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Does the Weather influence Sentencing? Empirical Evidence from Czech Data

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Abstract

Purpose: Sentencing has been shown to be influenced by different extralegal factors. Following psychological research into the various effects the weather can have on mood and two studies claiming finding an influence of weather on sentencing, we examine the extent to which the weather may influence sentencing.

Methods: Using sentencing decisions from twelve district courts in Prague in the period 2011-2015 and multilevel modelling techniques, we explore the impact of temperature, wind speed, sunshine, precipitation, barometric pressure and humidity on the decision to incarcerate and the duration of non-suspended prison sentences.

Results: In line with the inconclusive findings in the psychological literature on weather and mood and contrary to previous two studies finding the link between weather and sentencing, we do not find that the weather has any substantial impact on sentencing decision making.

Conclusions: We conclude that no meaningful unwarranted disparities in sentencing are caused by the weather in Prague, Czech Republic.

Keywords: sentencing, sentencing disparities, weather, Czech Republic, mood

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1. Introduction

More than four decades ago Judge Marvin Frankel ignited the debate on the shortcomings of judicial discretion with his famous allegation of 'lawlessness in sentencing' (Frankel, 1972), which resulted in the adoption of various institutions to 'guide' sentencing decisions (Ashworth & Roberts 2013; Council of Europe 1992). Frankel's claim was based on an emerging body of evidence concerning unwarranted disparities in sentencing. Since then, the literature on the topic has grown greatly. Unwarranted disparities between judges and courts have been detected by worldwide, with the literature focusing on State and Federal jurisdictions in the US and the Crown Court in England and Wales been particularly prolific (Johnson 2006; Fearn 2005; Pina-Sánchez, Lightowlers & Roberts 2016; Pina-Sánchez & Linacre 2013; Scott 2010; Anderson et al. 1999; Reid 2014).

Some of those studies, and many others, found that sentencing is influenced by certain of the offenders' characteristics that are not considered legally relevant, such as race, gender, or social class (Albonetti,1997, 2002; Daly & Tonry 1997; Everett and Wojtkiewicz, 2002; Koons-Witt 2002; Mustard, 2001; Pasko, 2002; Sporer & Goodman-Delahunty 2009; Stacey and Spohn, 2006; Steffensmeier et al. 1998; Steffensmeier & Demuth 2006, 2010) as well as by the judge's own characteristics (Johnson 2006; Spohn 1991; Steffensmeier & Britt 2001; Steffensmeier & Hebert 1999), the characteristics of the court (Johnson 2005, 2006; Kramer and Ulmer, 2009; Pina-Sánchez & Grech, 2017; Ulmer and Bradley, 2006; Ulmer and Johnson, 2004), and even the socio-economic composition of the area where the court is located (Bontrager, Bales and Chiricos, 2005; Britt, 2000; Demuth, 2000; Fearn, 2005; Feldmeyer and Ulmer, 2011; Johnson, 2005, 2006; Johnson, Ulmer and Kramer, 2008; Kramer and Ulmer, 1996; Myers and Talarico, 1987; Steffensmeier,

Kramer and Streifel, 1993; Steffernsmeier, Ulmer and Kramer, 1998; Weidner, Frase and Schultz, 2005; Weinstein, 2006).

More recent studies have even found that sentencing severity is influenced by a priori trivial factors, such as the time in relation to the day's lunch break, or sports results. Danziger et al. (2011) found that the probability of favourable parole decisions varied from 0 to 0.65 depending upon whether the judges rested or ate before making the decisions. Eren and Mokan (2016) found that unexpected losses in American football games increased the length of disposition for juveniles by 6.4%, with a stronger impact on those from demographic minorities.

This article seeks to expand the literature that has examined the effects of extraneous factors on sentencing. In particular, we make use of the psychological theories concerning the relationship between weather and mood to explore the effects of the weather on sentencing. The results of existing empirical studies of the relationship between weather and mood are inconclusive, however it is clearer that the weather does have an effect on a range of specific social, political, and economic behaviours, and this begs the question whether judicial practice might be similarly affected.

We proceed by reviewing the psychological literature on the topic. This is followed by a discussion of our methodology and the data used. We link meteorological data to a legal dataset of offenders sentenced in Prague, including the names of the judges who passed the sentences – a rather unique feature in European sentencing research – and explore this data using multilevel modelling. The results of our analysis show that although some weather related variables seem to have statistically significant effects on sentencing, the size of those effects is not substantial. In the last section we discuss possible reasons for this minor effect and its implications. We finally discuss why we believe that our results are more reliable than findings of two previous working papers, which find influence of weather on sentencing.

2. Literature Review

Psychological research has looked into the links between weather and mood for more than three decades, yet the results of that research have not been entirely conclusive. Even though it has been found that weather influences voting, consumer spending and stock prices (Murray et al. 2008, Bassi 2013, Saunders 1993; Krämer & Runde 1997; Hirshleifer & Shumway 2003), it is not yet clear how the weather impacts mood and/or behaviour more generally.

