are no data available. On the other hand, the election to Senate has more observations available – this is due to the system of voting explained in Chapter 2 summarizing the Context of the Czech Republic when each two years one third of the population has the right to vote.

Next, the descriptive statistics of the second dataset is described. Throughout the Municipalities, years, and election types, 10,582 observations were gathered.

Table 4.4: Descriptive statistics – Variables (Municipalities)

Variable	Min	Max	Mean	St.Dev.
Turnout	0.06	0.96	0.47	0.17
Precipitation	0.00	37.20	1.73	3.04
Population Size	40	52 509	4 091	7 381
Population Stability	-876	823	-2.18	53.20
Population Density	0.01	23.84	1.68	2.72
Unemployment	0.00	24.73	5.17	3.15

Unfortunately, the data was available only for a handful of municipalities that can't be considered a representative sample and the conclusions might be biased when related to the whole country – the data was acquired only for about 10 % of Czech cities and villages that do not copy the distribution in the country. However, it might show whether the findings from the district level research apply even on the level of municipalities, since unlike this dataset, the district level data are averaged to some extent.

In this case, no missing data are treated since only the municipalities with all data available are used. As per the outliers, 3 cities (Prague, Brno, and Ostrava) were removed from the dataset as their population size highly exceeded the one of other cities and villages. The next table shows the breakdown of descriptive statistics of the two main variables – precipitation and turnout, based on the election type.

Table 4.5: Descriptive statistics – Elections and Turnout (Municipalities)

Election type	Years	Obs.	Min	Max	Mean	St.Dev
European Parliament	2004-2019	2 293	0.06	0.74	0.26	0.08
Regional Council	2008-2020	1 732	0.17	0.74	0.38	0.08
President	2013-2018	1 080	0.42	0.95	0.63	0.07
Chamber of Deputies	2006-2017	2 316	0.36	0.96	0.62	0.07
Senate	2008-2020	1 125	0.17	0.88	0.41	0.10
Municipal Council	2006-2018	2 036	0.21	0.94	0.56	0.12

Table 4.6: Descriptive statistics – Elections and Rain(Municipalities)

Election type	Years	Obs.	Min	Max	Mean	St.Dev
European Parliament	2004-2019	2 293	0.00	37.20	3,73	4.50
Regional Council	2008-2020	1 732	0.00	18.20	1.39	2.70
President	2013-2018	1 080	0.00	9.50	0.49	1.02
Chamber of Deputies	2006-2017	2 316	0.00	25.85	2.04	2.58
Senate	2008-2020	1 125	0.00	18.20	0.93	1.99
Municipal Council	2006-2018	2 036	0.00	11.90	0.49	1.09

As is visible from the descriptive statistics, the order of the election types based on average turnout (and therefore the perceived importance of the election) remained unchanged. Thus, the examined election types to show the contrast between the most and the least "important" election will be the Chamber of Deputies and European Parliament again.

4.3 Outliers

As intuition suggests, there is one district that stands out from the others – Prague. As more than 10% of population of the Czech Republic lives in this city of area size less than 500 km^2, both the population size and density are considerably higher than for other districts. Also, the in-migration is substantially higher as most of the education and job opportunities are situated there, the average income is higher and unemployment rates are the lowest in the country. This difference between Prague and the rest of the districts is also visible in the table showing descriptive statistics of each district, available in Appendix A. Therefore, it is reasonable to eliminate observations related to Prague district to improve the informational value of the data. After removing Prague from the dataset, the information provided by descriptive statistics were more accurate on the first sight, (e.g, the average got closer to the middle between the minimal and maximal value).

Chapter 5

Methodology

As the system of creating the datasets as well as the variables are described above, this chapter will discuss the models that will be used to process the data to obtain empirical results.

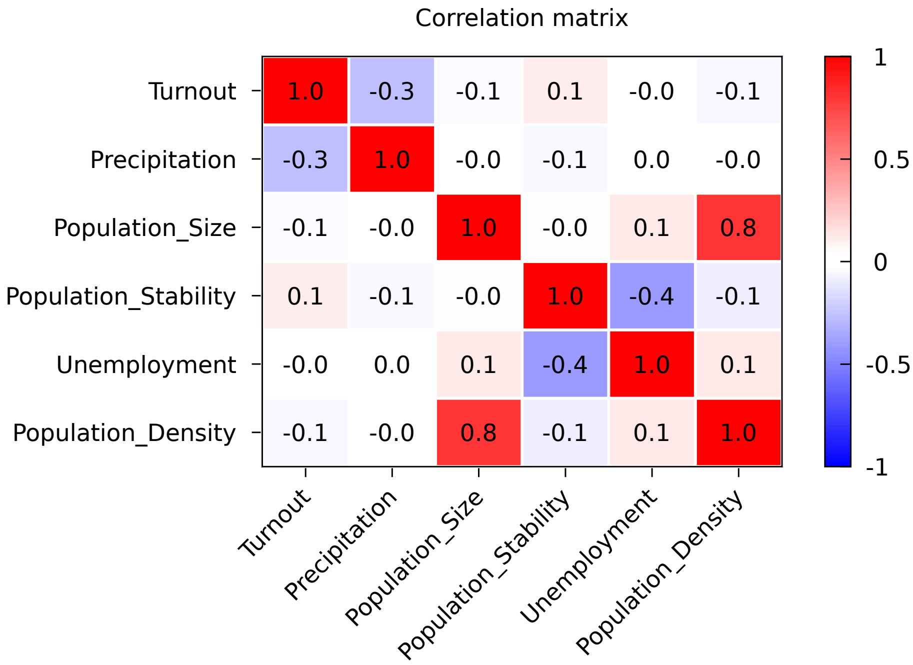
To begin with, a simple regression will be used using an OLS model to get first insight on all the relationships between dependent and independent variables. The formula used is as follows:

$$Y_i = \beta_0 + \beta_1 X_i + \epsilon_i \tag{5.1}$$

where Y_i is the dependent variable, β_0 is the parameter, β_1 represents the slope and ϵ_i is the random error. X_i stands for the matrix of independent variables described in the data section, namely Population Size, Population Density, Population Stability, Unemployment, Precipitation and Election type (as a Dummy).

To check for possible multicollinearity, correlation matrix is presented below.

Figure 5.1: Correlation matrix



As even intuition suggests, the correlation is rather high between Population Size and Population Density. Still, there is some degree of variability left and as both of the variables have different meaning and are aiming to explain different objectives, they will both be used in the research. Besides that, no problem with high correlation rates between any two variables is detected. Some kind of negative relationship is already visible from the matrix between turnout and precipitation suggesting an association between the two.

In the next phase of the research, the panel datasets on the level of specific election type are used. The model will be conducted on the most and the least important election types to see how the effect of rainfall on voter turnout changes when the election is perceived more (or less) crucial. As the average turnout suggests, those will be the elections to Chamber of Deputies and to European Parliament, respectively.

For the panel data that are available on the level of districts, there are several options when it comes to choosing the right method to use. There is the Pooled Ordinary Least Squares (OLS) model, the Random Effects model (REM) and Fixed Effects model (FEM) that can all be used when it comes to such panel data. To determine, which model will be more suitable for the data, a set of tests is carried out. The Breusch−Pagan Lagrange Multiplier test is used to determine whether the Pooled OLS or the Random Effects model will better fit the data. To see whether it is better to use Pooled OLS or Fixed effects model, the F−Test is performed. Hausman test is used to decide between Fixed effects and Random effects estimation. The conducted tests suggest that the most suitable model to analyze the datasets is the Fixed Effects model.

$$\begin{aligned} Turnout_{it} &= \beta_0 + \beta_1 X_{it} + u_{it} \\ i \in \{1..., 76\}&, t \in \{1, ..., T\} \end{aligned} \tag{5.2}$$

The choice of this model is also in line with the intuition behind − the average differences between the groups are controlled for in any observable and unobservable predictors. Without FEM there is a chance of picking up an effect of some of the unobserved variables correlated with precipitation. Using this method, the omitted variable bias is avoided. Further, FEM was used whilst analyzing the effect of rainfall on the turnout in previous studies and therefore is likely a suitable method for the analysis (Garcia-Rodriguez & Redmond, 2020; Persson *et al.*, 2014).

