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The Influence of Natural Disasters on Voter Turnout

An analysis of the floodings in Germany on July 14 and 15, 2021 and their influence on the federal election on September 26, 2021

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Authorship Declaration

I hereby declare and confirm that this thesis is entirely the result of my own work except where otherwise indicated.

I acknowledge the supervision and guidance I have received from Prof. Dr. Stefan Voigt.

This thesis is not used as part of any other examination and has not yet been published.

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Abstract

As the frequency of natural disasters is rising due to climate change, their effects on elections need to be understood to avoid negative consequences for the democratic voting system. This study examines the effect of the floodings in Germany on July, 14 and 15, 2021 on the federal election on September 26, 2021 regarding voter turnout and postal vote share. This study conducts difference-in-difference-analyses, finding no statistically significant effect of the floodings on the examined elections. This is in line with some prior research, neglecting an effect. In this specific case, finding no statistically significant effect results probably out of the period of 10 weeks between the floodings and the federal election. This study finds a statistically significant effect of the year 2021 on postal vote shares, implicating that Covid-19 lead to an enormous increase of postal vote shares. In the end, voting alternatives (postal voting, remote electronic voting, postponing elections and choosing the poll) to voting at the poll after natural disasters are evaluated and assessed.

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A. Introduction

Natural disasters of all kinds are ubiquitous these days. Floodings, droughts, blizzards, heat waves, bush fires, tornados, volcanic eruptions, earthquakes, landslides and avalanches are happening on almost every part of the planet. Even the Antarctica – which one would expect to be a place far from human influences and without natural disasters – experienced a heat wave leading up to 38.5 °C in March 2022 (Roston, 2022).

Natural disasters are enormously powerful and result in various consequences. Besides from obvious damages regarding infrastructure, housing and community facilities, natural disasters also lead to psychological, psychosocial, health-related, economic and fiscal consequences, to name only a few of them. In this thesis, the focus lies on political consequences of natural disasters, especially on consequences regarding the “fundamental political act in a democracy” (Fiorina, 1976), namely voting.

The influence of natural disasters on elections can be measured in basically two ways – either regarding voting shares of the incumbent party or candidate or regarding voter turnout. Besides from these two clusters, there are some studies covering special questions, for example the study of Rahman, Anbarci, Bhattacharya and Ulubaşoğlu (2017) on the influence of natural disasters on corruption. This thesis will focus exclusively on the influence on voter turnout and additionally – as a more practical question on postal vote shares.

Specifically, this thesis will examine the influence of the floodings in Germany on July 14 and 15, 2021 on voter turnout and postal vote share during the federal election on September 26, 2021. Due to the recency of this event, this impact has not been assessed in the literature yet.

The floodings on July 14 and 15, 2021 affected Germany in an enormous way, leading to the title ”one-hundred-year flooding” (*“Jahrhunderthochwasser”*) referring to the extent of the flood and the excessive amount of damages caused. The effect of this flooding on voter turnout depends on many different factors and is not predictable. Turning to general voting theory, people act retrospectively, resulting either in punishing or in rewarding politicians for prior decisions (Barro, 1973). Besides from this decision taken by the voter, turnout is further influenced by specific details of the voting system, for example the level of competition between voting districts (Jackman, 1987). Prior research has found a negative relationship between natural disasters and turnout (Rudolph & Kuhn, 2017) as well as a positive relationship (Fair, Kuhn, Malhotra & Shapiro, 2017) as well as no statistically significant effect (Bodet, Thomas & Tessier, 2016). This gives an idea of the complexity of voting which makes the impact of the flood in 2021 unpredictable.

To assess the specific effect, this thesis will analyse voter turnout in the affected districts by using control variables as voter turnout in previous years and the number of eligible voters. Secondly – as a more practical question linked to policy implications – the postal vote shares will be assessed.

B. Research Question and Methodology

I. Research Question

The aim of this project is to evaluate if the flood in July 2021 influenced voter turnout regarding the parliamentary elections in Germany on September 26, 2021.

Therefore, the research question is:

“How did the floodings in Germany on July 14 and 15, 2021 influence voter turnout in the parliamentary elections on September 26, 2021, in the affected districts?”

II. Hypotheses

To answer the Research Question, two main hypotheses are developed. The overall question of the thesis is the influence of the floodings in 2021 on voter turnout, leading to the first hypothesis:

H1: The floodings in 2021 lead to an increase of voter turnout in the affected districts.

Taking a more specific view on the effect of the flood on voter turnout, the effect on the share of postal vote is examined. Since many people lost their homes due to the flood, postal vote was the only available possibility to cast a ballot for them. But even postal vote requires an application for a ballot paper requiring some kind of infrastructure, for example functioning postal service. Shortly after a flood, infrastructure is frequently not available making even postal vote impossible. Therefore, the influence on postal vote share is examined to derive policy implications regarding natural disasters and elections.

H2: The share of votes casting a ballot via postal vote has increased in the affected districts.

III. Methodology and research scope

Assessing the research question empirically is conducted by empirical analysis regarding the two afore-mentioned hypotheses. To assess H1, a difference-in-differences analysis is conducted, comparing voter turnout in affected districts and non-affected districts at two different federal elections (2017 and 2021). The same strategy was used for H2 by comparing the shares of postal votes in affected districts and non-affected districts at the federal elections in 2017 and 2021.

Regarding the research scope, this thesis focuses exclusively on voter turnout in the districts affected by the flood. The flood affected 63 districts in Rhineland-

Palatinate, North Rhine-Westphalia, Bavaria and Saxony (Federal Ministry of the Interior and the Community, 2022; the districts are listed in Appendix 1). The respective flood exposure of each district is not part of my analysis as geocoded flood layer data regarding the flood in 2021 is not yet available (refer for example to the Ministry for Climate Protection, Environment, Energy and Mobility in Rhineland-Palatinate, accessible via Hochwassergefahren- und -risikokarten (rlp-umwelt.de), explicitly stating that the flood of 2021 is not yet included in their data).

C. Natural disasters and their influence on elections

Voting is "the fundamental act in a democracy" (Fiorina, 1976). The right to vote is a fundamental civic right of every citizen and turnout is therefore an important variable when measuring how well democracy works in a specific country. In the following chapters, a short introduction regarding the complex concepts of voting and turnout will be provided. Secondly, the concept of turnout will be linked to the impact of natural disasters whilst providing an overview on the existing literature. Thirdly, a short introduction on postal vote will be given.

I. Definition of turnout

Turnout can be defined and calculated in different ways, depending on the measuring unit employed to calculate the ratio. Referring to Geys (2006), three measuring units are commonly used: the voting age population, the number of

eligible voters and the number of registered voters. Whilst the voting age population measuring unit refers to all people above the voting age – which is 18 years in Germany -, eligible voters only includes citizens who are allowed to vote, for example not taking into account people who lost their civic rights. The third measuring possibility is to use the number of registered voters. Observing the impact on a German federal election, the third possibility turns out not be useful since no registration for elections is required. Instead, the voters' register is created based on the residents' register of the municipal authorities (The Federal Returning Officer, 2018). Regarding the other two measurement units, eligible voters seem to be the most suitable possibility because this study's aim is only to show how many people of those eligible to vote were influenced by the natural disaster in whatever way. People not eligible to vote could not have been influenced by the natural disaster regarding their turnout decision and are therefore irrelevant for this research. As Geys (2006) notes, statistical offices of many countries tend to register only the voting age population, but not the number of eligible voters. In Germany, statistical offices use explicitly the number of people eligible to vote ("*wahlberechtigt*"). According to Art. 38 (2) of the German constitution *("Grundgesetz")* this number does only include people eligible to vote which is why research in this thesis will be based on the numbers.

II. Retrospective voting

Deciding to vote or not to vote is a complex process, depending on different factors and influences. Literature has developed different approaches to explain

this decision-making process. The most common approach is the approach of retrospective voting. Retrospection can be described as “the act of recalling things past, especially in one’s personal experience” (Collins Dictionary, n.d. – 2). Voters acting and deciding retrospectively look back at their past experiences and make a voting decision based on these former experiences.

1. Retrospective voting as a four-step process

According to Healy and Malhotra (2013), retrospective voting can be described as a four-step process, a so-called “feedback loop” (Healy & Malhotra, 2013). Firstly, during their daily life voters gain information about happenings in the world of all kinds. Examples could be incidents such as natural disasters, economic results or implemented policy actions. During the first step, citizens only perceive these happenings and do not evaluate them. In a second step, they try to find the person responsible for the event. Pursuant to Healy and Malhotra (2013), this means allocating the responsibility to a political leader.. After allocating the responsibility to a person, the performance of this leader is examined. This is the crucial step of retrospective voting, the point where decisions are made. How these decisions are made, is explained by using different which will be explained below. Against this background, it needs to be highlighted that the process of retrospective voting does not end at this point even if one could assume so. Because politicians know their actions are being evaluated, they are incentivized to act in a specific way. This means, the voting decision has a direct influence on

policy actions after elections and will directly influence the next voting decision according to the “feedback loop” (Healy & Malhotra, 2013).