Several studies have found that mood is influenced by certain types of weather. Sanders & Brizzolara (1982) suggested that mood (operationalized using the Howarth Multiple Adjective Check List, see Howarth & Schokman-Gates 1981) is influenced by humidity. This analysis was followed by Howarth & Hoffman (1984) who noted that humidity, temperature, sunshine and pressure can affect levels of concentration and that scepticism can be associated with precipitation, sunshine and pressure. More recently, Bogomolov et al. (2014) found that humidity, visibility and wind speed can be used to predict daily stress. Denissen et al. (2008) found that three of the six weather features they measured (temperature, wind power and sunlight) had effects on negative affect, while the rest (precipitation, air pressure, and photoperiod) were not significant. Keller et al. (2005) found that both time spent outdoors and the season moderate the weather's effects on mood and cognition, with warm days providing an uplifting feeling in the spring but not during winter. Huibers et al. (2010) further noted that while depression and sad moods vary over seasons, daily weather conditions do not affect them at all. Most of the studies mentioned here were based on survey data, which is known to be affected by memory failures, interviewer effects, and other biases (Levine, 1976; Pina-Sánchez et al., 2014). However, further studies based on mood evaluations taken from Twitter posts have noted similar relationships with weather conditions. Park et al. (2013) found that temperature and atmospheric pressure have a positive effect on mood, while humidity has a negative effect. Li et al. (2014) also concluded that mood is affected by changes in temperature, but not by sunshine or wind speed.

In contrast to the above, a number of other studies have not found any noticeable effects on mood from weather conditions (Clark & Watson 1988; Watson 2000, Lucas & Lawless 2013).

Some researchers have concluded that weather's general effect on mood seems to be weak or non-existent (Klimstra et al. 2011). However, the same researchers also noted that the reason why the evidence from the literature is inconclusive might be due to different people reacting to weather differently: *"There are people who are in high spirits when the sun shines whereas others seem happier when it rains"* (Klimstra et al. 2011, p. 1498-9). Klimstra et al. (2011) thus suggest that people who are influenced by the weather can be divided into three basic groups: summer lovers, summer haters and rain haters. Similarly, Pray (2013) concluded that the weather affects mood differently for men than for women.

A final group of studies have reported results that are either counter-intuitive or in contrast with some of the previously mentioned studies. While Dennisson et al. (2008) found that a rise in temperature was positively associated with negative moods in Germany, Kööts et al. (2011) found that temperature increases in Estonia were associated with small rises in both negative and positive moods. Even more marked disagreements have been noted when trying to identify the specific mechanisms connecting weather and mood. Lambert et al. (2002) showed that a link between sunlight and season on serotonin levels influences mood, while others have suggested that changing mood might be a result of Seasonal Affective Disorder, during which depression occurs in fall or winter (Eagles 2003; Partonen & Lönnqvist 1998). Similarly, high levels of humidity have been shown to reduce blood pressure (Schneider et al. 2008); yet Kööts et al. (2011) suggested that this effect is indirect.

A clearer picture arises from the literature that focuses on the weather's influence on important social, political and economic institutions. When the weather is 'bad', voters are more likely to vote for the candidate they perceive to be less risky (Bassi 2013). Consumer spending is also strongly influenced by the weather (Murray et al. 2008). The link between weather and crime has been repeatedly studied (Cohn & Rotton 2000; Cohn 1990; Horrocks & Menclova 2011; Ranson 2014; Butke & Sheridan 2010; Field 1992); these studies appear to agree that the weather is related to variations in crime, although there is disagreement as to the direct or indirect nature of that

relationship; for example, violent behaviour has been shown to be correlated with high temperatures, yet it is unclear whether that is the case because of the weather's impact on mood or due to higher numbers of social interactions during pleasant weather or to what level (Hipp et al. 2004, Keller et al. 2005). Haberman et al. (2018) refuted this claim in relation to street robbery in Philadeplhia, PA, which seems to be unaffected by seasons, while Cohn and Rotton (2000) showed that in Minneapolis temperature was a significant predictor of property offenses and Andresen and Malleson (2013) confirmed that frequency of different crime types varies over season in Vancouver.

2.1. Weather and Sentencing

Considering that judges have been found to decide differently according to their mood (Englich & Soder 2009; Bodenhausen et al. 2000) and some psychological research suggesting that mood is influenced by weather, it seems logical to look more closely at whether the weather affects sentencing. Although it is not clear from the existing literature how weather variables influence mood or if they influence it at all, it is important to notice that a significant body of research has shown that the weather is associated with decision making in real life situations. Given the vast literature pointing at how sentencing can be affected by seemingly irrelevant phenomena such as sports events, we wonder if weather could also affect sentencers. For example, we might expect more lenient sentencing when it is not raining or when the temperature is not extreme. However, since the results of the psychological studies have not been conclusive as to what mechanisms might be in play, we proceed by taking an exploratory approach. The literature cannot be used to formulate specific hypotheses regarding the path that the relationship could take. We thus formulate only non-directional hypothesis.

Only one group of researchers have considered the weather's influence on sentencing so far, their results were published in two similar working papers (Bakhturina et al., 2016 and Chen et. al., 2017). They focus on the impact of weather and sports on sentencing in the United States in 1992-2013 in over 90 cities. The weather variables they investigate are sunshine, precipitation,

temperature (minimum and maximum) and cloudiness. Using random forest the authors found that minimum and maximum temperatures were positively correlated with sentence length. We debate the methodology of these studies and their results in more detail in Discussion, together with our objections to them.