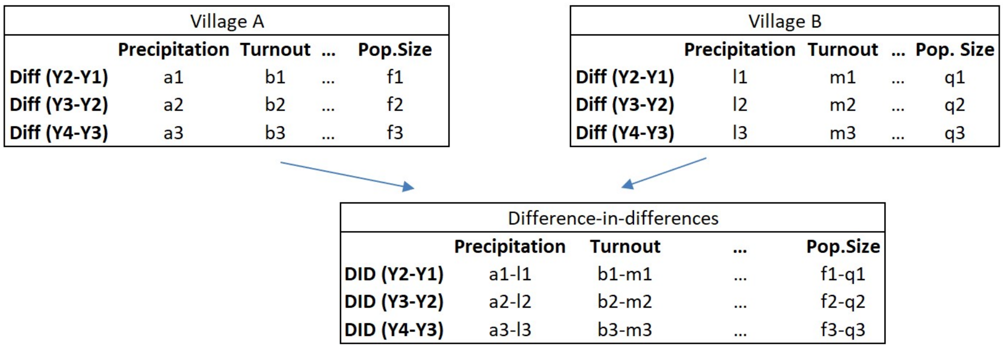
To analyze the data available on the level of single municipalities, we will use the Difference in differences (DID) method. This method compares the changes in outcomes between treatment group and comparison group in time, studying the effect of a certain treatment.

All the assumptions that are made for OLS are also applicable to DID. Further, the parallel trend assumption is being made, meaning that without the treatment, both of the observed subjects would have the same development. For this assumption to hold, the subjects (municipalities in this case) need to be very similar to one another. For this, the matching method is being used.

The goal of matching is to find two subjects that have similar observable parameters to reduce the bias in the treatment effect estimation. It is done based on the similarity in the parameters for which the data is available − Population Size, Population Stability, Population Density, Area and Unemployment. There are several methods that can be used for matching the municipalities together, like propensity score matching, balanced k-means clusters, or the k-nearest neighbors method. In this case, the balanced k-means clusters are being used since there is no loss in the number of observations. The rationale behind this is that if a dataset has N observations, making N/2 balanced clusters (each consisting of 2 items) will pair every single municipality from the dataset with another, most similar municipality from the dataset. On the other hand, this method might create a bias since some pairs of the municipalities will be more similar to one another than other pairs. For further elaboration on the created bias, please refer to Chapter 7. To see what steps preceded the choice of this model, as well as its considered modifications, refer to Appendix B.

The DID method is then applied to created pairs, observing the differences between the years in both municipalities, and then combining them together to obtain the final difference in differences. For better understanding the logical structure of the applied method is shown below.

Figure 5.2: DID model for municipalities (structure)



After gathering all the differences in differences from all of the paired municipalities, a dataset is formed. By using a simple OLS regression, the results will be obtained and interpreted.

Chapter 6

Empirical results and Discussion

The previous chapters described the necessary theoretical background for the research, as well as the data used as an input, and methodology used to obtain the results of this empirical study. This chapter below aims to describe them, along with their interpretation and discussion.

Firstly, we performed a regression on all available data on the district level. The table below shows the results of the district-level regression executed on 1,858 observations throughout the years and election types.

Table 6.1: District level regression results (General)

Variable	Coefficient
Constant	0.5175***
	(0.0057)
Precipitation	-0.0038***
	(0.0006)
Population Size	-1.30e-08
	(3.69e-08)
Population Stability	1.17e-05***
	(1.81e-06)
Population Density	2.29e-05**
	(9.47e-06)
Unemployment	-0.0049***
	(0.0005)
Dummy (EP)	-0.2264***
	(0.0049)
Dummy (Region)	-0.1103***
	(0.0046)
Dummy (Prez)	0.1259***
	(0.0055)
Dummy (Ch.o.D)	0.1372***
	(0.0046)
Dummy (Munic.)	-0.0767***
	(0.0041)

Note: Standard errors in parentheses. *p<0.1; **p<0.05; ***p<0.01; R^2: 0.83

From the results it is visible that the election type plays a significant role when determining voter turnout. Compared to the Senate elections used as a base, the type with the highest effect on turnout is Chamber of Deputies and the type with the lowest effect on turnout is the European Parliament. This outcome is in line with the data available on average voter turnout for each election type (Czech Statistical Office, 2021c) suggesting that the type of election is indeed an important determinant of voter turnout.

The variable of population density is significantly positive, which suggests that with increasing population density the turnout tends to increase as well. This is in line with both intuition and previous research saying that the costs of coming to the polling stations are lower in urban areas than in rural, as the polling stations are closer. Also, as previous research found, people with higher education and income levels are participating in the elections more often. The income and education variables weren't available on this level of granularity, but as people with higher levels of the two tend to live in cities with higher population concentration rather than villages (i.e., due to better job opportunities) the population density variable might serve as a proxy to some extent. Therefore, it is expectable that along with population concentration the turnout will increase as well, and the results are therefore in line with the expectations.

Population stability seems to have a significant positive effect throughout the years and election types. This is in line with the theoretical background saying that the higher the population stability, the higher the turnout levels. On the contrary, when the population stability decreases and people are moving out of the district a lot, it is to be expected that they are no longer interested in local politics, and therefore don't go to the polls.

Unemployment has a significantly negative coefficient, which is also in line with both intuition and literature review. People that are unemployed, seeking a job, are generally less interested in politics than the working population. An additional 1pp of unemployment decreases the voter turnout by 0.49pp.

Population size appears not to be significant, and the coefficient has only a descriptive value providing information about this particular dataset only, as the relationships might be random. It is negative, which is also in line with the theoretical foundations of this research. The insignificance of this variable might be caused by the level of detail of the variable used. As intuition suggests, when the data is on the level of districts, for some types of the election this information is not important − for example when the voter is casting their ballot to the Municipality Council elections, he is not affected by the number of people in the whole district, but only by the number of citizens in the particular municipality.

Most importantly, the precipitation variable is associated with a significant negative effect on voter turnout, supporting the first hypothesis of this thesis. Previous research, as well as the intuition, shows that precipitation in general decreases voter turnout, as the costs of voting are rising due to rain. As the results of this OLS regression show, on the general level where the election types and years are not distinguished and observations are only in the form of cross−sectional data, an additional 1mm of precipitation is associated with a 0.38pp decrease in the turnout.

As the regression suggests, the impacts of the variables on the turnout will be different for different election types. To see how they influence the turnout on the level of specific election type, the Fixed Effects model is carried out. The table below shows the results of the FEMs where (1) and (2) represent the elections to Chamber of Deputies and European Parliament, respectively, without the quadratic precipitation term; and (3) and (4) represent the elections to Chamber of Deputies and European Parliament, respectively, with the added quadratic precipitation term.