2. Three models of retrospective voting

Explaining the crucial part of retrospective voting – assessing the performance of a political leader – is complicated because of many different aspects working together. Basically, three models – each of them focusing on one probably influencing aspect – have been employed to explain how the performance is assessed by voters. The first model was the so-called reward-punishment or sanctioning model. Depending on their performance, voters either reward politicians for a good performance by voting them again or punish them for a bad performance (Barro, 1973). This model is mainly linked to the question which party or person the voter decides on but can also have an influence on the turnout as punishing can either result in voting for another person or party or in deciding not to vote at all.

The second model is closely linked to the first one and follows the same idea but focuses more on the selection of the right person or party than on sanctioning them. Described by Fearon (1999), citizens act retrospectively by looking at the former performance of a person. If they evaluate the performance as bad, they have the possibility to choose between the same person or party or another person without knowing about their future performance (Persson & Tabellini, 1997). Again, this can have an influence on voter turnout because voters who are

afraid of voting a person without knowing about this person's performance in the future, will probably abstain from voting.

The third model uses a different approach, employing behavioural economics. Referring to the first two models, deciding if and how to vote requires an understanding of the political landscape as well as a certain level of cognitive competence to evaluate all aspects. If this appears too difficult to voters, they are tempted to refer to shortcuts because this is the easier way (Healy & Malhotra, 2013). One shortcut could be to consider only the economic situation in the last year before the election instead of all years during the election period or to not reflect about their own values, but to vote in accordance with the popular opinion on a topic (Achen & Bartels, 2004). In the end, this also leads to a reward or punishment of current politicians and can result in lower turnout.

3. Blind and mediated retrospection

As shown by the three models above, retrospection can be done in different ways, focusing always on a specific aspect. Besides from this focus, two types of retrospection can be distinguished by looking at the amount of rationality applied by citizens. First, voters can act blind retrospectively by making the government responsible for their own negative status of any kind (damage, pain, loss) and therefore punishing them even if there is no rational reason to punish them because the government can – thinking rational – not be made responsible for the negative status. This decision is taken first and then justified by any possible

constructed explanation. A quite illustrating example for this way of thinking are the shark attacks in New Jersey between 1912 and 1916 which led to a decrease in the vote shares of the governmental party during the election in 1916. Blaming the government for the shark attacks cannot be seen as a rational act because shark attacks can only be stopped by prohibiting to swim in the ocean, but as long as citizens decide to swim in the ocean there is no way the government can successfully prevent shark attacks (Achen & Bartels, 2004). Applying this to the experience of a natural disaster, citizens acting blind retrospectively only take their personal consequences, for example loss of jobs or high financial losses, of the natural disaster in account.

Voters acting mediated retrospectively focus on implemented political responses related to the natural disaster rather than on their own status caused by the disaster (Fiorina, 1981). After a flood, political responses may be financial aid for individuals as well as companies, organizing temporary housing or coordinating volunteer workers. As a result, blind retrospective voting will lead to less political support because the natural disaster will have negative consequences whilst mediated retrospective voting can also lead to more support depending on the quality of the implemented political responses (Rubin, 2019). Even if the natural disaster led to negative impacts for citizens, the implemented political responses could be evaluated positively. In addition, one has to bear in mind that blind retrospection and mediated retrospection do not exclude each other and are often mixed (Rubin, 2019).

4. The concept of voter turnout

As natural disasters are a very special factor influencing voter turnout a basic understanding on the factors influencing voter turnout in general besides from the idea of retrospective voting is provided.

According to Jackman (1987), five factors are relevant: “nationally competitive districts, electoral disproportionality, multipartyism, unicameralism and compulsory voting”. Nationally competitive districts are increasing voter turnout because if there was no real competition in a district, all parties besides from the leading one in that district, would not have any incentive to increase voter turnout. But as there is competition in most of the districts, it is in their personal interest to increase turnout and their voting shares in all districts (Jackman, 1987). Electoral disproportionality is a result of the specific voting system linked to the difference in size of voting districts because only equal-sized districts would produce perfectly proportional results (Blais, 2006). Multipartyism seems to be self-explaining, referring to the existence of two or more parties. Unicameralism is given when the political system is built up upon one chamber as the only legislature (Jackman, 1987). In Germany, the first three factors (nationally competitive districts, electoral disproportionality and multipartyism) are given. Unicameralism and compulsory voting are not applicable. Therefore, according to Jackman, turnout is generally expected to be high in Germany because three of five requirements are applicable.

Later on, voting age and legislative rules with the goal to make voting as easy as possible, for example by offering postal voting, were found to also influence voter turnout (Blais, 2000). For example, Gimpel and Schuknecht (2003) found that turnout is increased or decreased depending on the degree of accessibility of the voting place. In addition to these factors, the socioeconomic environment also influences voter turnout. Especially, the economic development of the district influences voter turnout (Blais & Dobrzynska, 1998).

But those are not the only factors influencing voter turnout decision. In a recent study, Blais and Aachen (2018) conclude that apart from all the factors mentioned above related to the voting system mainly two factors are important for this decision, namely either the sense of a civic duty which is kind of an ethical decision or a “strong political preference” as an expressive decision (Blais & Aachen, 2018).

In addition, demographic aspects are influencing turnout. The so-called *age conservatism hypothesis* gives an explanation for higher turnout rates under elderly because as a result of the so-called *life-cycle effect*, stating that peoples’ life-cycles influence their specific turnout probability, elderly are used to the political system and to voting specifically (Konzelmann, Wagner & Rattinger, 2012). In Germany, the percentage of “older voters is steadily rising” referring to demographic developments (Konzelmann, Wagner & Rattinger, 2012). According to the life-cycle effect, turnout should therefore rise over time.

Besides from all these effects influencing individuals, events may also influence elections, more on the general than on the individual level. Examples are pandemics or national or international scandals involving politicians (Konzelmann, Wagner & Rattinger, 2012). The most ubiquitous topic in 2020 and 2021, influencing nearly every decision on every level, was the Covid-19 pandemic, being a national and international topic and therefore influencing the federal elections in 2021.

III. Relationship between natural disasters and electoral participation

After giving a short introduction regarding the general idea of retrospective voting, this concept is linked to natural disasters.

According to the rational choice theory – telling us that people will act fully rational and will choose the option with the highest utility or greatest benefit to them (Aldrich, 1993) – we would expect natural disasters to decrease the turnout because costs of voting are increased by the natural disaster, for example because people cannot reach the voting poll as easily as before (Bodet et al., 2016). This idea is confirmed by studies examining the impact of rain or other bad weather conditions on voting day, for example Fujiwara and Meng and Vogl (2016) who examined rainfall on election days in the US concluding that this will decrease voter turnout.

But this is only one side of the coin. Some studies found a positive relationship between natural disasters and electoral participation. This can be mainly explained by two kinds of psychological impacts. Either there could be a “direct psychological impact” on affected people (Jenkins, 2019), leading to a general increase in social behaviour and therefore leading to higher electoral participation. On the other hand, the relationship could be less individualistic, but more general and probably to some extent coincidentally (Jenkins, 2019). For example, Fair et al. (2017) came to the conclusion that the flood in Pakistan lead to higher political engagement, but not because of pro-social behaviour of affected people, but more because citizens were reminded of the importance of governmental institutions and their actions in their lives as they responded to the damages caused by the floodings.

IV. Previous work related to natural disasters and electoral participation

Many studies have been conducted to observe the influence of natural disasters on elections. To provide background information related to my research question, I am going to focus on studies observing the relationship of natural disasters and voter turnout. Thinking intuititvely, one would expect some kind of influence, either positive or negative, therefore studies finding no connection at all seems surprising at first glance. According to Bodet et al. (2016), such a connection cannot be confirmed, but they admit that their study design operates with low levels of turnout which is why the result could be biased. Remmer (2014) confirms this result and sees no effect between natural disaster and voter turnout.

Some studies report a negative relationship between the natural disaster and voter turnout. Sinclair, Hall and Alvarez (2011) conclude that there is no “linear relationship” between the natural disaster and the turnout, they even found that turnout is the highest in areas affected most by the natural disaster. Rudolph and Kuhn (2017) observed the effect of floodings in Germany in 2002 and 2013, showing a negative effect as well.

Finally, some studies find a positive relationship between natural disasters and voter turnout. Fair et al. (2017) studied the floods in Pakistan in 2010 and 2011 and found a “substantially” higher turnout after the floodings. The same applies for Jenkins (2019) studying the triple disaster – an earthquake leading to several tsunamis causing damages in three prefectures – in Japan in 2011. He concludes with a positive relationship, but the effect seems to be much smaller than in previous studies.

Looking at these contrary results, one might conclude that there is not a single explanatory mechanism underlying the relationship between natural disasters and voter turnout, but rather different mechanisms linked to each other and influencing one another (Rudolph & Kuhn, 2017). In the following, I am going to show some of these mechanisms which have possibly influenced the aforementioned study results. First of all, the studies were conducted in different countries, from developing states (Pakistan) to industrialized countries (Germany). As the political landscape and political stability vary enormously between different countries, this seems to influence the results (Rudolph & Kuhn,

2017). Secondly, habit formation could influence the results. According to Fujiwara et al. (2016), exogeneous shocks related to an election will not only influence this election, but also future elections. For example, if a voter would not be able to vote because of a flood this will influence his voting behaviour in following elections because he builds up a voting habit. This could especially play a big role in areas where floodings or other natural disasters appear frequently. Thirdly – as stated above – another explanation could be the difference between study settings. Since Bodet et al. (2016) observe districts with very low turnout levels, this underlying study premise differs significantly from the one Rudolph and Kuhn (2017) observe in German elections with comparatively high levels of turnout. Fourthly, Fair et al. (2017) assess the effect highlighting the importance of the ex-ante flood risk. This is again a district-specific factor that must be accounted for as higher ex-ante flood risks can lower the effect of floodings on voter turnout because citizens are more used to floodings and their consequences.