Following the psychological research we have formulated subsequent hypotheses: Firstly, we test whether the weather influences sentencing (1), which is composed of two sub-hypotheses: The weather influences whether a judge decides to pass a non-suspended prison sentence (1.1) and the weather impact the length of sentences imposed by judges (1.2). Secondly, we test whether the weather will have a differential impact on individual judges (2). If a substantial effect is detected, the judiciary should be made aware of it and possibly consider strategies to counter those extraneous effects.

3. Data

The sentencing data we use was provided by the Czech Ministry of Justice. Specifically, two different datasets were provided at different stages. The dataset initially obtained included the main characteristics of individual cases sentenced from 1995 to 2016. Additional data from the Ministry of Justice was then employed to extract the names of the district judges from the courts' information system and append these to the original dataset using the offence identifier as the linking criteria. The data cannot be openly shared due to reasons of confidentiality, researchers interested in using this data could obtain it through an application to the Ministry of Justice, department of judicial statistics.

To facilitate our examination of the weather's effect on sentencing we have only considered data relating to district courts in Prague, the capital of the Czech Republic. Such approach eliminates possible confounding effects for any form of between court disparities and the different weather across the Czech Republic. We examine the twelve district courts operating in Prague (the city in the Czech Republic with the highest number of district courts), which between them decided

67,149 cases from 2011 to 2015. This timeframe was chosen to maximize the sample size while using relatively recent data, and avoiding problems with legislative changes made to the Penal Code (a new one was enacted in 2009). The focus on district courts responds to two main reasons. First, they deal with the vast majority of cases, involving all offences except those that carry a minimum of five years of imprisonment or specific offences (e.g. involuntary manslaughter and financial crimes against European Union) listed in the code of criminal procedure. Second, the judge who passed the sentence can be identified accurately at these courts, where cases are heard either by one professional judge alone or by one professional judge with two lay judges. By contrast, sentencing at regional courts is never carried out by a single judge. The case is allocated to judges within their specializations; if several judges share a specialization, the case is quasi-randomly allocated to one of them.

We have further limited the sample in several ways. Cases decided via the simplified procedure known as "penal order" were dropped from our sample (loss of 32,154 cases). In these cases, the date of the decision might not represent the date on which the judge set the sanction – a crucial variable to our analysis. The judge might have prepared the penal order earlier and then given it to an assistant to finalize it. As a result, we have only considered cases in which a main hearing was held. Since main hearings are set in advance and there is a strong influence on judges to speed up the trial as much as possible, we do not deem probable that judges would either take time off on bad weather days or that they would delay their decisions on such days.

We have further excluded cases involving youth offenders (loss of 825 cases), which follow a different sentencing process; cases in which the sanction had to be higher or equal than a sanction fixed by a previous court decision for the same offender or when the case was decided differently than with a simple guilty verdict (loss of 14,131 cases); cases sentenced on dates for which weather data was not provided (loss of 204 cases, as a result of missing cases for the 14/1/2014 in the dataset provided by the weather agency); and cases sentenced by judges who decided five cases or fewer (loss of 41 cases). As a result of the above selection criteria the sample analyzed is composed of

20,064 cases in which a guilty verdict was passed, at 12 courts and by 99 judges. Within this sample, 7,079 offenders (35.3%) were given non-suspended prison sentences.

3.1. Outcome Variables

There is no clear hierarchy of sanctions by severity in the Czech Republic and only the most serious punishment is clearly defined: a non-suspended prison sentence. We have thus considered two outcome variables related to this sanction: the probability of such a sentence, and the length of the nonsuspended prison sentence. These two outcomes are related (Wheeler, Weisburd, and Bode 1982), but it is imperative to study them both for reasons of robustness (Johnson 2006; Ulmer and Johnson 2004; Ulmer, Light and Kramer 2011) as there are important differences in their composition. The probability of incarceration is calculated using all cases in the sample, whereas analyzing sentence length generates a problem of selection bias, since offenders who were not given prison sentences are excluded. On the other hand, the former is coded as a binary variable, capturing simply whether the offender was sentenced to custody or not, whereas prison sentence length is a continuous and therefore much more informative variable, capturing more nuanced differences in punishment severity.

3.2. Weather Data

Prague is situated at 50°05"N and 14°27"E in the middle of Central Europe, and experiences continental inland weather conditions. Daily data about the weather in Prague was obtained from two different agencies. The weather station at Strahov, close to the centre of Prague (http://weather.sh.cvut.cz/weather/), and associated with the Czech Technical University represents our main source of weather data. From this station we have extracted most of the weather variables used in our analysis. The only exception is the intensity of solar radiation, which was provided by the Czech Agricultural University weather station (http://meteostanice.agrobiologie.cz/).

The selection of weather characteristics to be studied seeks to replicate - as close as possible - the sets of variables used in psychological studies exploring the link between weather and mood.

These are: temperature, barometric pressure, sunshine, wind speed, rain and humidity. All of these were operationalized as average values for a specific period of time, except for rain, which was operationalized as the sum over the same period of time. The period starts at 6:00 to capture the earliest assumed time at which judges wake up. It ends at 8:00, since the office hours of analyzed courts started at 7:30 or 8:00. During this period the judges were necessarily exposed to the weather as they travelled to the court. Since it has been suggested that mood might also be affected by stark weather changes (Li et al. 2014), we have also calculated the changes in conditions against the mean values of the previous day. Change in temperature would thus suggest how different is the current temperature in absolute values from the temperature of the previous day.