Table 6.2: District level FEM

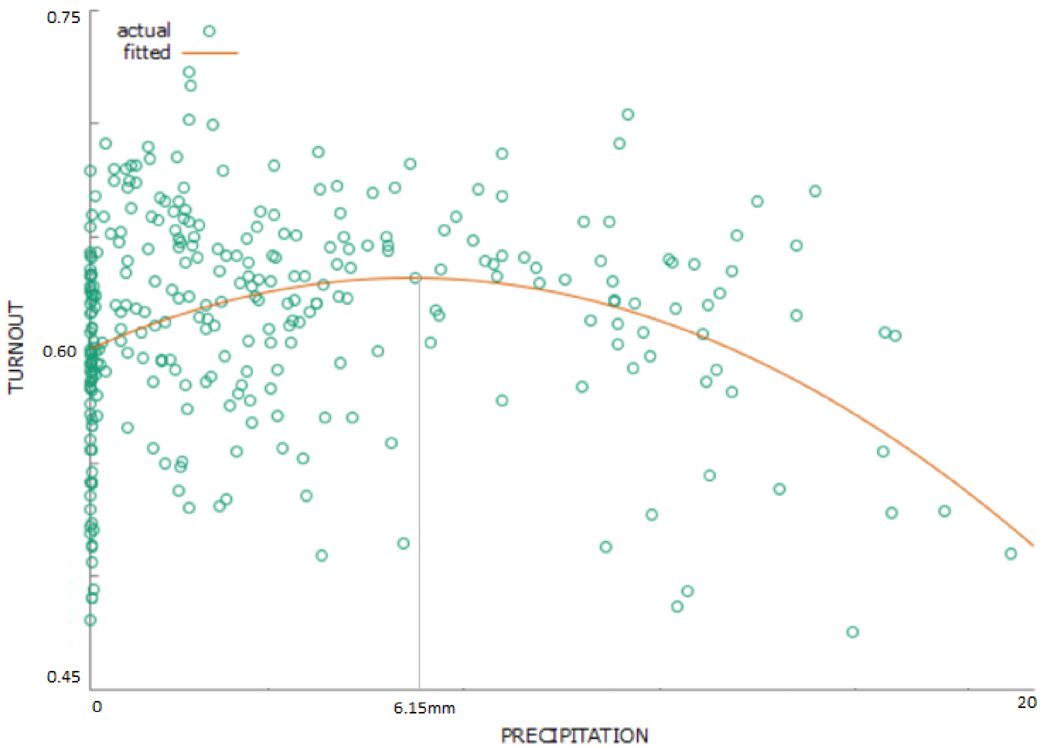
Variable	(1)	(2)	(3)	(4)
Constant	0.7152***	0.3348***	0.7290***	0.3242***
	(0.0335)	(0.0520)	(0.0323)	(0.0525)
Precipitation	0.0074***	-0.0082***	0.0123***	-0.0053**
	(0.0009)	(0.0009)	(0.0014)	(0.0023)
Precipitation sq.			-0.0010***	-0.0002
			(0.0002)	(0.0001)
Population Size	-1.60e-06***	-1.00e-06	-1.61e-06**	-9.13e-07
	(5.71e-07)	(1.02e-06)	(5.47e-07)	(1.01e-06)
Population Stability	2.30e-06	-2.35e-06	0.17e-06	-1.52e-06
	(1.76e-06)	(5.93e-06)	(1.71e-06)	(5.95e-06)
Population Density	0.0007**	0.0006	0.0007**	0.0006
	(0.0003)	(0.0005)	(0.0003)	(0.0005)
Unemployment	-0.0052***	-0.0076***	-0.0053***	-0.0077***
	(0.0010)	(0.0010)	(0.0009)	(0.0010)
Closeness	-0.0779***	-0.0730	-0.1516***	-0.0539
	(0.0363)	(0.0123)	(0.0386)	(0.0668)
Precip. X Close.	-0.0446**	0.0439***	-0.0194**	0.03657***
	(0.0069)	(0.0654)	(0.0087)	(0.0134)
Within R^2	0.38	0.53	0.43	0.54

Note: Standard errors in parentheses. *p<0.1; **p<0.05; ***p<0.01 Time dummies were used in each model. The number of observations is 308 for both types of elections.

Firstly, the fixed effects estimation for the Chamber of Deputies election is described as it is perceived as the most important one. Compared to the regression analysis results on the general level described above, the coefficient sign of all of the socio−economic variables remains unchanged. The impact on the dependent variable determined by the coefficients is also very similar for this specific type of election. Unlike on the general level, for this election type the population size appears to be significant with positive effect. On the other hand, population stability seems not to have a significant effect on the turnout. This is in line with the intuition since the election to the Chamber of Deputies is carried out on the national level. Therefore, it is understandable why migration between the districts doesn't have any significant effect on the voter turnout.

The effect of precipitation is rather complex. As is visible from the graph shown below, it has the form of inverted u−shape, which means that up to some point the precipitation enhances turnout, and after reaching the maximum a downturn in the turnout due to rainfall is observed.

Figure 6.1: Turnout v. Precipitation



Plugging the coefficients into an equation, this breakpoint is computed using a simple derivation. The calculation shows that this breakpoint is 6.15mm of precipitation.

$$\begin{aligned} Turnout = 0.73 + 0.0123 Precipitation - 0.001 \text{Precipitation}^2 + ... \\ \frac{\partial Turnout}{\partial Precipitation} = 0.0123 - 2 * 0.001(Precipitation) \\ 0 = 0.0123 - 2 * 0.001(Precipitation) \\ Precipitation = 6.15 \end{aligned} \tag{6.1}$$

The effect of precipitation on the turnout is different for different amounts of precipitation. Plugging into the equation we obtained the results for 3mm (as this amount of precipitation should enhance the turnout) and for 10mm of precipitation (as this should decrease the turnout) to illustrate how the effect changes with different amounts of rainfall [1].

$$\begin{aligned} \frac{\Delta Turnout}{\Delta Precipitation} = 0.0123 - 2 * 0.001(Precipitation) \\ 0.0123 - 2 * 0.001(3) = 0,0063 \end{aligned} \tag{6.2}$$

$$\begin{aligned} \frac{\Delta Turnout}{\Delta Precipitation} = 0.0123 - 2 * 0.001(Precipitation) \\ 0.0123 - 2 * 0.001(10) = -0,0077 \end{aligned} \tag{6.3}$$

It is visible that the initial change from no rain to 1mm of precipitation is associated with 1.23pp enhance in voter turnout. For 3mm of precipitation the effect is associated with 0.63pp increase in the turnout rates, and finally 10mm of precipitation are associated with 0.77pp decrease in the turnout.

Besides that, the closeness variable is added to the model, as using it is relevant in the case of Chamber of Deputies elections. Its coefficient is significant and negative, meaning that the bigger is the difference between the first and the second candidate, the lower the turnout. This is in line with the intuition that when the expected outcome of the election is closer, the turnout tends to get higher as the voter perceives that their vote might by pivotal and change the outcome of the election.

[1] The choice of the values is random, only to show the changes in the effect.

To assess the second hypothesis of this research that the effect of precipitation will be smaller when the election results are close, an interaction variable is added to the model. The coefficients of the precipitation and closeness variables show how the turnout changes when all the other variables are held constant. As the closeness variable increases by one unit, the effect of rainfall on voter turnout decreases by 0,019. This is in line with the initial hypothesis that when the election outcome is tight, the rainfall doesn't have as big effect as it would have if the difference between the first and the second candidate was substantial.

Columns (2) and (4) of Table 6.2 show the results of the FE model performed on the data available for elections to the European Parliament, as it is the "least important" election type, assessed from the turnout point of view.

Compared to the most important election type discussed earlier, the model assessing the elections to European Parliament only has a handful of significant variables. First of all, the precipitation is significant. As is visible from the table, the quadratic term of precipitation is not statistically important as its p-value is greater then the allowed level. Therefore, the model without it is being used to interpret the relationships, as it better fits the data. When the rain increases by 1mm, the turnout decreases by 0.82pp. This supports the initial claim that for unimportant election types, the effect of precipitation has greater negative impact on the turnout rates than for the important ones. As voters don't perceive this type of election as meaningful enough, an additional inconvenience in the form of rain is dissuading them from voting.

Also, unemployment significantly decreases voter turnout. With every additional percentage point of unemployment, the turnout drops by 0.76pp, holding other variables constant.

An interesting result is that the effect of rainfall on voter turnout is affected by the closeness of the result, but in rather opposite way than expected. With one additional unit of closeness, the effect of rainfall on voter turnout increases by 0,044. Therefore, the bigger the difference between the first and the second candidate, the smaller is the negative effect of rainfall on voter turnout. This actually goes against the hypothesis that when the election outcome is tight, the effect of rainfall on voter turnout will be smaller.

The previous part of the thesis discussed the results of the models executed on the level of specific districts throughout the years and election types. Next part focuses on the models using the data on the level of municipalities.

First of all, a simple OLS regression was run on all available data throughout the years and election types on the level of specific cities and villages. A whole of 10,581 observations were gathered and used as an input to the model whose results are described below. The purpose of this regression is twofold. First, it describes the relationships in the dataset used for the treatment effect/difference in difference analysis; and second, it serves as sort of a double check of the results presented for the level of districts.

Table 6.3: Municipality level regression results (General)

Variable	Coefficient
Constant	0.4436***
	(0.0030)
Precipitation	-0.0026***
	(0.0003)
Population Size	-3.24e-06***
	(1.64e-07)
Population Stability	-2.31e-05
	(1.71e-05)
Unemployment	-0.0040***
	(0.0003)
Population Density	0.0024***
	(0.0004)
Dummy (EP)	-0.1434***
	(0.0033)
Dummy (Region)	-0.0299***
	(0.0033)
Dummy (Prez)	0.2128***
	(0.0037)
Dummy (CH.o.D)	0.2164***
	(0.0031)
Dummy (Munic.)	0.1527***
	(0.0032)

Note: Standard errors in parentheses. *p<0.1; **p<0.05; ***p<0.01; R^2: 0.74

Following the previous OLS regression, dummy variables were added to the model to distinguish between the election types. The order of perceived importance of the election remains the same for the municipalities as it was on the district level. The values of the coefficients are slightly different, but for the analysis it is important that the signs of the coefficients and the order of importance remained unchanged.