V. Postal vote

In the following, the concept of postal vote and the expected impact of natural disasters on postal vote share is introduced. Postal vote is defined as casting a vote via postal services instead of voting at the polling station.

Postal vote share and natural disasters are connected in different ways. First of all, the obvious consequence of most natural disasters is the loss of relatives or

housing, leading to a lot of reconstruction work and other (organizational) obligations. Therefore, if an election takes place shortly after a natural disaster, people are often not able to reach the poll or they prioritize other things, for example the reconstruction of their housing over voting. This would then result in a decrease of turnout. But as the consequences of the natural disaster are mitigated, people are expected to prioritize political participation again, leading to an increase in postal vote share as this is the easier way because people do not have to reach the poll physically and they are not bound to a fixed date. Rudolph and Kuhn (2017) observed an increase of the postal voting share in Saxony after the flood in 2002, where the timespan between the flood and the federal election was only two to seven weeks, depending on the exact location.

Secondly, a closer look at the procedure of postal voting in Germany must be taken to assess the expected effect of a natural disaster. The German postal voting process consists of different steps. First, citizens must request postal voting documents in their local community, either by going there physically or by sending a written request. After the local community received this request, the documents will be sent to the requesting citizens via postal services. These documents consist of a ballot paper, a polling card and two envelopes (Heinl, Gölz & Bösch, 2021). After filling in the ballot paper, all documents need to be returned to the local authorities, either by bringing them physically or by using postal services (Heinl et al., 2021). In comparison to voting at the poll, postal voting consists of two acts that must be completed by the citizens, application for postal voting and returning voting documents. Voting at the poll consists only of the voting itself, as the required documents are sent automatically to all eligible

voters. After a natural disaster, citizens are often not able to apply in person for postal voting because of destroyed infrastructure. They may also not be able to apply using postal services because postal services are often not working shortly after natural disasters. For these cases, the postal voting system allows requesting postal voting documents either via e-mail or requesting them for another person using a written authorization (Heinl et al., 2021). Flood victims may therefore ask a third person to apply for postal voting in their names. As the written authorization must be an original document (Heinl et al., 2021) and might not be copied, this solution still bears the same problems as when applying on their own for postal voting documents. In comparison to voting at the poll, postal voting is therefore – even with the difficulties regarding applying for postal voting directly after a natural disaster – the easier way because voting at the poll requires going there personally. Therefore, postal voting shares are expected to increase due to the flood.

D. Empirical analysis

The research question is answered by taking a closer look at the unprecedented floods affecting Germany on 14th and 15th of July in 2021.

I. Flood 2021/election 2021

On 14th of July 2021, heavy rainfall – to be exactly: the double amount of the monthly precipitation (Belleflamme, Goergen, Iakunin, Vanderborght & Kollet,

2021) hit parts of Rhineland-Palatinate, North Rhine-Westphalia, Saxony and Bavaria and caused the most disastrous natural disaster since the storm surge in Hamburg in 1962 (Federal Ministry of the Interior and the Community, 2022). The enormous disastrous power of this natural disaster can be basically explained by two factors: Firstly, the soil in the affected areas was – already before the rainfalls – nearly saturated because of earlier rainfalls and dense building development and secondly, the most affected area, the so-called Ahrtal, contains narrow valleys with steep slopes resulting in harsh torrents (Federal Ministry of the Interior and the Community, 2022). These effects of the floodings, especially the significant erosions caused by rushing waters, are not part of common hydrological models predicting flood risks (Dietze & Ozturk., 2021) which is probably the reason for the enormous damages caused. The floodings led to damages in the amount of 12.3 billion Euro in North Rhine-Westphalia and to damages in the amount of 18 billion Euro in Rhineland-Palatinate. Saxony and Bavaria were affected less, resulting in damages in the amount of 298 million Euro in Bavaria and 256.1 million Euro in Saxony (Federal Ministry of the Interior and the Community, 2022). In addition, 180 people died because of the floodings (Tagesschau, 2021).

The affected districts are shown in this map:

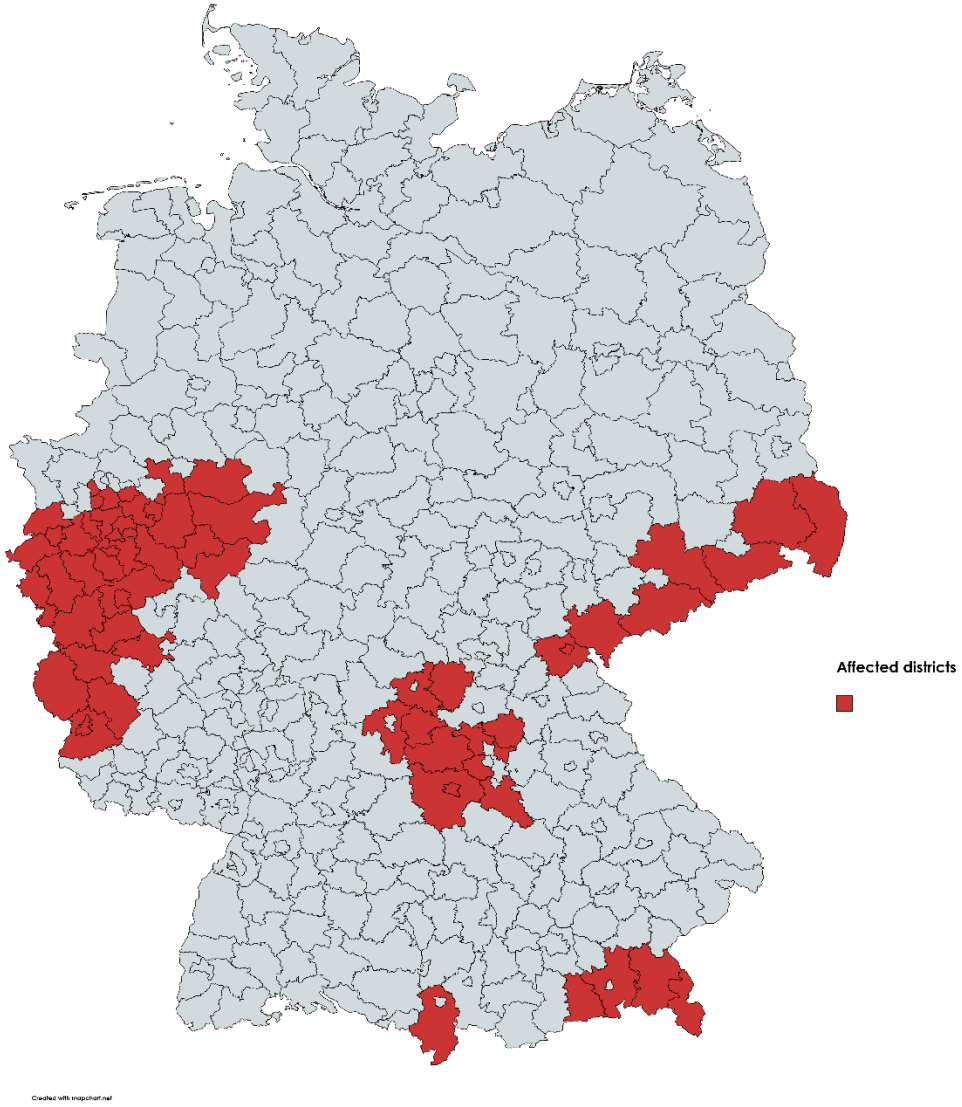

Figure 1: Flood extent in Germany; own figure created with mapchart.net using the data of the Federal Ministry of Interior and the Community (2022).

These high damages are the result of problems regarding Flood Risk Management before and during the flood. Flood Risk Management consists of four priorities. Firstly, citizens need to understand the risk of a natural disaster. In the flooded areas, people did not believe neither in a high probability for a natural

disaster nor in the predicted flood levels (Fekete & Sandholz, 2021). Secondly, authorities must “strengthen disaster risk governance” (Fekete & Sandholz, 2021) to handle the consequences of the natural disaster. During the floodings in 2021, the authorities experienced big difficulties in managing the enormous number of voluntary helpers (Fekete & Sandholz, 2021). This resulted in frustration among the flood victims and resulted in delaying the reconstruction of houses and infrastructure. The third priority in Flood Risk Management is to invest in disaster risk reduction. In Germany, early warning systems were not implemented broadly because they were seen as an unnecessary investment. Therefore, warning citizens in an appropriate way before the flood, was impossible. In addition, on the individual level, many citizens were not insured against natural disasters, leading to high investments of households for reconstruction (Fekete & Sandholz, 2021). The fourth and last priority is increasing preparedness for future disasters. This priority was probably the most underestimated and therefore the one leading to most of the problems during the flood. Before the flood, the dependency on critical infrastructures as power and communication was underestimated as well as the time needed to reconstruct critical infrastructures (Fekete & Sandholz, 2021). In addition, flood protection usually focuses on big rivers rather than on smaller streams because of the high damages expected after a flood of a big river. During the flood in 2021, many small streams without a concept for flood protection were affected and led to unexpected damages (Fekete & Sandholz, 2021). Due to these many lacks in effective Flood Risk Management, the floodings resulted in high personal and infrastructural damages.

