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Too hot to reject: The effect of weather variations on the patent examination process at the United States Patent and Trademark Office

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ABSTRACT

This paper documents a small but systematic bias in the patent evaluation system at the United States Patent and Trademark Office (USPTO): external weather variations affect the allowance or rejection of patent applications. I examine 8.8 million reject/allow decisions from 3.5 million patent applications to the USPTO between 2001 and 2014, and find that on unusually warm days patent allowance rates are higher and final rejection rates are lower than on cold days. I also find that on cloudy days, final rejection rates are lower than on clear days. I show that these effects constitute a decision-making bias which exists even after controlling for sorting effects, controlling for applicant-level, application-level, primary class-level, art unit-level, and examiner- level characteristics. The bias even exists after controlling for the quality of the patent applications. While theoretically interesting, I also note that the effect sizes are relatively modest and may not require policy changes from the USPTO. Yet, the results are strong enough to provide a potentially useful instrumental variable for future innovation research.

1. Introduction

For an innovation system to work efficiently, an unbiased patent examination system is essential. On the one hand, patent applications that should be granted should be granted; if they are not granted, inventors who deserve patent protection will not be able to exercise their legal rights. High-quality patent applications should also be granted at the appropriate stage of the examination process: if a high-quality patent application is unduly rejected, then even if it is eventually granted, the delay in granting may take years. The delay comes with serious consequences, especially for small entity inventors and start-ups (Farre-Mensa et al., 2016). On the other hand, allowing patent applications that should not be granted because of obviousness or lacking novelty, has detrimental consequences. This results in higher legal costs, which burden the legal system and place often unbearable legal and financial costs on inventors (Jaffe and Lerner, 2004; Lemley and Sampat, 2008).

In an ideal world, the United States Patent and Trademark Office (USPTO) would evaluate patent applications based on merit only. It is, however, operated by humans, therefore decisions may be subject to the numerous of cognitive shortcuts and environmental influences documented in the psychology and behavioral economics literatures (Kahneman, 2011). Just as parole judges are influenced by the time of day when a decision is made (Danziger et al., 2011), one should also expect patent examiners to be at risk of cognitive biases and environmental influences.

This paper investigates one possible factor that may affect the behavior of patent examiners, and asks: does weather variation affect decision processes at the USPTO? The research question is motivated by a significant body of research that demonstrates that weather variations affect human decision making. Weather influences stock market returns (Hirshleifer and Shumway, 2003; Saunders, 1993), tipping (Rind, 1996), consumer spending (Murray et al., 2010), aggression in sports (Larrick et al., 2011), art auction prices (Kliger et al., 2015), college entry decisions (Simonsohn, 2007, 2010), and willingness to help (Cunningham, 1979). Variations in weather influence not only how people decide, but also how much they work (Lee et al., 2014). The primary mechanism behind these findings is the effect weather has on people's mood, and consequently, their behavior in terms of optimism, risk-taking, frame of thinking, and preferences (Cao and Wei, 2005; Goldstein, 1972; Kamstra et al., 2003; Wyndham, 1969). Other proposed mechanisms include weather's effect of expectations (Hirshleifer and Shumway, 2003) and availability of alternative activities (Lee et al., 2014).

One may expect weather variations not to influence behavior at the USPTO. While most extant research discusses the effect of weather in individual decision settings or in unstructured and unregulated settings, the USPTO is a bureaucratized government office. Decisions often are an outcome of a multi-day process. Examiners work indoors in a temperature-regulated environment with not much direct view of the external weather variations. Yet, there are pathways through which

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Table 1
Final reject, non-final reject, and allow decisions at the USPTO, 2001–2014 (In this table and in all subsequent analyses I present data on patent applications for which information on all relevant variables used in this paper are available).

Decision order	Final Rejection	Non-final Rejection	Allowance	Total[a]
1	6323	3,053,123	385,258	3,444,704
2	1,344,510	310,173	888,400	2,543,083
3	160,239	651,850	520,902	1,332,991
4	335,579	133,126	226,564	695,269
5	68,961	159,794	130,965	359,720
6	84,526	44,614	61,854	190,994
7	23,917	40,541	35,604	100,062
8	21,921	13,699	17,920	53,540
9	7416	10,574	10,180	28,170
10	5777	3989	5327	15,093
Total	2,059,169	4,421,483	2,282,974	8,763,626

[a] 0.02% of the patent applications take more than 10 rounds, these are not included in this table.

examiners' decision may be affected. Examiners travel to work,[1] and thus are exposed to weather variations. Weather variations influence mood not only in a fleeting minute-by-minute fashion, but have effects that last for weeks. Think about the "winter blues" effect (Kamstra et al., 2003) or consider how weather variations influence sleep patterns, affecting decisions for days.