The effect of precipitation on voter turnout is negative, even on the level of municipalities, suggesting 0.26pp decrease in voter turnout with every additional mm of precipitation. The coefficients for population size as well as unemployment remain negative, on the contrary the population density still has a positive effect on voter turnout.

6.1 Difference−in−differences model evaluation

The section below shows the results of the introduced experimental method − DID model, aiming to discover whether there is also a causality between precipitation and turnout. After obtaining 867 observations of the differences of differences for each election type, a pooled OLS regression was performed on the data from elections to Chamber of Deputies and European Parliament. Its outcomes are described below.

Table 6.4: DID model results

Variable	Chamber of Deputies	European Parliament
Constant	0.0310***	0.0420***
	(0.0028)	(0.0032)
Precipitation	0.0010	-0.0008
	(0.0012)	(0.0006)
Precipitation sq.	-0.0001	-2.21e-05
	(0.0001)	(2.89e-05)
Population Size	-1.48e-05**	-4.97e-06***
	(5.78e-06)	(4.03e-06)
Population Stability	-2.32e-05	-9.79e-05
	(1.44e-05)	(2.23e-05)
Unemployment	-0.0027***	-0.0025***
	(0.0006)	(0.0007)
Population Density	0.0155	0.0070
	(0.0106)	(0.0057)
R^2	0.045	0.053

Note: Standard errors in parentheses. *p<0.1; **p<0.05; ***p<0.01

Firstly, the results for Chamber of Deputies are discussed. The population size appears to have significantly negative effect on voter turnout, supporting the previous findings. Unemployment is also significant and negative, confirming prior conclusions. On this sample with these criteria, no significant effect of any of the remaining variables on the turnout was found. Although, the p−values of population stability and population density are somewhat close to the preset acceptable level of significance. Their coefficients are also in line with the outcomes of previous models.

The precipitation variable shows a positive effect on the turnout, but when this effect is magnified using the quadratic term, it turns negative, suggesting an inverted u-shape. This is supporting the earlier findings of FEM for Chamber of Deputies. The p-value of this variable is very high, indicating that the effect of precipitation on voter turnout is not strong enough to conclude that the effect exists in the whole population. This might be due to relatively small size of the sample, or simply the effect of the precipitation is too small for the model to detect it.
For the European Parliament elections some significant determinants of the turnout were found. Yet again, the population size significantly decreases the turnout rate. Also, unemployment was found to be a significant negative determinant. Last but not least, the population density positively and significantly affects the total count of the people that decide to cast their ballots. The causality in the effect of precipitation that this model aimed to demonstrate wasn't found as the p-value for this variable is rather high.

6.2 The evaluation of hypotheses

Hypothesis #1: Voter turnout decreases with increasing precipitation.

The research supports this hypothesis, showing that the rainfall decreases the turnout to some extent. In general, the rainfall was found to affect the turnout rates, being associated with 0.38pp decrease on the level of districts and with 0.26pp decrease on the level of municipalities.

Hypothesis #2: The effect of precipitation on voter turnout will be smaller the more important the election is.

As in general the rainfall has diminishing effect on the turnout rates, we also found that it has a different effect for different election types. For the election to Chamber of deputies that is perceived as the most important one based on the average turnout rates, the effect was found to be positive for a small amount of precipitation. The positive effect decreases with every additional millimeter of precipitation, reaching the maximum at 6.15mm of precipitation. After that, additional precipitation tends to decrease the turnout rates. For the least important election, to European Parliament, the effect was negative from the very beginning, decreasing the turnout by 0.82pp with every additional mm of rainfall. Therefore, it can be concluded that the effect of precipitation on voter turnout is different for each kind of election, supporting the hypothesis that the impact of rainfall will be smaller for more important elections.

Hypothesis #3: The tighter the outcome of the election, the smaller the impact of precipitation on the turnout.

The results of the model executed for the Chamber of Deputies elections support the hypothesis. When the closeness variable increases by 1pp, the coefficient of precipitation decreases by 0.019. Vice versa, when the closeness variable decreases by 1pp, meaning that the election outcome was tighter, the negative effect of rainfall increases by 0.019 − the influence of rainfall on voter turnout is smaller. Therefore, when there is a big difference in number of votes between the first and the second candidate, the more are the voters discouraged by the rain and tend to abstain as they feel like their vote can't change the outcome of the election anyway, and an extra obstacle such as rain dissuades them from casting their ballots.

On the other hand, this hypothesis is rejected for the "unimportant" European Parliament elections. Moreover, the results suggest the exact opposite outcome. The bigger is the difference between the first and the second candidate, the less the rain discourages the voters from voting.

Chapter 7

Limitations and further research suggestions

As every research, even this one has its limitations and biases that unfortunately isn't possible to overcome, at least at this point. The most important ones are described and discussed in this section below. Even with these drawbacks, the research provides an interesting insight into whether and how the rainfall affects voter turnout.

Firstly, there are several limitations regarding the level of granularity of the data. Undoubtedly, the best outcomes would be acquired if the research was conducted on the level of specific villages and cities. Due to lack of data, this is not possible as for now since the information are not available in such detail for the whole population of Czech municipalities. Therefore, the research was conducted on the most detailed level for which the data was available – districts. This brings up the first bias as all of the variability of the independent predictors from the level of municipalities is somewhat averaged to the district level.

The biggest issue and the most of averaging comes up with the precipitation variable. Firstly, the data on precipitation are given in the average amount of mm of rainfall that fell per hour, calculated per the specific date. This means that when it rains 72mm in one hour in the middle of the night, and then for the rest of the day there is no rainfall at all, the average precipitation per hour given by the CHMO is 3mm. Even though there was no precipitation present during the time when the polls were open. Then, the general research is focused on the districts, therefore not only the precipitation is time-averaged. It is also averaged with respect to the location. Meaning, that the districts are usually relatively wide and the fact that it was raining on one side of the district doesn't have to mean that it was also raining on the other side. Last but not least, the daily precipitation is also averaged between the two days when the elections are held, due to absence of day-to-day data on voter turnout. Therefore, the assumption is made saying that the same (average) amount of precipitation falls on every hour of both of the election days.

When it comes to precipitation, another drawback is observed, namely it is not distinguished between rainfall and snow. As the studied elections are held during the summer and early autumn months, this doesn't create a bias per se. The only election held in the winter months is the presidential election. Although, it is expectable that the effect of precipitation on the turnout will be different for both snow and rainfall. As for now, there wouldn't be enough observations to realize such research, but it is undoubtedly an interesting topic to be studied in the future. The effect of rainfall on the turnout will also most likely be related to the temperature and sunshine coverage, as the rainfall effect might be different on hot days and cold days, and cloudy and sunny days. This opens a door for deeper research studying the impact of weather on the turnout, not only the impact of rainfall.

Another bias on the general level of research might be caused by the omission of certain variables. Even though the R^2 of the general level OLS is quite high for a model that estimates people's behavior, some of the variables that were shown by previous research to be significant, such as education or income, were omitted as they weren't available. Further, the model is only conducted on the aggregate level, excluding the individual decision-making process of each citizen. In this case, further research is needed, working with the data gathered from each individual, for example by a questionnaire survey. The sample will expectably be rather small, but it might show the impact of variables, that are not available on the aggregate level.

Next, the drawbacks of the DID model are to be discussed. This model is rather experimental and aims to show whether there is some causality present between the rainfall and voter turnout by trying to explain the year-to-year changes in variability of the dependent variable with the precipitation variable. It is expected that the R^2 will be very small, on the other hand the introduced model only explained around 5% of the variability of the dependant variable, which is far below the expectations.