All of these variables have been demeaned. In addition, hange in sunshine was dropped from the study since it was highly correlated with sunshine (Pearson's r = 0.86) and inclusion of both variables would thus result in multicollinearity. Lastly, we have included three dummy variables to represent the four seasons (with autumn used as the reference category).

3.3. Legal and Extralegal Variables

To deal with differences amongst the offences in the data set, we have controlled for some offence and offender characteristics. In the Czech criminal justice system there are no sentencing guidelines, so the court enjoys ample discretion in choosing the type and length of any sanction given. That said, courts can only impose non-suspended custodial sentences for offenses with statutory maximums of less than five years if other sanctions would clearly not be effective in persuading the offender to desist (s. 52/2 of the Penal code). There is broad scope for issuing suspended custodial sentences: If the court imposes a three-year custodial sentence, it can be suspended provided that the court deems it would lead the offender to desist (s. 81/1 of the Penal code).

We have included the offender's number of previous convictions as a series of dummy variables, differentiating between offenders who have no previous convictions, one to three, four to

six, six to ten, or more than ten previous convictions. Two additional dummy variables capture the judges' and offenders' genders, since it has been suggested that weather may differently impact mood in men than in women (Pray, 2013). This variable was deduced from the judges' names; this was a straightforward process since male and female names are clearly distinguishable in Czech. We use the sentencing range to control for seriousness of offence.[1] Lastly, we also account for the most common offence types (defined as those consisting of at least 2.5% of sentences). These were included as seven dummy variables, the reference category being "other offences". Descriptive statistics for each weather and sentencing variable are presented in Appendixes A and B.

4. Analysis

To explore the effect of weather features on the length of non-suspended prison sentences and on the probability of receiving such a prison sentence we use multilevel linear and logit regression models, respectively. Each of these outcomes is estimated in two stages: first, the response variables are regressed on the set of variables described in the previous section; then, to avoid problems of misspecification, the models are 'trimmed down' by removing any weather variables that have not been found statistically significant in the first regression. The analyses presented here were carried out using the software MLwin (v. 3.00), R (v. 3.2.3), the package R2MLwin (v. 0.8-3), and MCMC as the estimation method.

4.1. Length of Non-suspended Prison Sentences

First, we report the results concerning the association between the length of non-suspended prison sentences and various weather conditions (Table 1). Even though change in rain was statistically significant in the Model 1, it was not significant in the trim-down regression (Model 2). None of the other weather conditions (temperature, barometric pressure, sunshine, wind speed or

1 Seriousness was operationalized in following way: Seriousness = (MaxSentence-MinSentence) / 3 + MinSentence. Using the sentencing range as a proxy for the offence seriousness is in line with Cambridge Crime Harm Index (Sherman et al., 2016) and theory (Drápal, 2017).

humidity) were found statistically significant. These findings refute hypothesis 1.2. This was the case regardless of whether these variables were included in the model using their absolute values or as changes compared to the previous day. For robustness' sake we have replicated our model using an expanded time period during which the weather variables are considered, from 6am to 5pm (the end of the courts' office hours), and obtained the same results[2]. It seems that there is no relationship between weather conditions and the length of non-suspended prison sentences. On the other hand, other legal and extra-legal characteristics of the case were found to have a strong and statistically significant effect on the length of the non-suspended sentences. Numbers of previous convictions, sentencing ranges and the specific type of offence committed greatly influenced the sentence length, as could be expected. Interestingly, the offender's gender also influenced the sentence, while we did not find that the judge's gender played any role.

[Table 1 near here]

4.2. Probability of Incarceration

The models relating to the probability of incarceration reveal a more complex picture (Table 2). We find that three weather variables have a statistically significant effect on sentencing: wind speed, humidity, and pressure. Overall levels of wind speed and atmospheric pressure seem to be associated with harsher punishments, as do increases in humidity. On the other hand, positive changes in wind speed are associated with more lenient sentencing.

These apparent relationships must, however, be interpreted with caution given the small size of the effect identified and the large size of our sample, which requires a critical reflection on whether statistical significance equates substantive significance (Lin, Lucas, and Shmueli, 2013). To put the size of these weather effects in context we can compare them to the effects observed for various relevant case characteristics using the estimated probabilities of being sentenced to custody under different scenarios. For the reference case of an offence of robbery (subsection 173/1) where the

2 Results from these models are available upon request.

offender has no previous convictions, when there are average weather conditions on the day the sentence is passed, the probability of being sentenced to custody is 0.565.[3] For comparison, the probability of being sentenced to custody on a day where wind speed (the strongest weather feature detected in our model) is at the third quartile of the recorded distribution (i.e. a relatively windy day), all other conditions remaining the same, is 0.581.[4] That is just 0.016 higher. By contrast, if weather conditions remain average but the offender has one to two previous convictions, the probability of incarceration is 0.804.[5] As before, for robustness' sake, we replicated our model using an expanded time period during which the weather variables are measured, from 6am to 5pm (the end of the courts' office hours), and obtained similar results. In summary, although the weather conditions have a statistically significant effect, they do not play a meaningful role in determining sentencing decisions, thus hypothesis 1.1 can be refuted.