The analyses in the paper reveal a small but systematic bias in the patent evaluation process at the USPTO. I find that on unusually warm days patent allowance rates are higher and final rejection rates are lower than on cold days. On one hand, this is bad news for the USPTO because factors unrelated to patent quality should not influence patent decisions. On the other hand, the effect sizes are good news for the USPTO: the marginal effect of one SD increase in temperature increases allowance rates by only 0.4%. This is quite a small effect, much smaller than other weather-related effects documented in the literature: for example, Murray et al. (2010) document a 37% effect of sunlight on consumer spending (sunny vs. not sunny condition), Connolly (2013) demonstrates that having any precipitation decreases life satisfaction reported on that day by about 15%, Larrick et al. (2011) shows a 7% increase in violence with one SD increase in temperature, and Rind (1996) finds that tipping in hotels is 50% higher on sunny than on rainy days. The effect size is even smaller than the 1% marginal effect of sunshine on stock market prices (Hirshleifer and Shumway, 2003).

The effect sizes notwithstanding, the results presented in this paper may help understand decision processes at the USPTO and may aid the USPTO in its efforts to further rationalize the patent examination process. In general, the empirical approach of this paper may provide a framework for innovation scholars to investigate additional cognitive biases that may influence patent decision outcomes. Moreover, by documenting that weather influences patent application decisions, this paper provides innovation scholars a valid instrumental variable on which future research could build to pinpoint pathways from patents to knowledge recombination, patent litigations, venture capital investments, or IPOs (Farre-Mensa et al., 2016).

The paper is structured as follows. First, I introduce the setting, the datasets, and the main variables used in the analyses. Second, I demonstrate that weather variations have a significant effect on decisions at the USPTO, even after controlling for a wide range of heterogeneities at the application-level, the examiner-level, and art unit-level. Specifically, I include in the models examiner fixed effects, art unit fixed effects, technology class fixed effect, and to control for seasonality, I include year, week-of-year, and day-of-week fixed effects. I further control for the examiner's experience, the examiner's workload, the decision stage, the technological width of the application, whether the application was submitted by a US-based entity, whether the application was submitted by a small entity, and whether the patent application is a continual or divisional patent application. Third, I explore if weather variations influence decision outcomes through a sorting effect, and if the "final reject" and "allow" decisions made in various weather conditions are of higher or lower quality. Fourth, I investigate if "final reject" decisions lead to Type I errors and if "allow" decisions lead to Type II errors. Fifth, I explore a few potential moderators to the effects weather variations may have on examiners' decisions, such as the seniority of the examiner, and the gender of the examiner. I discuss how deadlines at the USPTO influence decisions, and if weather variations influence examiners who take part in the Hoteling program. I conclude by discussing the implications of the findings.

2. Setting and data sources

2.1. Data on decisions by patent examiners

I obtained data from the Public Pair System on all publicly available patent application decisions at the USPTO from 2001 to 2014, in total of over 8.7 million decisions[2] made by over 12,000 patent examiners regarding 3.5 million patent applications (for a detailed description of the dataset, see Carley et al. (2015)). Importantly, the Public Pair dataset contains the date on which the decisions were made, which I can then link to the weather data.

Table 1 illustrates the decision process patent applications go through. After the inventor(s) submit a patent application, the USPTO assigns the patent application to an Art Unit and then to an examiner, and it is the task of the examiner to evaluate the specific patent application. After evaluating the patent application (and after possible other actions, such as requesting additional information from the applicant or interviewing the applicant), the examiner decides whether to allow the patent application, to give a non-final rejection, or to give a final rejection. In almost all cases after "allowance," the patent examination process is over.[3] A non-final rejection is a decision that invites applicants for further refinement of the application and its claims (this is similar in function to a revise and resubmit in academia). A final rejection, as the name suggests, should be final – applicants, however, can file a Request for Continued Examination (see §706.7 of the Manual of Patent Examination Process (MPEP) (USPTO, 2015)). This requires a formal appeal process with substantial additional fees and delays. Yet, the data indicate that 75% of the applications get back to the review process after a final rejection. As Table 1 illustrates, in the first round of decisions, most applications receive a non-final rejection decision (82.8%) or are allowed (17%). Only very few applications receive a "final rejection" decision in the first round. The review process then continues on, often taking multiple rounds (and often multiple years – the average length of the review process is 3–4 years). The data show that roughly 70% of the original applications will eventually be allowed. For more information about the review process, see the Manual of Patent Examination Process (MPEP) (USPTO, 2015).

[1] Except the "Hoteling" examiners. I conducted additional analyses regarding the Hoteling examiners, see the results in Section 6.5.

[2] While the full dataset contains roughly 10 million decisions, some of the crucial control variables that I employ in my models are not available for all the patent applications. Therefore, in all subsequent analyses I present data on the sample of patent applications for which information on all relevant variables are available. As additional robustness checks, I re-ran the main models on the full set of patents but without the control variables on which I have missing observations, and the main results presented in the paper hold.

[3] In certain cases, the applicants may ask for further modification, such as modifying the claims (see MPEP §1303.01). Other parties may also request a re-examination. Technology Center directors may withdraw an allowed application if a relevant prior art is discovered later on (MPEP §1308.01). These cases constitute less than 4% of the "allow" cases in the dataset.