Although some of the variables were found to have significant effect on the turnout, precipitation wasn't one of them. This doesn't necessarily mean, that there is no causality. It only shows that the effect isn't strong enough in this sample to be related to the whole population. This might be caused by a number of things – small sample size, too much variability etc. But also, it might be due the chosen method of matching. As the pairs of the most similar municipalities are forced together, creating balanced clusters of exactly 2 municipalities in one, the actual similarity can be somewhat averaged. A different matching method couldn't be used as the dataset was already small to some extent and therefore it was desirable to use all of the observations. Nevertheless, when there will be more observations available in the future due to improvement in digitalization and data availability and/or as more elections will be held, it is suggestable to use a different method of matching. Such that the similarity of the municipalities will be controlled, determining boundaries and thresholds which, when exceeded, will not (unlike the used matching method) pair the village to any other village from the available observations.

Previous research shows that the effect of rainfall on the turnout is different for different levels of another variable – we found that the rainfall decreases the turnout more in densely populated areas then in rural ones (Garcia-Rodriguez & Redmond, 2020). In this research, one interaction term like this is introduced, measuring how the effect of rainfall on the turnout depends on the closeness of the election results. It might be interesting to carry out further analysis in this area on Czech data, presenting other interaction terms such as precipitation and density, precipitation and unemployment or precipitation and population size as the strength of the effect might differ for specific levels of some variables.

What might also be interesting is conducting the research on a different level of granularity. When analyzing the impact of rainfall on turnout on the national level, more variables will be available – such as campaign expenditures or the number of parties that the voter can choose from (as this increases the cost of obtaining information about the candidates, but on the contrary increases the chances that a person might identify themselves with some of the candidates). Therefore, it is suggestible to execute a research that would analyze the effects from time perspective rather than the geographical one.

Chapter 8

Conclusion

As previous research showed on evidence from multiple countries, in most of them there is a significant negative effect of precipitation on voter turnout observed. The analysis of presidential election in the US (Gomez *et al.*, 2007) found that one additional inch of rain causes a 1pp decrease in turnout rates. Analysis conducted on the Irish data (Garcia-Rodriguez & Redmond, 2020) found a 2pp decrease in turnout induced by rain. On the other hand, the research based on Danish data hasn't found any significant effect of precipitation on people's participation in voting (Eisinga *et al.*, 2012). As the studies always covered different states, getting different results for each of them, it was desirable to conduct similar research providing the evidence from the Czech Republic.

The first goal of this thesis was to analyze whether the rainfall has any effect on Czech citizens when they are deciding whether to go to the polls or not. A simple OLS regression was run on all available cross−sectional data on district level. It was found that in general, the rainfall has significant negative effect on the turnout, reducing voter's participation in elections by 0.38pp with every additional mm of precipitation. The same regression was run on a random sample of around 600 municipalities, showing the results on more detailed level. It was found that rainfall has a significant negative impact, decreasing the turnout by 0.26pp with every other mm of rain.

Next, the thesis aimed to address the assumption, that the effect of rainfall on the turnout is different for each election type based on their importance saying, that the effect will be smaller when it comes to an important type of election. As the average voter turnout suggested, the most important election is the election to Chamber of Deputies and the least important one appears to be the election to European Parliament. Therefore, the analysis was carried out for these two election types to show the contrast in the importance of the election. It was found that for the election to the Chamber of Deputies the effect of rainfall has an inverted u-shape. At first the voter turnout is enhanced by the rainfall, but after reaching the maximum of 6.15mm of precipitation, the turnout starts to decrease with every additional mm of rain. For the election to the European Parliament, the effect of rainfall on voters' participation was less complex, being significantly negative from the very beginning. As the results showed, with every other millimeter of rainfall, the turnout decreases by 0.82pp. Therefore, the initial assumption that the effect of rainfall will be bigger the less important the election is, was confirmed.

Last but not least, the link between the tightness of the election, precipitation and voter turnout was to be examined. It was expected that the smaller the difference between the first and the second candidate, and therefore the tighter the outcome, the smaller will be the effect of the rainfall on the turnout. The evidence to support this expectation was only found for the election to Chamber of Deputies, where the bigger was the difference between the candidates, the bigger was the decrease in turnout caused by rain − with every additional 1pp difference in the tightness, every additional mm of rainfall caused an extra 1.9pp decrease in turnout. Hence, the initial assumption was confirmed. The hypothesis had to be rejected for the European Parliament, as the empirical evidence showed the exact opposite. The less tight the outcome of the election was, the stronger was the effect of precipitation on the turnout. With every additional 1pp difference in the tightness between the candidates, every additional mm of precipitation increased the turnout by 4.4pp, which goes against the assumed effect.

In addition, to assess whether there is also a causality effect between the rainfall and voter turnout an experimental treatment effect model was introduced, analyzing the differences in the differences between the variables. Even though the coefficients describing the impact of the independent variables on the turnout were in line with theoretical background and the results of this thesis, precipitation was not found to have any significant effect on the turnout − no matter the election type.

Further, the thesis addressed the main drawbacks and limitations of conducted research. Firstly, the averaging on the district level and related bias was discussed. Due to limited availability of the data, the research had to be conducted on the level of districts, instead of the level of municipalities. This issue is addressed by using the random sample of municipalities for which the data is available, executing a regression on them and double checking the results. Also, the data available for the daily precipitation come as a per-hour average, which doesn't reflect the exact current precipitation. Further a two-days average had to be created as the turnout data is only available for the election as a total. Lastly, the matching method used to create pairs for the DID model had to be used not to reduce the number of observations, as it was already low due to lack of available data on this level of granularity. Ideally, a different matching method would be advisable, considering the actual similarity between the municipalities while pairing them instead of finding the most suitable pair within the dataset regardless of the level of similarity. Despite these limitations, the outcomes of the models bring enough evidence to address the hypotheses and draw meaningful conclusions.

Although this research answered some basic questions related to the relationship between voter turnout and rainfall, further research is needed in this particular area. With the increase in digitalization and automatization it is likely that in time more data will be available, even on the level of municipalities. This would allow for addition of some other variables into the model and also for an analysis executed on more detailed data. Also, the number of observations will increase naturally, as more and more elections will be held. What might be interesting is conducting the analysis studying the effects of weather on the turnout in general, adding sunshine coverage or average daily temperatures. Another option is to study interactions between precipitation and other determinants of voter turnout to see whether the effect of precipitation differs for different segments of populations (clusters). Further, a different level of data granularity might be chosen. As some of the variables are only available on the level of the whole country it would be interesting to assess the data from the time perspective rather than the geographical one. Also, analyzing one specific election type into more depth, assessing for example the contents of the candidates' programs, seems like a good approach.

To conclude, this thesis provides an initial insight into how the rain affects the turnout in the Czech Republic based on different election types, but further research in this area is needed.