Shortly after the floodings, the German Federal Agency for Technical Relief (*Technisches Hilfswerk*) started working on the reconstruction of damaged buildings and provided emergency help, for example electricity, clean water or emergency housings. Every day, 1.000 to 3.000 emergency task forces were on duty and provided emergency help until December 10, 2021, which resulted in the biggest mission in the 70-year long history of the German Federal Agency for Technical Relief. Additionally, 60.000 man-service-days of federal forces were employed to evacuate citizens and to make technical devices as power generators available to the affected citizens (Federal Ministry of Interior and the Community, 2022).

Regarding financial aid, different means were employed. First, the federal states decided to provide emergency financial aid to affected citizens. The Federal State of Germany decided to bear half of these costs. To facilitate the reconstructions in the long run, the Federal State of Germany additionally created a solidarity fond with a volume of up to 30 billion Euro (Federal Government, n.d. - 1). Affected citizens, companies and public institutions might apply for payment, amounting up to 80 per cent of their damages. In special cases, for example if infrastructure is affected or the damages threaten the existence of a company, the payment can amount up to 100 per cent of their damages. The payments out of this fund are coordinated and conducted by the state officials (Federal Government, n.d. - 2).

Looking at the provision of financial aid, it becomes clear that aid was not only provided locally by the affected states, but also by the Federal State of Germany.

This cooperation is the result of federalism and the reason why an effect on federal elections can be expected. Financial aid plays a massive role in the rehabilitation after natural disasters. As shown above, the Federal State of Germany provided massive amounts of financial aid and can therefore be seen responsible for the political reactions to the flood.

Parliamentary elections took place in Germany on September 26, 2021, about ten weeks after the disaster. Because of this short time span, an impact on voter turnout is to be expected sincecitizens were able to take the reaction of the Federal State of Germany and the states into account when deciding to vote or not to vote. Additionally, ten weeks seem to be long enough to mitigate effects on voter turnout because of relocation due to the disaster. Under normal circumstances, one can expect citizens to be able to vote again, either by going to the poll or by postal vote, ten weeks after the disaster.

Parliamentary elections on September 26, 2021, were the first federal elections in Germany conducted after the beginning of the Covid-19 pandemic in 2020. Due to social distancing, postal voting shares are expected to increase since postal voting mitigates the spread of the virus at the voting poll.

II. Data

1. Empirical Research Design

Speaking in econometric terms, the flood can be seen as a so-called “treatment”. If one would only compare voter turnout in the affected districts before and after the flood, the result would be distorted because factors influencing voter turnout besides from the flood could have changed in the meantime. To overcome this problem, the flood is seen as a treatment in a treatment group – the affected districts – and compared to voter turnout in a group without the treatment – the so-called control group. By comparing the difference in voter turnout before and after flood in the control group with the difference in the treatment group, so-called “difference-in-differences” are observed, naming this strategy the “difference-in-differences”-approach (Lee, 2016).

The treatment group consists of all districts in Germany affected by the flood on July 14 and 15, 2021. Building a control group requires to find a group being as similar as possible in comparison to the treatment group (Goodman-Bacon & Marcus, 2020). Districts differ in many dimensions, for example geographical, social, financial and political dimensions. Assuming that districts located close to each other are similar to each other, at least in some dimensions, control groups were built by using districts located next to the affected districts. As 7 districts or district-free cities in Rhineland-Palatinate were affected by the flood, I decided to build a control group for these districts or district-free cities by taking the 7 districts district-free cities located next to the affected districts. The same applies to Saxony where 5 districts or district-free cities were affected and the 5 closest districts or district-free cities were taken as control group. In North Rhine-Westphalia another strategy had to be employed because 30 out of 52 districts or district-free cities were affected. Therefore, only 22 districts or district-free

cities could be taken as control group. An extension to one of the neighbouring states, for example Hesse, would have been possible but due to the distance between the affected districts or district-free cities and the northern border of North Rhine-Westphalia already being big, I did not want to extend the distance even more which results in a control group consisting of 22 districts or district-free cities in North Rhine-Westphalia that are not neighbouring states of the affected districts. In Bavaria, the 18 affected districts or district-free cities are divided between South and North of the State as 13 of them are located in the North and 5 of them are located in the South of Bavaria. Therefore, the control group consists of the 13 districts or district-free cities located closest to the affected states in the North and of the 5 districts located closest to the affected states in the South. Since the affected districts or district-free cities in the North of Bavaria are close to the Bavarian Border, only districts or district-free cities located in Bavaria are part of the control group to mitigate effects resulting out of different states, for example differing financial support for citizens or differing social benefits.

Treatment and control groups are shown in the following graphic.

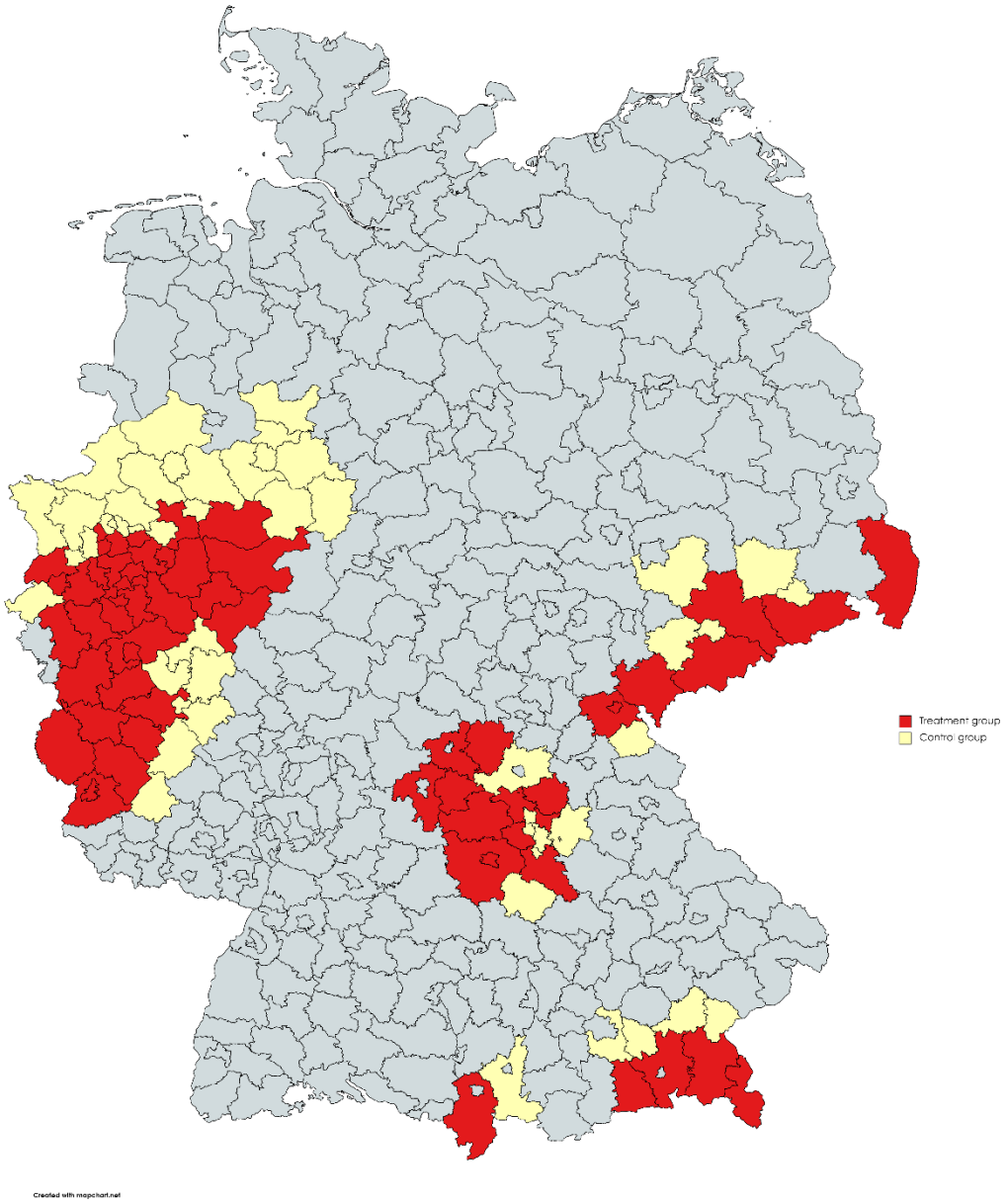

Figure 2: Treatment and control group; own figure created with mapchart.net using the data of Federal Ministry of Interior and the Community (2022) for the treatment group; the red districts are part of the treatment group, the yellow districts are part of the control group.

2. Collection of Data

The collection of data consisted of two parts: firstly, data regarding Hypothesis 1 (voter turnout and control variables) and secondly, postal vote shares to assess Hypothesis 2 were collected.

a. Hypothesis 1

Data regarding voter turnout during the federal election in 2021 and – for the comparison and the difference-in-differences strategy – regarding voter turnout in the federal elections in 2017 stem from the publicly available website of the statistical offices of the states and the federal republic of Germany (https://www.statistikportal.de/de/datenbanken). The databases also contain data regarding the control variables (logged population, unemployment rate, eligible voters and logged brute income). Those control variables were chosen according to the voting theory and research regarding the influence of specific factors on voter turnout (Rudolph & Kuhn, 2017).