[Table 2 near here]

We concluded our analysis with the specification of random slopes multilevel models. As explained in the literature review, some psychological research (Keller et al. 2005) has suggested that different people might react differently to the same weather conditions (e.g. summer-lovers vs. summer-haters). This hypothesis can be tested using random slopes, which measure the variability in the detected effect of a weather condition across the 99 judges in our sample. We specified four additional models that extend Model 4, each one of those includes a different random slopes term for each of the weather variables that were found statistically significant. The highest between judge variability in the effect of weather out of those four models was detected for wind speed, with a

3 This probability was estimated using the coefficients for the intercept and sentencing range shown in Model 4 (-3.86 and 0.896), and the sentencing range value for robbery (4.6).

4 This probability was estimated by adding the coefficient for wind speed shown in Model 4 (0.025) and the third quartile of the variable wind speed (2.59) to the estimation of the probability of incarceration for the reference category described above.

5 This probability was estimated adding the coefficients for one to two previous convictions shown in Model 4 (1.15) to the estimation of the probability of incarceration for the reference category described above.

standard deviation of 0.026. To assess the substantive effect of this random slope we can estimate the 95% credible interval of the probably of being sentenced to custody for the reference case (a case of robbery, where the offender has no previous convictions, sentenced on a day with average weather conditions). The probability of incarceration for such case was previously estimated at 0.565, taking the between judge variability of the effect of wind speed into consideration, and based on a 95% credible interval, that probability could range from 0.552 to 0.578. That is, even for the weather variable for which its effect was detected to be most variable across judges, the extent of this variability is almost negligible, which can be used to refute hypothesis 2.

5. Discussion

We have shown that there is a lack of support for a hypothesis that the length of non-suspended custodial sentences is influenced by the examined weather features. We have further shown that even though humidity, pressure and wind speed are statistically significant when we consider the impact of weather on the decision whether to incarcerate the offender or not, their coefficients are not substantively meaningful. These findings are consistent regarding whether measuring weather in absolute terms or as the difference with the values observed from one day to the next We have also shown that season has no effect on sentencing. Finally we have shown how there is no substantial variability in the effect of weather across judges. Hence, we can conclude that none of the mechanisms by which various psychological studies have suggested that weather influences mood played any noticeable role in sentencing decisions at district courts in Prague between 2011 and 2015.

This is good news for the justice system, especially so since the Czech system provides judges with a very high degree of discretion in determining both the type and length of any sanction. As Thomas Weigend wrote, when studying sentencing in Germany, in this case 'No news is Good News' (Weigend 2016). This article will not generate any shocking newspaper headlines, yet finding that weather had no substantive effect on sentencing in our sample shows that judicial

decision making might not be so easily influenced by extraneous factors as has sometimes been suggested. That is not to say that sentencing or judicial discretion in Czech Republic are unproblematic. On the contrary, high inter-court disparities have been shown to exist in the Czech Republic (Drápal, 2018a), especially where sentencing principles are not properly defined (Drápal 2018b). Yet, we cannot attribute those disparities to weather conditions.

There might be a simple reason why judges are not influenced by the weather. For one thing, judges do not spend much time outdoors during their working hours. Previous research into the way weather influences mood revealed different effects on people who spent their time indoors compared to those who spent time outdoors, especially as far as temperature and pressure were concerned (Keller et al. 2005). It might be the case that if judges took their decisions outdoors they would be influenced by the weather. It might be interesting for further research to measure the temperature and level of humidity *inside* courtrooms and study whether these have any association with sentencing decisions.

Only two other studies have considered the weather's influence on sentencing (Bakhturina et al., 2016 and Chen et al., 2017). Unlike ours, the first study found that minimum and maximum temperatures did affect sentence length and indeed that these were the 2nd and 3rd most important extra-legal features affecting sentencing decisions. However, the authors did not explore the influence of the weather in full detail: they use the weather characteristics for the entire day (and only maximum and minimum temperatures), rather than examining the weather characteristics as they were directly before or during sentencing, and as a result some of their conclusions are problematic. Similar critique applies to the paper by Chen et al. (2017). For example, the temperature might drop after the end of office hours, but this could not possibly influence the sentences processed on that day. Bakthurina et al. also analyzed courts from different cities in the US with very different meteorological conditions. Given the well documented between court disparities due to a myriad of political, socio-economic, organizational, and cultural factors (e. g. Chen, 2014; Fearn, 2005; Johnson, 2005; Johnson, Ulmer, & Kramer, 2008; Ulmer, Bader, & Gault,

2008) and the fact that weather also varies by district , the possibility of the detected effects for the weather variables representing being due to problems of omitted relevant variable bias is quite high. The fact that the authors used a data-driven (inductive), rather than theory-driven (deductive) approach increases the likelihood of reporting spurious correlations.