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Appendix A

Descriptive Statistics

Figure A.1: Descriptive statistics of Districts

District	Area	Cities/Villages	Turnout				Precipitation			
	km²		Min	Max	Mean	St.Dev.	Min	Max	Mean	St.Dev.
Benešov	1,474.69	114	0.19	0.67	0.46	0.14	0.00	12.73	1.84	2.84
Beroun	661.91	85	0.19	0.67	0.45	0.13	0.00	10.99	1.81	2.42
Blansko	862.65	116	0.20	0.69	0.50	0.14	0.00	3.66	0.98	1.26
Brno-město	230.22	27	0.22	0.65	0.44	0.12	0.00	5.83	1.05	1.81
Brno-venkov	1,498.95	187	0.20	0.69	0.48	0.14	0.00	8.26	1.05	1.92
Bruntál	1,536.06	67	0.13	0.58	0.38	0.14	0.00	6.67	1.66	2.01
Břeclav	1,048.91	63	0.15	0.62	0.42	0.14	0.00	7.03	1.10	2.01
Česká Lípa	1,072.91	57	0.14	0.72	0.39	0.14	0.00	14.37	1.96	3.25
České Budějovice	1,638.30	109	0.19	0.66	0.44	0.13	0.00	5.16	0.95	1.31
Český Krumlov	1,615.03	46	0.15	0.68	0.45	0.14	0.00	6.90	1.07	1.55
Děčín	908.58	52	0.14	0.58	0.38	0.12	0.00	13.41	2.29	3.25
Domažlice	1,123.46	85	0.17	0.64	0.44	0.13	0.00	7.32	1.61	1.81
Frýdek-Místek	1,208.49	72	0.16	0.65	0.43	0.13	0.00	10.10	2.25	3.45
Havlíčkův Brod	1,264.95	120	0.18	0.67	0.47	0.14	0.00	12.77	1.48	2.72
Hlavní město Praha	496.03	57	0.26	0.69	0.46	0.14	0.00	11.79	1.64	2.77
Hodonín	1,099.13	82	0.16	0.64	0.44	0.14	0.00	10.70	1.60	3.16
Hradec Králové	891.62	104	0.21	0.69	0.46	0.13	0.00	9.76	1.23	2.29
Cheb	1,045.94	40	0.14	0.57	0.37	0.12	0.00	6.45	1.92	2.22
Chomutov	935.30	44	0.12	0.54	0.36	0.12	0.00	9.33	2.13	2.46
Chrudim	992.62	108	0.18	0.67	0.46	0.14	0.00	9.07	1.42	2.31
Jablonec nad Nisou	402.30	34	0.18	0.63	0.43	0.13	0.00	13.44	2.75	3.43
Jeseník	718.96	24	0.14	0.62	0.41	0.14	0.00	8.31	1.67	2.44
Jičín	886.63	111	0.18	0.65	0.48	0.14	0.00	11.00	2.21	3.36
Jihlava	1,199.32	123	0.17	0.66	0.47	0.14	0.00	14.00	1.26	2.80
Jindřichův Hradec	1,943.69	106	0.17	0.64	0.44	0.13	0.00	8.06	0.98	1.71
Karlovy Vary	1,514.95	54	0.16	0.66	0.41	0.13	0.00	9.03	2.06	2.47
Karviná	356.24	17	0.13	0.58	0.35	0.12	0.00	9.91	1.53	2.74
Kladno	719.61	100	0.17	0.61	0.42	0.12	0.00	8.40	2.14	2.60
Klatovy	1,945.69	94	0.18	0.65	0.45	0.13	0.01	3.93	1.28	1.30
Kolín	743.57	89	0.18	0.65	0.45	0.13	0.00	11.37	1.76	2.81
Kroměříž	795.67	79	0.18	0.67	0.46	0.14	0.00	10.78	1.50	2.78
Kutná Hora	916.93	88	0.16	0.66	0.45	0.14	0.00	14.90	1.60	3.17
Liberec	988.87	59	0.18	0.62	0.42	0.13	0.00	17.57	2.54	3.89
Litoměřice	1,032.16	105	0.17	0.62	0.44	0.12	0.00	10.13	1.95	2.64
Louny	1,117.65	70	0.15	0.59	0.42	0.13	0.00	8.27	1.90	2.42
Mělník	701.08	69	0.16	0.62	0.42	0.13	0.00	16.39	2.22	3.57
Mladá Boleslav	1,022.83	120	0.18	0.66	0.45	0.13	0.00	13.80	2.09	3.48
Most	467.16	26	0.12	0.55	0.36	0.12	0.00	15.78	3.17	3.75
Náchod	851.57	78	0.18	0.66	0.45	0.13	0.00	13.36	1.80	3.17
Nový Jičín	881.59	53	0.17	0.64	0.42	0.14	0.00	8.17	1.68	2.62
Nymburk	850.07	87	0.19	0.66	0.45	0.13	0.00	10.83	1.58	2.76
Olomouc	1,620.28	96	0.17	0.65	0.43	0.13	0.00	5.38	1.12	1.74
Opava	1,113.11	77	0.15	0.64	0.42	0.14	0.00	7.00	1.59	2.22
Ostrava-město	331.53	13	0.15	0.59	0.37	0.12	0.00	7.01	1.68	2.58
Pardubice	880.09	112	0.18	0.67	0.44	0.13	0.00	7.90	1.54	2.56
Pelhřimov	1,290.00	120	0.19	0.68	0.48	0.15	0.00	16.27	1.54	3.30
Písek	1,126.84	75	0.17	0.66	0.43	0.14	0.00	9.83	1.32	2.03
Plzeň-jih	990.04	90	0.18	0.65	0.45	0.13	0.00	6.38	1.44	1.77
Plzeň-město	261.46	15	0.20	0.64	0.43	0.12	0.00	6.01	1.42	1.59
Plzeň-sever	1,286.79	98	0.17	0.64	0.45	0.13	0.00	6.97	1.63	1.74
Praha-východ	754.91	110	0.23	0.70	0.49	0.14	0.00	13.40	1.91	3.24
Praha-západ	580.63	79	0.26	0.72	0.50	0.14	0.00	10.53	1.53	2.42
Prachatice	1,375.03	65	0.16	0.62	0.43	0.14	0.00	2.45	0.84	0.88
Prostějov	777.32	97	0.16	0.65	0.45	0.14	0.00	5.51	1.00	1.46
Přerov	844.74	105	0.16	0.64	0.42	0.13	0.00	9.67	1.62	2.87
Příbram	1,692.05	121	0.19	0.67	0.46	0.13	0.00	7.12	1.36	1.84
Rakovník	896.30	83	0.18	0.65	0.45	0.13	0.00	6.67	1.51	1.86
Rokycany	575.11	68	0.18	0.65	0.46	0.13	0.00	6.29	1.26	1.60
Rychnov nad Kněžnou	981.78	80	0.18	0.68	0.47	0.14	0.00	11.15	1.58	2.71
Semily	698.99	65	0.19	0.68	0.47	0.15	0.00	11.99	2.54	3.31
Sokolov	753.60	38	0.12	0.53	0.35	0.11	0.00	7.01	1.98	2.26
Strakonice	1,032.10	112	0.19	0.65	0.44	0.14	0.00	4.01	1.14	1.32
Svitavy	1,378.56	116	0.17	0.67	0.46	0.14	0.00	5.53	1.13	1.66
Šumperk	1,313.06	77	0.16	0.65	0.43	0.13	0.00	6.67	1.46	1.77
Tábor	1,326.01	110	0.18	0.67	0.46	0.13	0.00	8.95	1.33	2.00
Tachov	1,378.68	51	0.14	0.58	0.39	0.13	0.00	6.41	1.42	1.84
Teplice	469.27	34	0.13	0.55	0.38	0.12	0.00	10.49	1.83	2.59
Trutnov	1,146.78	75	0.17	0.65	0.44	0.14	0.00	8.05	2.48	2.82
Třebíč	1,463.07	167	0.18	0.67	0.47	0.14	0.00	8.05	0.81	1.77
Uherské Hradiště	991.37	78	0.17	0.68	0.47	0.14	0.00	12.36	2.03	3.86
Ústí nad Labem	404.44	23	0.15	0.59	0.38	0.12	0.00	9.74	2.00	2.60
Ústí nad Orlicí	1,258.31	115	0.18	0.68	0.46	0.14	0.00	8.25	1.25	2.05
Vsetín	1,142.87	59	0.17	0.64	0.43	0.13	0.00	14.60	2.01	4.04
Vyškov	876.06	80	0.18	0.69	0.46	0.14	0.00	6.88	1.46	2.46
Zlín	1,033.59	89	0.18	0.68	0.47	0.13	0.00	13.24	1.80	3.84
Znojmo	1,590.50	144	0.16	0.70	0.46	0.15	0.00	2.87	0.65	0.85
Žďár nad Sázavou	1,578.51	174	0.20	0.69	0.49	0.15	0.00	10.43	1.20	2.24