Regarding logged population, the newest available data originates from December 31, 2020. The data on the unemployment rate display the unemployment average of 2021. Therefore, there should be no distortion because the population does not change heavily in one year. The same applies to the data on logged brute income originating from 2019. In reference to the article of Rudolph and Kuhn (2017), the percentages of young and old citizens should have been added as control variable as well. Unfortunately, the latest available German data originates from the last census which took place in 2011.

Since the population has changed massively in the last 10 years, using this data would have distorted the results because the population data originates from 2020.

Regarding the control group, data stem from the same source (the publicly available website of the statistical offices of the states and the federal republic of Germany (https://www.statistikportal.de/de/datenbanken)).

b. Hypothesis 2

The data regarding Rhineland-Palatinate stem from the statistical office of Rhineland-Palatinate (Statistical office Rhineland-Palatinate, 2021b), data regarding North Rhine-Westphalia stem from the State Returning Officer of North Rhine-Westphalia (State Returning Officer of North Rhine-Westphalia, 2021), data regarding Bavaria stem from the Statistical Office of Bavaria (Statistical Office of Bavaria, 2021; Statistical Office of Bavaria, 2017) and data regarding Saxony stem from the Statistical Office of Saxony (Statistical Office of Saxony, 2021; Statistical Office of Saxony, 2017).

For North Rhine-Westphalia and Saxony, postal vote shares are not available, but shares of voters voting with a ballot paper are. Therefore, the postal vote share is approximated by using these data because a ballot paper is only provided upon request and is required to make a postal vote (The Federal Returning Officer, 2015b). Theoretically, it would be also possible to vote in the

polling station after requesting a ballot paper, but as the ballot paper requires a specific request and casting a vote in the polling station would be also possible without a ballot paper, the percentage of people acting like this is negligible and the share of votes by using a ballot paper seems to be a suitable approximation.

In addition, data on voters voting with a ballot paper or by postal vote in Bavaria, North Rhine-Westphalia and Saxony is only available regarding electoral districts, but not regarding local districts. As electoral districts differ from local districts and electoral districts sometimes consist of two or more combined local districts, this research will only focus on the electoral districts which comprise exclusively affected districts or non-affected districts and does not contain electoral districts comprising affected and non-affected districts since this would distort my result.

Data regarding North Rhine-Westphalia, Saxony and Rhineland-Palatinate is only available since 2017. Therefore, my analysis is based only on data from 2021 compared to data from 2017.

c. Excluded districts

Regarding Hypothesis 1, the district of Bautzen could not be included because Bautzen is divided into two electoral districts (Bautzen I and Dresden-Bautzen II). As the second electoral district contains Dresden and Dresden is neither part of the treatment nor part of the control group, including this electoral district would have distorted the result. In addition, the unemployment rate as control variable

was not available for the districts of Chemnitz, Leipziger Land and Zwickau. Since voter turnout for the district of Aachen is not publicly available, this district was excluded from the analysis.

Regarding Hypothesis 2, many districts could not be included in the analysis because in some states postal vote share data is only available regarding electoral districts and electoral districts differ from local districts. Therefore, only electoral districts comprising treatment group districts or control group districts exclusively are part of the analysis. Electoral districts comprising treatment group districts and control group districts are not part of the analysis because this would have distorted the result. The Treatment and Control Group are listed in appendices 3 and 4.

3. Analysis

a. Summary Statistics

Summary Statistics for all variables are attached in Appendix 5.

b. Hypothesis 1

A difference-in-differences analysis can be defined as “a causal identification strategy that identifies the effect of a given treatment by finding the difference in

the outcome variable between the treatment and the control group in two or more time periods" (Jenkins, 2019). Calculating the treatment effect is possible by using linear regression analysis. The treatment effect is estimated by "the estimated coefficient on the interaction of a treatment group dummy and a post-treatment group dummy" (Goodman-Bacon, 2021) and leads to the following equation

$$Y_i = \beta_0 + \beta_1 * P_i + \beta_2 * T_i + \beta_{DiD} * P_i * T_i + X_{i\beta} + \varepsilon_i$$

whereas P_i equals the post-treatment period, referring to voter turnout during the federal election in 2021, T_i refers to the treated group - the affected districts - and $X_{i\beta}$ is a vector for the additional control variables.

Linear regression has four requirements: multicollinearity, homoskedasticity, normality and no auto correlation. These requirements need to be fulfilled to perform a linear regression analysis.

First of all, there should be no multicollinearity between variables. Multicollinearity is given if there is a linear relationship between two or more variables, resulting in a high correlation between them (Jensen & Ramirez, 2013). I tested multicollinearity by using the so-called Variance Inflation Factor (VIF), leading to values of 2.39 for year, 2.00 for flood and 3.39 for interaction. Since all of these values are below 5 (Jenkins et al., 2013), there is no multicollinearity.

Secondly, linear regression requires homoskedasticity. The data shall not be heteroskedastic which is Greek for not equally scattered (Collins Dictionary, n.d. - 1). Therefore, heteroskedasticity is given in case of a differing error variance (Kutner, Nachtsheim & Neter, 2004). I tested heteroskedasticity with the Breusch-Pagan-Test (Breusch & Pagan, 1979), using the stata command “hettest”, leading to a p-value of 0.8568. As this result is bigger than 0.05, H_0 equalling heteroskedasticity in the model, can be rejected.

Thirdly, normality is required. Normality refers to the normal distribution of data and can be tested with the Shapiro-Wilk-Test (Shapiro & Wilk, 1965), leading to a p-value of 0.05263, confirming normality.

The last requirement is auto correlation, tested with the Durbin-Watson Test (Durbin & Watson, 1950), leading to a d-statistic value of 1.545219. As this value is close to 2, the requirement is fulfilled.

All results of those tests are listed in Appendix 6.

In conclusion, regarding Hypothesis 1, all requirements for a linear regression are fulfilled.

The regression analysis was run in Stata. The regression was done by using robust standard errors. Robustness can be defined as “insensitivity to small deviations from the assumptions made” (Huber, 1996). The quality of a regression analysis shall not be diminished because of small deviations.

Therefore, robust standard errors were used to mitigate the effects of small deviations.

In addition, difference-in-differences analysis requires the fulfilment of the so-called Parallel Trends Assumption. Difference-in-differences analysis examines the difference in the treatment group over two or more time periods by comparing this difference to the difference in the control group in the same periods. The result will only be correct if the outcome in the treatment group and in the control group would have been the same without the treatment, meaning without the flood (Callaway & Sant'Anna., 2021). Without this assumption, high differences can arise between the output in the treatment and in the control group, but their origin cannot be found, as this can be a factor not linked to the treatment. The Parallel Trends Assumption can be tested by comparing two or more data points before the treatment. Therefore, I will compare turnout in the treatment and control group during with respect to the federal election in 2013 and the federal election in 2017.

Summarizing the turnout in Stata for the treatment group during the federal elections in 2013 and 2017, bears the following result:

Variable	Obs	Mean	Std. Dev.	Min	Max
turnout2013	62	71.26721	3.479717	60.1	78.2
turnout2017	62	76.63115	3.036313	69.3	83

For the control group, summarizing returns this result:

Variable	Obs	Mean	Std. Dev.	Min	Max
turnout2013	45	71.34091	3.436457	65.2	79.1
turnout2017	45	76.02955	3.405182	68.2	84.1

The Parallel Trend Approach is satisfied, if the trend of voter turnout before the treatment is the same in the treatment group and in the control group. Looking at the mean of the variables, the treatment group and the control group increase from a mean of 71 % in 2013 to a mean of 76 % in 2017, implying the same trend. The Parallel Trend Assumption is therefore satisfied.

c. Hypothesis 2

Regarding Hypothesis 2, linear regression could also be an appropriate way of analysing data. Therefore, the same tests are applied to the data used for the regression analysis in Hypothesis 2. The Variance Inflation Factor equals 1.22 for year, 1.15 for flood and 1.36 for interaction. As all these values are below 5, there is no multicollinearity. The Breusch-Pagan test leads to a p-value of 0.0001 equalling the confirmation of heteroskedasticity. Therefore, the requirement of homoskedasticity is not fulfilled.

The Shapiro-Wilk test leads to a p-value of 0.0001. This means, normality cannot be confirmed. The Durbin-Watson Test leads to a d-statistic value of 0.7617072. This means, the requirement of auto correlation is also not fulfilled.

All results of these tests are listed in Appendix 5.

Therefore, only one requirement for linear regression is fulfilled regarding the data used for the regression analysis in Hypothesis 2 which means that linear regression cannot be used in Hypothesis 2.

Besides from linear regression, there are many models for non-linear regression, for example logarithmic regression or growth modelling. Non-linear regression assumes that there is no linear relationship between the dependent and the independent variable, but some kind of non-linear relationship. This is the case for the data used in Hypothesis 2 as shown above. In the following, I will analyse these data by use of logarithmic regression, also known as linear regression with logarithmic transformation of variables (Benoit, 2011).