Another reason why our studies have reached different conclusions might be related to the different judicial traditions operating in continental Europe and the United States. In particular, the fact that certain type of judges in the United States are elected, and that they do not need to be professional judges it seems to us particularly significant. Such judges might be less well anchored in the routine of decision-making and thus be more susceptible to the impacts of extraneous factors like weather. Another speculative reason might be that since judges in the Czech Republic decide on both the offender's guilt and the sanction, whereas judges in the United States only decide the sanction, Czech judges might think about the appropriate sanction for a longer period over the course of the whole process and the weather on the day of announcing the decision might thus not have such a great influence on the final sentence.

6. Conclusion

In this article we have examined whether different weather conditions, namely temperature, wind speed, pressure, rain, sunshine and humidity, influence sentencing in district courts in Prague, Czech Republic. Since previous psychological studies examining the link between weather and mood found that weather might have different impacts on different people, and since it has been suggested that weather might only impact people when they are outdoors, we have used specific methods to explore whether these mechanisms might play role in the possible link between weather and sentencing. Many previous studies have found links between the weather and consumer spending, behaviour during elections, and crime, and several studies have shown that various extraneous factors, such as hunger, tiredness, the results of football games or indeed the weather can

influence sentencing outcomes. It was thus appropriate to examine properly whether any link between the weather and sentencing exists in the Czech context or not.

Specifically, we have analyzed a dataset that links the names of specific judges with individual proceedings in order to account for possible individual reactions to various weather conditions. We used weather data that was minute-based rather than day-based, so that we could analyze only the weather conditions that might really have influenced the judge immediately before starting work, or during the decision-making hours. We also analyzed changes in temperature compared to the previous day, since previous psychological research had suggested that these changes might be of significance.

We have not discovered any significant association between the weather conditions studied and the length of non-suspended sentences issued, in our sample of 7,079 cases with 99 judges. When looking at the probability of a non-suspended prison sentence being set, rather than other sanctions (20,064 cases), we have found that certain weather conditions are statistically significant (wind speed, humidity and change in humidity). However, their impact is so small that they have virtually no real effect on sentencing. We then examined whether the weather might have a different impact on different judges, but our data did not support this hypothesis. We have thus reached a different conclusion than Bakhturina et al. (2016) and Chen et al. (2017). This might be because we were looking at a different country and, moreover, one with a continental legal system rather than a common law system; it might also be related to the fact that we used more detailed data and a more robust methodology. We have further analyzed data on weather only for the hours during which judges' decisions might have been influenced. On the basis of the data used, we conclude that no (or extremely low) unwarranted disparities in sentencing are caused by the weather.

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Appendix: Weather and sentencing values

[Table A here]

[Table B here]

LIST OF TABLES

Table 1: Impact of the weather on the length of non-suspended prison sentence (multilevel model)

	Model 1: Length of non-suspended prison sentence			Model 2: Length of non-suspended prison sentence, reduced model		
	Coef.	Std.Err..	P-value	Coef.	Std.Err.	P-value
(Intercept)	-10.01	1.2	< 0.001	-10.07	1.145	< 0.001
Weather characteristics						
Average temperature	0.005	0.265	0.852			
Pressure	0.011	0.014	0.463			
Rain	-0.263	0.23	0.251			
Wind speed	0.044	0.041	0.274			
Sunshine	0.001	0.002	0.458			
Humidity	0.008	0.016	0.598			
Change in temperature	-0.029	0.056	0.641			
Absolute change in pressure	-0.015	0.04	0.713			
Change in wind speed	-0.057	0.042	0.137			
Change in rain	0.066	0.033	0.0495	0.055	0.03	0.071
Humidity	-0.013	0.015	0.396			
Season: Spring (ref: Autumn)	0.116	0.423	0.78			
Season: Summer	0.112	0.44	0.8			
Season: Winter	0.409	0.344	0.235			
Legal characteristics						
Number of previous convictions 1-2 (ref: 0)	3.6	0.606	< 0.001	3.55	0.601	< 0.001
Number of previous convictions 3-6	4.82	0.573	< 0.001	4.76	0.562	< 0.001
Number of previous convictions 7-10	6.03	0.586	< 0.001	5.98	0.581	< 0.001
Number of previous convictions >10	6.24	0.611	< 0.001	6.18	0.598	< 0.001
Sentencing range	18.39	0.321	< 0.001	18.38	0.317	< 0.001
Section 178 (Breaking into home) (ref: 173 (Robbery))	3.01	0.952	0.002	2.98	0.94	0.002
Section 196 (Non-payment of alimony)	1.26	0.901	0.163	1.25	0.909	0.169
Section 205 (Theft)	0.286	0.749	0.702	0.262	0.748	0.725
Section 209 (Fraud)	6.3	0.957	< 0.001	6.28	0.958	< 0.001
Section 274 (Drunk-driving)	2.64	1.32	0.046	2.61	1.3	0.044
Section 283 (Drug offences)	-2.49	0.738	< 0.001	-2.54	0.737	< 0.001
Section 337 (Frustration of Execution of Official Decision)	-6.08	0.761	< 0.001	-6.09	0.762	< 0.001
Section Other	1.29	0.689	0.061	1.28	0.689	0.064
Extra-legal characteristics						
Gender of offender: Female (ref: Male)	-1.3	0.331	< 0.001	-1.29	0.341	< 0.001
Gender of judge: Female (ref: Male)	-0.416	0.348	0.231			
Level 1 variance	1.312	0.38		1.324	0.386	
Level 2 variance	81.29	1.389		81.24	1.363	
Number of sentences	7,079			7,079		
Number of judges	99			99		
DIC	51,299.6			51,281.8		