Figure A.2: Descriptive statistics of Districts continued

District	Population				Population stability				Population Density				Unemployment			
	Min	*Max*	*Mean*	*St.Dev.*	*Min*	*Max*	*Mean*	*St.Dev.*	*Min*	*Max*	*Mean*	*St.Dev.*	*Min*	*Max*	*Mean*	*St.Dev.*
Benešov	90,908	99,414	95,537	2,567	151	846	560	193	61.65	67.41	64.78	1.74	1.56	5.65	3.34	1.40
Beroun	76,773	94,571	86,880	5,191	756	1,442	1,095	203	115.99	142.88	131.26	7.84	2.56	6.78	4.38	1.53
Blansko	104,047	109,136	107,165	1,453	71	673	264	160	120.61	126.51	124.23	1.68	2.54	7.86	5.20	1.95
Brno-město	366,757	381,346	375,441	4,858	-1,447	1,385	-81	914	1,593.07	1,656.44	1,630.79	21.10	3.71	8.76	6.39	1.71
Brno-venkov	185,784	224,642	207,674	11,645	1,359	2,512	1,807	228	123.94	149.87	138.55	7.77	2.41	7.07	4.69	1.69
Bruntál	91,597	99,328	95,639	2,496	-528	-107	-329	115	59.63	64.66	62.26	1.62	5.64	14.33	10.08	3.07
Břeclav	112,920	116,291	114,632	1,130	37	407	137	114	107.65	110.87	109.29	1.08	3.43	9.89	6.57	2.35
Česká Lípa	102,267	104,144	103,169	482	-311	367	-51	192	95.32	97.07	96.16	0.45	2.41	9.51	5.97	2.67
České Budějovice	179,326	195,903	188,510	4,563	289	1,194	793	233	109.46	119.58	115.06	2.79	1.78	5.78	3.69	1.36
Český Krumlov	59,941	61,635	61,214	359	-243	159	-47	113	37.11	38.16	37.90	0.22	3.63	9.69	6.73	2.14
Děčín	129,542	135,740	132,619	2,148	-575	516	-189	299	142.58	149.40	145.96	2.36	4.12	11.22	8.39	2.64
Domažlice	58,574	61,987	60,699	949	-64	366	183	126	52.14	55.18	54.03	0.84	2.05	7.32	4.64	1.84
Frýdek-Místek	208,015	214,660	212,046	1,875	152	676	430	148	172.13	177.63	175.46	1.55	2.85	8.03	5.51	1.87
Havlíčkův Brod	94,486	96,079	95,043	473	-245	410	-2	197	74.70	75.95	75.14	0.37	2.40	7.68	5.04	2.06
Hlavní město Praha	1,165,581	1,324,277	1,243,788	44,426	-5,297	19,044	8,507	5,935	2,349.96	2,669.91	2,507.61	89.59	1.70	5.14	3.36	1.16
Hodonín	153,943	158,445	155,898	1,348	-286	69	-146	115	140.06	144.15	141.84	1.23	4.70	11.93	8.64	2.68
Hradec Králové	159,885	164,283	162,622	1,191	-161	790	225	238	179.32	184.25	182.39	1.34	2.52	7.45	4.69	1.78
Cheb	91,164	95,452	92,826	1,524	-379	296	-1	213	87.16	91.26	88.75	1.46	1.76	8.04	5.24	2.27
Chomutov	124,249	126,438	125,188	677	-381	611	42	332	132.84	135.18	133.85	0.72	4.85	11.91	8.40	2.51
Chrudim	103,266	104,439	104,029	358	-45	400	152	140	104.03	105.22	104.80	0.36	2.48	8.43	5.47	2.32
Jablonec nad Nisou	88,054	90,667	89,907	693	-311	475	82	196	218.88	225.37	223.48	1.72	2.87	8.17	5.40	1.72
Jeseník	37,968	42,148	40,105	1,332	-248	-22	-165	66	52.81	58.62	55.78	1.85	4.76	13.19	9.15	2.89
Jičín	77,066	80,045	79,185	834	-216	942	304	303	86.92	90.28	89.31	0.94	1.78	6.68	4.40	1.90
Jihlava	109,796	113,628	112,217	934	-159	539	111	174	91.55	94.74	93.57	0.78	2.78	7.82	5.35	1.90
Jindřichův Hradec	90,574	93,298	92,014	929	-209	501	-64	185	46.60	48.00	47.34	0.48	1.93	7.35	4.40	1.87
Karlovy Vary	114,641	119,923	117,343	1,673	-433	614	-65	286	75.67	79.16	77.46	1.10	2.58	9.21	6.49	2.27
Karviná	246,324	277,975	261,858	11,276	-2,239	28	-1,309	604	691.46	780.30	735.06	31.65	6.71	12.52	9.83	1.96
Kladno	151,794	166,483	159,889	4,244	-51	1,832	1,069	450	210.94	231.35	222.19	5.90	3.25	8.42	5.98	1.75
Klatovy	86,318	88,721	87,325	862	-143	472	89	191	44.36	45.60	44.88	0.44	2.37	7.67	5.08	1.97
Kolín	89,400	102,623	96,926	3,675	251	1,312	724	341	120.23	138.01	130.35	4.94	3.44	9.39	6.18	2.12
Kroměříž	105,343	108,036	106,905	917	-158	250	9	127	132.40	135.78	134.36	1.15	2.62	9.11	6.35	2.48
Kutná Hora	72,296	75,828	74,494	752	4	913	309	258	78.85	82.70	81.24	0.82	3.16	8.81	5.92	2.00
Liberec	162,305	175,332	170,556	3,677	-62	1,610	501	497	164.13	177.31	172.48	3.72	3.14	8.46	6.05	1.94
Litoměřice	114,848	119,668	118,440	1,526	-1,357	964	61	519	111.27	115.94	114.75	1.48	2.92	9.75	6.70	2.42
Louny	85,104	86,868	86,273	492	-150	398	98	160	76.15	77.72	77.19	0.44	4.32	10.94	7.99	2.35
Mělník	94,936	109,302	103,257	4,269	-50	2,142	755	592	135.41	155.91	147.28	6.09	3.06	8.15	5.64	1.77
Mladá Boleslav	113,503	130,365	124,097	4,348	-520	2,453	787	872	110.97	127.46	121.33	4.25	1.65	4.69	3.24	1.17
Most	111,708	117,294	114,923	1,987	-426	383	-175	245	239.12	251.08	246.00	4.25	4.58	14.78	10.34	3.24
Náchod	103,842	112,582	110,600	2,708	-376	106	-175	133	121.94	132.21	129.88	3.18	3.04	6.94	4.80	1.37
Nový Jičín	151,566	152,563	151,987	345	-298	104	-116	123	171.92	173.05	172.40	0.39	2.97	9.34	5.82	2.12
Nymburk	84,077	100,886	94,137	4,937	523	1,139	898	225	98.91	118.68	110.74	5.81	3.24	8.59	6.09	1.82
Olomouc	228,831	235,472	232,436	1,922	-54	418	165	128	141.23	145.33	143.45	1.19	2.62	9.21	6.00	2.41
Opava	170,813	177,213	176,572	1,245	-158	306	10	145	153.46	159.21	158.63	1.12	2.60	8.96	6.18	2.35
Ostrava-město	320,145	340,124	329,214	6,516	-1,755	-247	-966	470	965.66	1,025.92	993.01	19.65	5.10	11.56	8.17	2.17
Pardubice	159,176	175,441	168,171	4,242	192	2,388	962	578	180.86	199.34	191.08	4.82	2.04	6.13	4.02	1.46
Pelhřimov	71,977	73,227	72,447	364	-132	311	77	148	55.80	56.77	56.16	0.28	1.49	5.89	3.77	1.66
Písek	69,118	71,587	70,557	590	84	391	212	79	61.34	63.53	62.62	0.52	1.86	6.46	4.31	1.71
Plzeň-jih	55,997	63,488	60,815	2,402	75	1,148	332	277	56.56	64.13	61.43	2.43	1.71	5.52	3.65	1.41
Plzeň-město	178,064	194,280	186,127	4,371	-1,099	4,063	953	1,324	681.04	743.06	711.88	16.72	1.79	6.15	4.03	1.56
Plzeň-sever	69,910	79,979	75,926	2,763	309	840	609	170	54.33	62.15	59.00	2.15	2.27	6.13	4.36	1.45
Praha-východ	105,071	185,178	153,336	22,697	3,162	7,676	3,965	1,203	139.18	245.30	203.12	30.07	1.10	3.53	2.25	0.94
Praha-západ	88,190	149,338	125,100	17,706	2,014	5,307	2,997	936	151.89	257.20	215.46	30.50	1.35	4.37	2.72	1.11
Prachatice	50,545	51,551	51,065	374	-162	265	-21	129	36.76	37.49	37.14	0.27	2.25	6.14	4.17	1.36
Prostějov	108,362	110,214	109,234	555	-70	300	83	108	139.40	141.79	140.53	0.71	1.96	8.32	5.11	2.51
Přerov	127,572	135,165	132,299	2,136	-465	364	-249	211	151.02	160.01	156.61	2.53	3.34	10.74	7.38	2.56
Příbram	109,862	115,104	113,084	1,699	51	796	356	206	64.93	68.03	66.83	1.00	3.48	9.52	6.40	2.19
Rakovník	52,612	55,565	54,821	1,019	-65	1,029	253	315	58.70	61.99	61.16	1.14	2.51	7.97	5.23	1.93
Rokycany	45,576	49,349	47,670	995	-62	444	248	164	79.25	85.81	82.89	1.73	2.48	6.32	4.16	1.22
Rychnov nad Kněžnou	78,409	79,383	79,011	232	-255	365	3	151	79.86	80.86	80.48	0.24	1.31	5.92	3.47	1.81
Semily	73,735	75,041	74,388	391	-170	331	-6	102	105.49	107.36	106.42	0.56	3.30	8.69	5.90	1.92
Sokolov	88,212	93,434	91,042	1,901	-469	-36	-306	109	117.05	123.98	120.81	2.52	3.79	11.13	7.80	2.48
Strakonice	69,206	70,906	70,504	440	-152	512	79	174	67.05	68.70	68.31	0.43	2.69	8.2	5.44	2.06
Svitavy	103,322	105,208	104,584	508	-233	192	-13	131	74.95	76.32	75.86	0.37	2.67	9.5	6.40	2.66
Šumperk	120,417	125,572	122,909	1,614	-457	-145	-242	107	91.71	95.63	93.61	1.23	3.39	10.45	7.06	2.62
Tábor	98,784	103,015	102,291	1,078	-33	294	105	115	74.50	77.69	77.14	0.81	2.74	7.94	5.40	1.97
Tachov	51,573	53,587	52,912	509	-280	707	84	248	37.41	38.87	38.38	0.37	2.85	11.17	6.52	2.76
Teplice	127,103	130,070	128,604	801	-71	864	342	323	270.85	277.18	274.05	1.71	2.64	10.2	7.17	2.84
Trutnov	117,978	120,778	119,494	829	-554	206	-145	201	102.88	105.32	104.20	0.72	2.33	8.99	5.55	2.30
Třebíč	110,810	114,153	112,663	1,173	-423	81	-240	135	75.74	78.02	77.00	0.80	3.44	10.49	7.38	2.72
Uherské Hradiště	142,226	144,533	143,336	785	-178	288	-26	129	143.46	145.79	144.58	0.79	2.25	7.76	5.03	2.09
Ústí nad Labem	117,594	121,458	119,752	935	-560	530	-20	299	290.76	300.31	296.09	2.31	4.02	12.72	8.78	2.91
Ústí nad Orlicí	137,598	139,381	138,503	575	-400	307	-121	245	109.35	110.77	110.07	0.46	1.69	7.75	4.71	2.20
Vsetín	112,994	146,127	141,992	8,783	-334	66	-166	117	98.87	127.86	124.24	7.69	2.97	9.67	6.52	2.49
Vyškov	86,490	92,172	89,609	1,729	111	538	321	119	98.73	105.21	102.29	1.97	2.02	7.31	4.73	1.95
Zlín	191,517	194,104	192,360	664	-505	51	-134	147	185.29	187.80	186.11	0.64	2.05	7.33	4.75	2.08
Znojmo	112,311	114,351	113,426	532	-37	341	179	118	70.61	71.90	71.31	0.33	5.15	11.39	8.84	2.29
Žďár nad Sázavou	117,931	120,046	118,818	698	-381	107	-167	141	74.71	76.05	75.27	0.44	2.85	8.41	5.92	1.97