Regarding data used for Hypothesis 2, the “problematic” variable, equalling the badly skewed variable making linear regression impossible, must be the postal vote share as all other control variables are used in Hypothesis 1 as well. Consequently, I will use a so-called log-linear model which can be described as a linear model with a logarithmic transformation for the dependent variable – which is postal vote shares.

The model can be specified as

$$logY_i = \beta_0 + \beta_1 * P_i + \beta_2 * T_i + \beta_{DiD} * P_i * T_i + X_{i\beta} + \varepsilon_i.$$

As I conduct a Difference-in-Difference analysis regarding postal vote shares as well, the Parallel Trend Assumption must be satisfied. Therefore, I compare postal vote shares in 2013 and 2017 in the treatment and control group. Unfortunately, data regarding postal vote shares is not available for the federal election in 2013 regarding the states Rhineland-Palatinate and Saxony. The Parallel Trend Assumption is therefore only tested in North Rhine-Westphalia and Bavaria.

Regarding the data for Hypothesis 2, summarizing the postal vote shares in the treatment group during the federal elections in 2013 and 2017 renders the following results in the treatment group:

Variable	Obs	Mean	Std. Dev.	Min	Max
year2013	26	28.276	4.30224	20.5	37.51
year2017	26	32.87866	4.30507	24.3	45.66

The result for the control group is the following:

Variable	Obs	Mean	Std. Dev.	Min	Max
year2013	14	28.82231	6.152718	21.1	40.12
year2017	14	32.08692	6.01732	23.45	43.6

Comparing the mean, we observe again the same trend in the treatment and the control group, increasing postal vote share from 28 % in 2013 to 32 % in 2017.

Therefore, the Parallel Trends Assumption is satisfied for the data used for Hypothesis 2.

d. Empirical findings

Hypothesis 1

```
Linear regression                               Number of obs     =        210
                                                F(3, 206)         =       1.72
                                                Prob > F          =     0.1645
                                                R-squared         =     0.0242
                                                Root MSE          =     3.4193
```

turnout	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
year	.8475	.7803823	1.09	0.279	-.6910601	2.38606
flood	.6016021	.6501652	0.93	0.356	-.6802289	1.883433
interaction	.0410246	.9756995	0.04	0.967	-1.882613	1.964662
_cons	76.02955	.5183105	146.69	0.000	75.00767	77.05142

Table 1 - Stata Output of the Linear Regression Analysis

Table 1 presents the results of a Linear Regression run with Stata. Whilst voter turnout is the dependent variable, the variable year shows 1 when using data of 2021 and 0 when using data of 2017, the variable flood displays 1 when the district was flooded during the floodings in July 2021 and interaction shows 1 when the district was flooded and we observe data from 2021. The number of inhabitants, the number of eligible voters, the average unemployment rate and the brute income of households were used as control variables.

Linear Regression leads to a p-value of 0.1645. The p- (abbreviation for probability) value shows whether the relationship between the dependent and the independent variables is significant. Significancy is given, if the p value is 0.05 or even lower. If this is not the case, the null hypothesis, namely the hypothesis that there is no relationship between the dependent and the independent variables, cannot be rejected, leading to the result that a relationship cannot be confirmed (Alexopoulos, 2010). Secondly, a p-value higher than 0.05 can tell that there is no linear relationship between the variables and a non-linear regression should be used (Alexopoulos, 2010). Testing logarithmic transformation of either the dependent variable, the independent variables or both of them, also leads to p-values around 0.165, far higher than 0.05. As the requirements for linear regression are fulfilled, this seems to be the model with the relative best fit. Secondly, the p-values for flood (0.356) and year (0.279) are higher than 0.05, showing that neither year nor flood are statistically significant related to voter turnout. This is in line with the result of Bodet et al., (2016) who could also not find a statistically significant relationship between a natural disaster and voter turnout. They highlight the problem of poor data and control groups that were not chosen in a correct manner.

Hypothesis 2

Linear regression

Number of obs	=	124			
F(3, 120)	=	68.71			
Prob > F	=	0.0000			
R-squared	=	0.5732			
Root MSE	=	.2253			

lnpostalvo~e	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
year	.5322781	.0495344	10.75	0.000	.4342034	.6303527
flood	.0266158	.0477781	0.56	0.579	-.0679816	.1212132
interaction	-.0747788	.0538472	-1.39	0.167	-.1813925	.031835
_cons	3.394396	.0404788	83.86	0.000	3.31425	3.474541

Table 2 - Stata output of Linear Regression Analysis with logarithmic transformation

Table 2 presents the results of a Linear Regression Analysis with logarithmic transformation run with Stata. The dummy variables year, flood and interaction were used in the same way as in Hypothesis 1. In addition, the same control variables (number of inhabitants, number of eligible voters, average unemployment rate and the brute income of households) were used.

The p-value in this Linear Regression Analysis with logarithmic transformation is 0.00, showing a statistically significant result. As the p-values for year, flood and interaction show, only the variable year has a statistically significant impact on the postal vote share. The coefficient of 0.5322781 reveals – when the logarithmic transformation is considered – a change of 19.49 % on average in the postal vote share between 2017 and 2021. This is a statistically significant result because the 95 % Confidence Interval does not contain zero.

An increase of 19.49 % on average is quite high. Thinking of other factors that could have influenced postal vote share – besides from the flood – Covid-19 plays a role. The federal elections in 2021 were the first German federal elections after the beginning of the pandemic. Because of social distancing rules, individual fears of getting infected and solidarity, higher postal vote shares were to be expected. This expectation was already confirmed in state elections, for example in Rhineland-Palatinate, where the postal vote share in 2021 was 65.9 % in comparison to 30.6 % in 2017 (Statistical Office Rhineland-Palatinate, 2021a). The same trend could be seen in Baden-Wurttemberg, where the postal vote share increased from 21 % to 51.5 % from 2016 to 2021 (Baden-Wurttemberg Center for Political Education, n.d.). Therefore, an overall increase in the postal vote share could be expected.

III. Limitations

Regarding Hypothesis 2, Covid-19 seems to influence the result strongly. As the last federal election in 2017 took place before the pandemic, control data did not include this factor. It would have been possible to use data regarding elections on state level during the pandemic, but because state elections have a different meaning and weight in society than federal elections, distortions in the result due to this fact were to be expected.

Another limitation results out of the timespan between the natural disaster and the election day, which was about 10 weeks. Regarding reconstruction of houses

and villages, 10 weeks seem to be a quite short period of time, but regarding emergency measures to save peoples' life and to make them able to cast a vote, either at the poll or by postal vote, 10 weeks seem to be quite long. This is an advantage for the data used in Hypothesis 1 since after 10 weeks people should normally be able to cast a vote again. Regarding Hypothesis 2, this is a great disadvantage because after ten weeks the probability for people being able to go to the poll again is quite high and we therefore cannot expect a statistically significant effect regarding postal vote share.

E. Policy Implications

As shown above, the floodings in July 2021 had no significant effect on voter turnout or postal vote share in the federal election in September 2021. But as this theses only focuses on one specific natural disaster, the effect of more than one natural disaster and different natural disasters on voter turnout remain open. Natural disasters differ in their extent and their timing and can therefore have a significant effect on voter turnout (Bodet et al., 2016). The voting system should therefore be prepared to upcoming natural disasters as their frequency will rise because of climate change. In the following chapter, I want to highlight problems in the electoral systems and possible solutions.

I. Postal voting in Eastern Germany

Comparing postal vote shares, the differences between Western Germany and Eastern Germany become clear. Whilst the postal vote share in 2021 in the affected districts in Western Germany was 54 % on average, the average in the affected districts in Eastern Germany was only 34 %. The same effect can be observed in the control groups, implicating that the flood had no significant effect on postal vote shares, but that postal vote shares are lower in Eastern Germany in general.

Lower postal vote shares can be the result of a lack of acceptance of postal voting. In case of a lack of acceptance, postal vote shares will remain low when a natural disaster occurs, leading in total to lower turnout because polling stations might not be reachable because of the natural disaster. Thinking of possible explanations for this lack of acceptance, the "lack of democratic experience" (Neugart et al., 2021) regarding citizens in Eastern Germany might be the biggest problem. This problem is expected to shrink over time but will remain a problem in the upcoming years. Therefore, postal voting should be promoted after natural disasters especially in Eastern Germany.

II. Security concerns regarding postal voting

In addition to the lack of trust in postal voting in some parts of Germany, general security concerns regarding postal voting must be considered. Promoting postal

voting cannot be the one and only solution in case of natural disasters because it comes with many security concerns. Exemplarily, I will discuss two of them.

First of all, postal voting is prone to fraud. In Germany, postal vote documents might be applied for via email. This allows attackers to use a shipping address differing from the actual registration address of the eligible citizen. In this case, the German Election Law (*Bundeswahlgesetz*) requires sending a notification to the actual registration address to prevent fraud. In some cases, these notifications were sent to the shipping address instead of the registration address and therefore fraud would have easily been possible. Attackers would be even able to cast a vote in the name of another citizen (Heinl et al., 2021).

Secondly, letters containing postal voting documents do not contain security measures – like a seal for example. Therefore, they could be opened by employees of the postal service or the administrative office without the citizen noticing this (Heinl et al., 2021).

To conclude, postal voting should be improved first, for example by implementing additional security mechanisms (Heinl et al., 2021), before it is promoted actively as the one and only solution after natural disasters.