Table 2: Impact of the weather on the probability of imposing a non-suspended prison sentence (multilevel model)f

	Model 3: Decision to incarcerate or not			Model 4: Decision to incarcerate or not, reduced model		
	Coef. (OR)*	Std. Err.	P-value	Coef. (OR)*	Std. Err.	P-value
Intercept	-3.92 (0.02)	0.188	< 0.001	-3.86 (0.02)	0.17	< 0.001
Weather characteristics						
Wind speed	0.02 (1.02)	0.007	0.003	0.025 (1.02)	0.006	< 0.001
Change in wind speed	-0.013 (0.99)	0.007	0.049	-0.018 (0.98)	0.007	0.005
Pressure	0.006 (1.01)	0.002	0.011	0.005 (1.005)	0.002	0.029
Change in humidity	0.001 (1.00)	< 0.001	0.017	0.007 (1.007)	0.002	< 0.001
Humidity	-0.005 (0.99)	0.003	0.067			
Temperature	0.008 (1.01)	0.005	0.093			
Rain	-0.034 (0.97)	0.039	0.386			
Sunshine	-0.001 (1.00)	0.001	0.332			
Change in temperature	0.005 (1.00)	0.009	0.625			
Absolute change in pressure	0.011 (1.01)	0.007	0.101			
Change in rain	0.004 (1.04)	0.005	0.456			
Season: Spring (ref: Autumn)	0.063 (1.06)	0.076	0.41			
Season: Summer	-0.028 (0.97)	0.078	0.72			
Season: Winter	-0.029 (0.97)	0.058	0.617			
Legal characteristics						
Number of previous convictions 1-2 (ref: 0)	1.14 (3.13)	0.069	< 0.001	1.15 (3.16)	0.069	< 0.001
Number of previous convictions 3-6	2.41 (11.13)	0.066	< 0.001	2.42 (11.25)	0.066	< 0.001
Number of previous convictions 7-10	2.97 (19.49)	0.074	< 0.001	2.97 (19.49)	0.071	< 0.001
Number of previous convictions >10	3.35 (28.50)	0.083	< 0.001	3.36 (28.79)	0.079	< 0.001
Sentencing range	0.896 (2.45)	0.049	< 0.001	0.89 (2.43)	0.048	< 0.001
Section 178 (Breaking into home) (ref: 173 (Robbery))	0.917 (2.50)	0.154	< 0.001	0.889 (2.43)	0.163	< 0.001
Section 196 (Non-payment of alimony)	-0.087 (0.92)	0.136	0.523	-0.106 (0.90)	0.143	0.46
Section 205 (Theft)	1.078 (2.94)	0.119	< 0.001	1.04 (2.83)	0.129	< 0.001
Section 209 (Fraud)	-0.287 (0.75)	0.144	0.046	-0.303 (0.74)	0.154	0.049
Section 274 (Drunk-driving)	-0.702 (0.50)	0.186	< 0.001	-0.712 (0.49)	0.188	< 0.001
Section 283 (Drug offences)	0.23 (1.26)	0.122	0.014	0.268 (1.31)	0.134	0.046
Section 337 (Frustration of Execution of Official Decision)	0.833 (2.30)	0.121	< 0.001	0.802 (2.23)	0.131	< 0.001
Section Other	-0.13 (0.88)	0.108	< 0.001	-0.527 (0.59)	0.117	< 0.001
Extra-legal characteristics						
Gender of offender: Female (ref: Male)	-0.111 (0.89)	0.053	0.038			
Gender of judge: Female (ref: Male)	0.015 (1.01)	0.09	0.865			
Level 2 variance	0.178	0.034		0.173	0.034	
Number of observations	20,064			20,064		
Number of judges	99			99		
DIC	18,469.2			18,469.7		

*Odds ratios of the coefficients from the logistic regressions expressed within brackets.