Figure A.3: Descriptive statistics - Election Types (Districts)

Election Type	Population Size				Population stability			
	Min	Max	Mean	St.Dev	Min	Max	Mean	St.Dev
European parliament	38,330	380,681	121,264.24	58,163.18	-1,777	4,953	218.10	729.12
Regional Council	37,968	381,346	121,927.03	58,048.78	-2,239	7,676	283.08	872.67
Presidential	38,659	379,527	122,254.75	58,132.60	-1,774	4,030	207.10	687.71
Chamber of Deputies	38,957	378,327	121,198.06	57,925.98	-1,774	4,282	197.86	732.74
Senate	38,659	381,346	122,732.93	59,203.63	-2,239	7,676	275.36	844.27
Municipal Council	38,659	379,527	121,232.18	57,983.49	-1,777	4,282	245.36	754.90

Election Type	Population Density				Unemployment			
	Min	Max	Mean	St.Dev	Min	Max	Mean	St.Dev
European parliament	36.76	1,653.55	163.62	226.01	1.10	13.54	5.39	2.77
Regional Council	36.90	1,656.44	164.35	225.86	1.35	13.09	5.43	2.22
Presidential	36.87	1,648.54	164.75	226.42	1.13	14.33	5.78	3.19
Chamber of Deputies	36.87	1,643.33	163.54	225.56	1.34	14.78	6.52	2.74
Senate	36.76	1,656.44	165.86	234.18	1.13	12.52	5.64	2.45
Municipal Council	36.76	1,648.54	163.57	225.51	1.13	14.78	6.13	2.76

Figure A.4: Descriptive statistics - Election Types (Municipalities)

Election Type	Population Size				Population stability			
	Min	Max	Mean	St.Dev	Min	Max	Mean	St.Dev
European parliament	43	52,282	4,154.41	7,551.21	-858	236	-3.39	51.68
Regional Council	52	52,509	4,128.67	7,486.65	-596	823	0.45	57.52
Presidential	40	50,330	4,082.43	7,269.00	-372	310	-1.61	40.87
Chamber of Deputies	41	52,260	4,221.52	7,622.75	-876	710	-4.93	57.01
Senate	52	52,509	3,982.19	7,212.99	-596	310	-0.35	50.67
Municipal Council	40	51,320	3,901.59	6,960.27	-876	710	-1.23	53.62

Election Type	Population Density				Unemployment			
	Min	Max	Mean	St.Dev	Min	Max	Mean	St.Dev
European parliament	0.01	23.84	1.69	2.75	0.00	21.69	5.40	3.39
Regional Council	0.01	23.43	1.69	2.75	0.00	24.73	4.72	2.45
Presidential	0.01	23.22	1.68	2.70	0.00	13.19	3.20	1.74
Chamber of Deputies	0.01	23.68	1.71	2.76	0.00	22.54	5.36	3.25
Senate	0.01	23.15	1.61	2.51	0.00	22.54	5.45	3.12
Municipal Council	0.01	23.68	1.68	2.75	0.00	22.54	5.98	3.37

Appendix B

Methodological Addendum

The purpose of this appendix is to describe the process that preceded the final form of the treatment effect / DID model. At first it might seem that there are better ways related to the DID to evaluate the available data, however this chapter aims to explain why it was not possible to use them.

Initially, the villages were matched based on all available data in the first year – population size, population stability, area, population density and unemployment; creating the most alike "pair". After that the precipitation for each year for both of the villages was inspected, searching for years when there was no rainfall on election day in both of the villages – where both subjects of the study were without the treatment in the first period. For those pairs that passed this condition it was searched for those where it would be applicable to use the binary treatment effect DID method described above. In other words, it was checked for such pairs where there was no rainfall in one of the villages and some rainfall in the other village in the second period. In the first year there was no treatment in both and in the second year there was treatment in one of them and no treatment in the other one. This approach is similar to event study method, that is used to describe an effect of some event (precipitation) on the outcome (turnout). Unfortunately, only lower units of such cases were found, as only limited amount of data on this level of granularity is available, and therefore it would be impossible to draw any conclusions out of that.

After that, the data was adjusted, not allowing only for the one most similar village to be paired with another but searching for more villages that would fall within set range in the available parameters, creating a cluster. As an illustrative example: for village A not only the village B with the most similar parameters (e.g., unemployment) was found, but also villages C, D, etc., that would fall within a pre−set range in the parameters (e.g., +− 0,5% of unemployment rate) would also be grouped together. After using this approach, the number of observations increased, which was also supported by the fact that the acceptable range in the parameters was only determined intuitively, and therefore it was possible for it to be expanded as needed to increase the number of observations. On the other hand, the condition of a certain similarity to reduce the bias while using the DID could have been violated and in the end, the number of observations was still insufficient even with a quite wide range of tolerance, being in lower tens of observations.

Finally, the condition of being either in the no−treatment or the treatment group (village) was dropped, evaluating only the differences in the amount of the treatment (mm of precipitation) received, changing the treatment variable from binary to continuous. Also, the criterion related to the 2−period model was abolished, observing all available periods at once. Therefore, the final model considers all of the observations available for both villages in the pairs, not dividing them into the with or without treatment groups but rather evaluating the differences between the villages in time and all of the variables, treatment variable included.