III. Alternatives

As natural disasters may influence voter turnout heavily, alternative methods to secure voter turnout after natural disasters are shown.

1. Remote electronic voting

The biggest problem in securing voter turnout after natural disasters is the lack of accessibility of polling options. If voting polls are not reachable, postal voting is possible, requiring a written or personal application first. If disaster victims are neither able to apply in person nor able to use postal services, internet voting could be a possibility. Internet voting, also known as electronic voting, may include different steps, for example the electronic registration of voters, remote voting or electronic counting of votes (Kersting & Baldersheim, 2004). As mainly the act of voting itself is affected by the natural disaster, I will focus on this part.

Remote voting – referring to casting the vote at home by use of an electronic system – is possible in Germany, according to judgements of the Federal Constitutional Court in 2009 (ref. nos 2 BvC 3/07 and 2 BvC 4/07). Until now, technical possibilities assuring secrecy when using own private Personal Computers have not been developed yet which is why online elections cannot be executed in Germany at this time (The Federal Returning Officer, 2015a). Besides from technical concerns, democratic concerns are highlighted as well. In a survey, citizens highlighted a lack of acceptance of remote voting because of the complexity of the technical process, a lack of transparency because the voting process takes place in the private sphere at home and concerns regarding anonymity of the vote (Fitzpatrick & Jöst, 2022). Therefore, remote electronic voting is not an option today, but might become one in the future.

2. Postponing elections

Another possibility besides the technical aspects of casting the vote itself would be the postponement of elections. In general, regular elections are a manifest part of democracies, even regulated in Article 21 (3) of the Universal Declaration of Human Rights. Therefore, elections may only be postponed if the postponement seems proportionate in comparison to the reason of postponement. Natural disasters as floods might be an acceptable reason of postponement, but still the postponement must be proportionate referring to the facts of the specific natural disaster (James & Alihodzic, 2020). This requires balancing all factors, for example, the timespan between the natural disaster and the extent of damages resulting out of the natural disaster. Regarding federal elections, disproportionality may arise out of the fact that only a small number of electoral districts may be affected by the natural disasters, but the postponement affects all electoral districts. Postponing elections is therefore not always possible in reaction to a natural disaster but can be a possible solution.

3. Voting at different polling stations

Another possibility to secure voter turnout after natural disasters, could be the free choice of polling stations. Because of infrastructural damages, it can be hard for citizens to reach a specific polling station. Having the choice to use another

one at a different location easier reachable after the natural disaster, could increase voter turnout.

In Germany, voting is only possible at a pre-determined polling station. Enabling voters to choose their polling station comes with high transaction costs. For voters, transaction costs are probably the lowest at the chosen station because they will probably choose the most convenient one. Regarding administration, transaction costs are extremely high. First of all, all polling stations need to have a register of all voters. In the most extreme case – if voters would be able to choose their polling station out of all polling stations in the country – each polling station would need a register of all voters in the country. Secondly, polling stations would need to exchange their data regarding voters regularly because otherwise citizens would be able to vote at two or more polling stations. This process comes with very high transaction costs because the exchange needs to be done very frequently and if a person votes twice despite all these efforts, all votes casted in this polling station are invalid leading to enormous transaction costs because the election needs to be repeated.

4. Comparison

Comparing the four alternatives to regular voting at the poll – postal voting, remote electronic voting, postponing elections and choosing the voting poll – requires a view out of different perspectives.

The first point of view is citizens' acceptance. Citizens will only vote if they accept the voting system. Regarding postal vote, the acceptance in Germany seems to be as high as never before. As described in the empiric part of this paper, on average, 51 % used postal vote during the federal election in 2021. As this is more than half of all voters, postal voting seems to be widely accepted. This is not fully true for parts of Eastern Germany as described above, but in general, postal voting seems to be accepted in Germany. A lack of trust in postal services as seen in the US (Menger & Stein, 2019), cannot be detected.

Citizens' acceptance regarding remote electronic voting is lower than regarding postal voting. Since this technology has not been used before in elections, citizens are critical and distanced. They have technical concerns, especially regarding data security and privacy as well as democratic concerns regarding the transparency of voting (Fitzpatrick & Jöst, 2022).

Postponing elections seems to be more accepted by citizens, but there can be a lack of acceptance in political parties because elections require planned preparations of them and these plans would be distorted by a postponement. A lack of acceptance may also arise regarding federal elections, if only a small part of the country is hit by the natural disaster, but the elections are postponed in all voting districts of this country. In this case, postponing elections might be unproportionate. Regarding proportionate postponement of elections, citizens' acceptance is given.

The same reasoning applies to the possibility of choosing the voting poll. This option has only advantages for citizens and should therefore be highly appreciated.

The second point of view is the administrative effort, equalling the transaction costs resulting out of administrative work. Regarding postal vote, the administrative effort consists of sending postal voting documents and counting the returned ones. This effort generates less transaction costs than voting at the polling stations because polling stations require administrative personnel to operate them.

Turning to remote electronic vote, the administrative effort depends on the system used. Imagining a system that works on citizens' private computers, remote electronic voting would probably only require sending out access links to the system. After voting, the system would then count votes automatically. Since privacy concerns arose because of the use of private computers, citizens would perhaps need to use distributed ones. This solution would then come with very high transaction costs.

Postponing elections comes with high administrative efforts and high transaction costs as citizens need to be informed about the postponement, a new voting date must be found, volunteers working at the polling stations have to be obligated again and perhaps also new voting documents have to be sent out. The option with the highest administrative effort is probably the possibility of citizens choosing the polling station out of all polling stations in the country. The

administrative effort to prevent citizens voting twice is very high as well as the transaction costs if a person despite these efforts still voted twice.

The third point of view is related to transparency and data security and is highly connected with citizens' acceptance. Elections deal with personal data requiring high standards of data privacy. Postal voting may only fulfil these standards if the national postal service guarantees data security. As the constitution in Germany contains the right of postal security in Art. 10, this should be guaranteed for postal voting. Regarding remote electronical voting, data security remains a problem because data is processed via the Internet. In addition, the use of personal computers poses a high risk to data security (Fitzpatrick & Jöst, 2022). Postponing elections does not affect transparency and data security because the election is held in the regular manner and just postponed timewise. The possibility for citizens to choose their polling station does also not affect data security and transparency of the election.

Combining these three different points of view leads to the following result: Postal vote is the most preferable alternative because it is accepted by citizens, does not generate unproportionate administrative effort and guarantees data security. In addition, postal voting does not generate high transaction costs. Remote electronic voting is the least preferred option due to a lack of acceptance and security. Transaction costs for remote electronic voting are expected to be low but cannot outweigh the lack of acceptance and the lack of security. Choosing polling stations and postponing the election are in between and should be chosen only if postal voting is not possible.

Summing this comparison up and taking the actual state of data security into account, postal vote is the preferred alternative after a natural disaster.

F. Conclusion

This thesis analyses the effect of the floodings in July 2021 on voter turnout during the federal election in September 2021, finding no statistically significant effect.

The main reason for this is probably the Covid-19 pandemic. Since the federal elections in 2021 were the first ones to take place after the beginning of the Covid-19 pandemic in 2020, the effect of the floodings cannot be depicted exclusively. Especially postal vote shares increased heavily since 2017, probably mainly due to the fear of infection with Covid-19.

The second cause seems to be the period of ten weeks between the floodings and the federal elections. Ten weeks seem to be long enough to be able to vote again, either personally or by using postal vote. Studies finding a statistically significant of natural disasters on voter turnout often evaluate elections taking place earlier than ten weeks after the natural disaster.

Neglecting these two causes, countries still should be prepared for natural disasters of all kinds in the future, influencing elections in some kind. Finding no

statistically significant effect for this flood is probably an exception and only linked to the specific circumstances.

Being prepared requires different options in case of a natural disaster and deciding for the best option after the natural disaster has happened. Postal voting should be promoted further in Eastern Germany to increase postal vote shares and to establish postal voting as a reliable option, especially after natural disasters. Remote electronic voting should be developed further, striving for better data security and especially for higher acceptance amongst voters. Postponing elections and giving citizens the choice where to vote should be seen as “emergency options” if postal voting and remote electronic voting are not deemed appropriate.

Besides from these options explicitly concerning elections, Flood Risk Management in general should be ameliorated. Flood Risk Management decreases the effects of floodings on citizens, leading to less frustration and less problems for citizens and in the end leading to higher turnout. Therefore, Flood Risk Management should be promoted regarding all four priorities.

Preparing for elections after natural disasters does not only serve this purpose but may also benefit for elections during pandemics. As pandemics or epidemics are expected to appear more frequently in the future, states should also be prepared for elections during pandemics. Since pandemics are characterized by a rapid spread of a disease, social distancing might be the consequence. Postal voting and remote electronical voting serve social distancing the best and should

therefore be ameliorated. Postponing elections has no effect on social distancing and giving citizens the choice between polling stations would probably distort social distancing because polling stations would not be used equally. Preparation for pandemics and epidemics can therefore be seen as another reason to invest in postal voting and remote electronic voting.