Table A: Values of weather conditions in Prague for 2011-2015*

	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
Amount of rain 6 to 8	0	0	0	0.1	0	6.2
Average sunshine 6 to 8	0	1.83	52.11	95.94	177.8	323.9
Average temperature 6 to 8	-15.5	1.93	7.58	7.43	12.97	23.7
Average pressure 6 to 8	976.3	1013	1018	1018	1024	1042
Average wind speed 6 to 8	0	2.58	5.15	5.84	8.43	27.17
Average humidity 6 to 8	45.04	79.96	86.68	85.19	92.12	99
Change amount of rain 6 to 8	-37.4	-0.6	0	-1.15	0	6.2
Change average sunshine 6 to 8	-164.6	-25.41	-5.96	19.76	63.15	258.6
Change average temperature 6 to 8	-12.24	-4.18	-2.65	-2.52	-0.92	7.08
Change average pressure 6 to 8	-21.05	-2.66	0.13	0.13	3.04	16.82
Change average wind speed 6 to 8	-11.56	-3.14	-1.19	-0.85	1.14	16.9
Change humidity 6 to 8	-30.02	2.67	9.19	9.89	16.67	44.85
Amount of rain 6 to 17	0	0	0	0.51	0	19.8
Average sunshine 6 to 17	5.5	50.01	134.8	154.8	246.1	411.6
Average temperature 6 to 17	-12.85	4.15	10.4	10.43	16.54	30.56
Average pressure 6 to 17	977.3	1013	1018	1018	1024	1042
Average wind speed 6 to 17	0.39	3.98	6.28	6.94	9.26	23.86
Average humidity 6 to 17	31.93	62.75	74.89	73.88	85.66	99
Change amount of rain 6 to 17	-36.6	-0.4	0	-0.74	0	19.8
Change average sunshine 6 to 17	-97.64	14.92	66.04	78.67	134.6	366
Change average temperature 6 to 17	-12.24	-1.04	0.62	0.47	2.17	9.24
Change average pressure 6 to 17	-22.95	-3.07	0.03	0.17	3.49	20.28
Change average wind speed 6 to 17	-10.97	-1.82	-0.04	0.25	2.2	15.22
Change humidity 6 to 17	-37.34	-7.51	-1.48	-1.42	3.75	36.08
Amount of rain 6 to 8 scaled	-0.1	-0.1	-0.1	0	-0.1	6.1
Average sunshine 6 to 8 scaled	-95.94	-94.11	-43.84	0	81.87	227.9
Average temperature 6 to 8 scaled	-22.93	-5.5	0.15	0	5.54	16.27
Average pressure 6 to 8 scaled	-41.82	-5.36	-0.43	0	5.45	24.08
Average wind speed 6 to 8 scaled	-5.84	-3.27	-0.69	0	2.59	21.32
Average humidity 6 to 8 scaled	-40.15	-5.23	1.49	0	6.93	13.81
Change amount of rain 6 to 8 scaled	-36.25	0.55	1.15	0	1.15	7.35
Change average sunshine 6 to 8 scaled	-184.4	-45.17	-25.72	0	43.39	238.8
Change average temperature 6 to 8 scaled	-9.71	-1.66	-0.13	0	1.6	9.61
Change average pressure 6 to 8 scaled	-21.17	-2.79	0	0	2.92	16.69
Change average wind speed 6 to 8 scaled	-10.71	-2.29	-0.34	0	1.99	17.75
Change humidity 6 to 8 scaled	-39.91	-7.22	-0.7	0	6.78	34.96
Amount of rain 6 to 17 scaled	-0.51	-0.51	-0.51	0	-0.51	19.29
Average sunshine 6 to 17 scaled	-149.4	-104.8	-20	0	91.28	256.8
Average temperature 6 to 17 scaled	-23.28	-6.28	-0.02	0	6.11	20.14
Average pressure 6 to 17 scaled	-40.81	-4.91	-0.31	0	5.42	24.01
Average wind speed 6 to 17 scaled	-6.56	-2.96	-0.66	0	2.31	16.92
Average humidity 6 to 17 scaled	-41.95	-11.13	1.01	0	11.78	25.12
Change amount of rain 6 to 17 scaled	-35.86	0.34	0.74	0	0.74	20.54
Change average sunshine 6 to 17 scaled	-176.3	-63.75	-12.62	0	55.97	287.3
Change average temperature 6 to 17 scaled	-12.71	-1.51	0.15	0	1.7	8.77
Change average pressure 6 to 17 scaled	-23.13	-3.24	-0.14	0	3.31	20.11
Change average wind speed 6 to 17 scaled	-11.22	-2.07	-0.29	0	1.95	14.97
Change humidity 6 to 17 scaled	-35.92	-6.09	-0.06	0	5.17	37.5

* The units are following: rain: mm; sunshine: kJ/m2; temperature: °C; pressure: hPa; wind speed: km/h; humidity: %.

Table B: Values of sentencing data in Prague for 2011-2015*

	All cases	Nonsusp. prison sentences
Male offender	85,7 % (17201)	87,3 % (6180)
Male judge	39,9 % (8005)	39,5 % (2797)
Section: 173	3,7 % (734)	4,7 % (336)
Section: 178	2,5 % (510)	3,6 % (255)
Section: 196	6,9 % (1375)	4,5 % (319)
Section: 205	26,2 % (5259)	43,9 % (3111)
Section: 209	3,1 % (632)	2 % (144)
Section: 274	6,8 % (1373)	1,1 % (78)
Section: 283	3,7 % (742)	4,3 % (304)
Section: 337	14,9 % (2993)	22,2 % (1575)
Section: Other	32,1 % (6446)	13,5 % (957)
Sentencing range in years: Min.	0,167	0,333
Sentencing range in years: 1st Qu.	0,833	0,833
Sentencing range in years: Median	0,833	0,833
Sentencing range in years: Mean	1,104	1,132
Sentencing range in years: 3rd Qu.	1,333	1,33
Sentencing range in years: Max	3	3
No. of previous convictions: Min.	0	0
No. of previous convictions: 1st Qu.	0	3
No. of previous convictions: Median	3	6
No. of previous convictions: Mean	4,3	7,27
No. of previous convictions: 3rd Qu.	7	10
No. of previous convictions: Max. [6]	60	60
N	20064	7079

6 Three cases are not described since they presented extreme nonsensical values for previous convictions (114, 240 and 818). The maximum that is reasonable in the Czech courts is 60.