Besides from preparing technically for different voting options, states need to bear citizens' acceptance in mind. A voting system will only be successful if citizens are willing to accept the system. As seen above with remote electronic voting, acceptance requires transparency of the system as well as some time to adapt to the system. States should therefore invest in ensuring transparency of all new systems, especially electronic ones. Citizens must be able to understand the way their voting data are processed. Adaptation requires the possibility to adapt. Therefore, states should even use optional voting systems even without natural disasters happening to offer citizens the opportunity to adapt to the newly introduced system. Without adapting, citizens will not accept the system after a natural disaster and turnout might decrease massively. Therefore, states need to be conscious about alternative voting options.

Concluding, states should be prepared for deciding on the best option after a natural disaster has happened. Decisions must be made quickly and the process to decide on the appropriate option should be built up before the natural disaster happens. States should decide upon criteria when to decide for each voting option to avoid losing time after the natural disaster. In addition, states should decide on the most appropriate means of information to keep citizens informed

about their voting options. If a natural disaster happens shortly after an election, this information must be spread quickly.

Concluding, I want to highlight again that natural disasters are highly individual and specific because of their differences in duration, kind of damages caused, the extent of damages, the number of affected districts etc. and therefore, results of studies looking at a specific disaster should not be generalized. As climate change becomes more severe and regular natural disasters approach, states should be prepared with different options in case of a natural disaster and should choose the most suitable option to be followed after the disaster.

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H. Appendix

Appendix 1: Hypothesis 1 - Treatment Group

State	District
North Rhine-Westphalia	Bochum
	Bonn
	Dueren
	Düsseldorf
	Ennepe-Ruhr district
	Essen
	Euskirchen
	Hagen
	Heinsberg
	Hochsauerlandkreis
	Cologne
	Leverkusen
	Maerkischer Kreis
	Mettmann
	Moenchengladbach
	Muelheim an der Ruhr
	Oberbergischer Kreis

	Oberhausen
	Olpe
	Remscheid
	Rhein-Erft district
	Rhein-Kreis Neuss
	Rhein-Sieg district
	Rheinisch-Bergischer Kreis
	Soest
	Solingen
	Siegen-Wittgenstein
	Unna
	Viersen
	Wuppertal
Rhineland-Palatinate	Ahrweiler
	Bernkastel-Wittlich
	Cochem-Zell
	Eifelkreis Bitburg-Prüm
	Mayen-Koblenz
	Trier-Saarburg
	Vulkaneifel
	City of Trier
Bavaria	City of Ansbach
	Ansbach
	Berchtesgadener Land

	Erlangen-Hoechstadt
	Forchheim
	Fuerth
	Haßberge
	City of Hof
	Hof
	Kitzingen
	Miesbach
	Neustadt a. d. Aisch- Bad Windsheim
	Oberallgaeu
	Rosenheim
	Roth
	Schweinfurt
	Traunstein
	Wuerzburg
Saxony	Erzgebirgskreis
	Goerlitz
	Mittelsachsen
	Saechsische Schweiz-Osterzgebirge
	Vogtlandkreis

Appendix 2: Hypothesis 1 - Control Group

State	District
North Rhine-Westphalia	Bielefeld
	Borken
	Bottrop
	Coesfeld
	Dortmund
	Duisburg
	Gelsenkirchen
	Guetersloh
	Hamm
	Herford
	Herne
	Hoexter
	Kleve
	Lippe
	Minden-Luebbecke
	Muenster
	Paderborn
	Recklinghausen
	Steinfurt
	Warendorf

	Wesel
Rhineland-Palatinate	Altenkirchen
	Birkenfeld
	Koblenz
	Neuwied
	Rhine-Hunsrueck-Kreis
	Rhine-Lahn-Kreis
	Westerwaldkreis
Bavaria	Altoetting
	Ebersberg
	Erlangen
	City of Fuerth
	Muehldorf
	Munich
	Nuremberg
	Nuremberg Land
	Ostallgaeu
	Schwabach
	Weissenburg-Gunzenhausen
	Wunsiedel
Saxony	Chemnitz
	Leipziger Land
	Meissen
	Zwickau

Appendix 3: Hypothesis 2 – Treatment Group

State	District
North Rhine-Westphalia	Bonn
	Dueren
	Duesseldorf
	Hagen-Ennepe-Ruhr-Kreis
	Muelheim-Essen
	Euskirchen-Rhein-Erft-Kreis
	Heinsberg
	Hochsauerlandkreis
	Olpe-Maerkischer Kreis
	Mettmann
	Moenchengladbach
	Oberbergischer Kreis
	Rhein-Sieg-Kreis
	Rheinisch-Bergischer Kreis
	Soest
	Siegen-Wittgenstein
	Viersen
Rhineland-Palatinate	Ahrweiler
	Bernkastel-Wittlich
	Cochem-Zell

	Eifelkreis Bitburg-Pruem
	Mayen-Koblenz
	Trier-Saarburg
	Vulkaneifel
	Stadt Trier
	Ahrweiler
Bavaria	Ansbach
	Fuerth
	Hof
	Oberallgaeu
	Rosenheim
	Schweinfurt
	Traunstein
	Wuerzburg
Saxony	Goerlitz
	Mittelsachsen
	Saechsische Schweiz-Osterzgebirg
	Vogtlandkreis

Appendix 4: Hypothesis 2 – Control Group

State	District
North Rhine-Westphalia	Bottrop-Recklinghausen
	Dortmund
	Duisburg
	Gelsenkirchen
	Herford-Minden-Luebbecke
	Kleve
	Muenster
	Paderborn
	Warendorf
Rhineland-Palatinate	Birkenfeld
	Altenkirchen
	Koblenz
	Neuwied
	Rhine-Hunsrueck-Kreis
	Rhine-Lahn-Kreis
	Westerwaldkreis
Bavaria	Altoetting
	Erlangen
	Munich
	Nuremberg and Nuremberg Land
	Ostallgaeu
Saxony	Chemnitz
	Leizpiger Land
	Meißen
	Zwickau

Appendix 5: Descriptive Statistics of all variables

Hypothesis 1:

Treatment Group:

Variable	Obs	Mean	Std. Dev.	Min	Max
voterst~2021	61	77.51967	3.390173	69.3	84.3
inhab2021	61	239256.2	177660.7	41681	1083498
unempra~2021	61	3.001393	1.442519	1.28	7.875
eligible2021	61	179842	123137.9	30172	732048
brutein~2021	61	7104.951	5683.523	1079	34537
voterst~2017	61	76.63115	3.061511	69.3	83
inhab2017	61	244017.9	181422.7	41652	1080394
unempra~2017	61	5.509836	2.466016	2	11.4
eligible2017	61	178724.8	125811.7	31067	732825
brutein~2017	61	6639.024	5294.713	1014.952	32172.05

Control Group:

Variable	Obs	Mean	Std. Dev.	Min	Max
voterst~2021	44	76.87705	3.877089	66.7	85.2
inhab2021	44	246858.6	143442.8	41056	613599
unempra~2021	44	5.593182	2.756233	2.3	14.8
eligible2021	44	181762.7	102638.7	29819	463750
brutein~2021	44	6845.196	4005.386	1399.898	16234.74
voterst~2017	44	76.02955	3.444549	68.2	84.1
inhab2017	44	268407.4	232552.9	40781	1456039
unempra~2017	41	5.746341	2.862176	2	14
eligible2017	44	222420.3	209003.4	30191	1157097
brutein~2017	44	7547.267	9589.736	1313.464	65466.82

Hypothesis 2:

Treatment Group:

Variable	Obs	Mean	Std. Dev.	Min	Max
postals~2017	37	31.07261	6.30197	16.71	45.66
postals~2021	37	51.89563	10.28143	28.13	68.05

Control Group:

Variable	Obs	Mean	Std. Dev.	Min	Max
postals~2017	25	30.878	6.759045	18.54	43.6
postals~2021	25	51.3164	10.48063	28.87	66.3

Description of the variables:

The variable “voterst” shows voters turnout in, “eligible” equals the number of eligible voters, “unempra” shows the unemployment rate, “inhab” the number of inhabitants and “brute” the logged brute income of households in mio. €. “Postals” equals the share of postal vote. The control variables were used for both hypotheses.

Appendix 6: Testing the requirements for linear regression

Hypothesis 1:

Variance Inflation Factor

Variable	VIF	1/VIF
interaction	3.39	0.295302
year	2.39	0.419048
flood	2.00	0.500000
Mean VIF	2.59	

.

Breusch-Pagan Test

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of turnout

         chi2(1)      =     0.03
         Prob > chi2  =   0.8568
```

Shapiro-Wilk Test

```
. swilk res
```

Shapiro-Wilk W test for normal data

Variable	Obs	W	V	z	Prob>z
res	210	0.98703	2.018	1.620	0.05263

Durbin-Watson Test

```
Durbin-Watson d-statistic(  4,   210) =  1.545219
```

Hypothesis 2:

Variance Inflation Factor

Variable	VIF	1/VIF
interaction	1.36	0.733771
year	1.22	0.822015
flood	1.15	0.872372
Mean VIF	1.24	

Breusch-Pagan Test

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of postalvoteshare

         chi2(1)      =    14.60
         Prob > chi2  =   0.0001
```

Shapiro-Wilk Test

Shapiro-Wilk W test for normal data

Variable	Obs	W	V	z	Prob>z
res	124	0.93292	6.637	4.248	0.00001

Durbin-Watson Test

```
Durbin-Watson d-statistic(  4,   124) =  .7617072
```