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ABSTRACT

The quality of governance depends on public sector worker productivity. We use micro data from China to document that judges are less productive on polluted days. Building on the insights of Alchian and Kessel (1962), we discuss the role of organization design and the incentives of public versus for profit organizations in designing a workplace that reduces the productivity costs of local disamenities. We find that the public sector productivity elasticities are larger than published estimates of the private sector productivity elasticities with respect to pollution.

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1. Introduction

Government quality plays an essential role in promoting long run economic growth and building up trust in institutions. Economists have faced the challenge of measuring differences in government quality. One novel empirical strategy used mislabeled mailed letters to see which governments around the world were most likely to notify the mailer of the "mistake" (Chong et al. 2014). The quality of government service mainly depends on the skill and the effort devoted by government employees.

Both heat and pollution can reduce the public sector's short run productivity. These effects are likely to be larger in the developing world relative to developed nations. Recent research in environmental economics has documented that both private sector agricultural workers and indoor workers perform worse when it is more polluted and hotter outside (Adhvaryu et al. 2014; Chang et al. 2016; Chang et al. 2019; Graff Zivin and Neidell 2012; He et al. 2019; Somanathan et al. 2018).

We examine the effects of pollution and heat on public sector worker productivity in China by measuring the decision time for a judge to rule on a given case. A longer deliberation period creates congestion and delays. We observe the decisions made by 135,924 judges in 9.7 million criminal and civil cases adjudicated during the years 2014 to 2016. These judges work in 337 different prefectures. Judges are highly educated people who are well compensated. China's cities feature extremely high levels of pollution and the summers are quite hot and humid. We use this variation to study the workplace performance of China's judges. We find that China's judges are more susceptible to outdoor pollution relative to outdoor heat. Our estimates of the summer heat/productivity gradient suggests that air conditioning offsets the vast majority of the temperature effect.

Our estimates of air pollution's effect on public sector productivity in China contribute to an emerging literature. Obradovic et al. (2018) find adverse weather conditions significantly reduce the number of police stops and diminish the probability of a visit from a health inspector. Heyes and Saberian (2019) examine 207,000 asylum court cases in the United States and document that higher outdoor temperatures increase the likelihood that judges do not grant asylum.

Using estimates from the recent literature measuring the productivity effects of pollution, we compare our public sector results to these recent private sector productivity estimates. Building on the insights of Alchian and Kessel (1962), we argue that organizational design is an important (and understudied) mediating force in determining the effects of climate and pollution on worker productivity. As we discuss below, the private sector features a residual claimant who has strong incentives to anticipate the productivity impacts of pollution and heat exposure.

2. Worker Exposure to Heat and Pollution

An urban worker's exposure to pollution and heat depends on her time allocation over indoor and outdoor activities and how her residence and workplace is designed and what self-protection technologies are used. Given the predictability of pollution and heat in China, workers can invest in self-protection to reduce their exposure (Moretti and Neidell 2011, Sun et al. 2017). Self-protection products include air conditioning, home air filters and outdoor masks.

For profit firms have strong incentives to internalize their workers' lost productivity brought about by pollution and heat. If a firm's manager is aware of the causal effects of heat and pollution on productivity, then the firm will be more likely to incur the upfront costs to engage in worker risk reduction (Ehrlich and Becker 1972).[1] If firms choose to invest little in workplace comfort, then in a competitive labor market, such firms will have to pay a wage premium ("combat pay") or risk losing workers (Rosen 2002).[2] If workers work at a firm that chooses to provide little worksite protection, then such workers can invest more in household protection to help them to reduce their exposure to heat and pollution when they are not at work.

[1] Graff-Zivin and Kahn (2016) model the adaptation decision of a for profit firm that internalizes the productivity effects of heat exposure. This firm is aware of the causal effects of heat and recognizes the marginal benefits of investing in offsetting technology. In their model, firms differ with respect to their productivity. They solve for the marginal firm that is just indifferent between bearing a fixed cost to acquire costly adaptation friendly products such as air filters an air conditioners. The most productive firms are the most likely to adopt this technology. They study the implications of this decision rule for how the industry's aggregate output is affected by outdoor heat.

[2] Owners of shopping malls and suburban residential development internalize the externalities taking place within the physical boundaries of their property (Henderson and Mitra 1996, Pashigian and Gould 1998). They have strong incentives to address negative spillovers and to maximize positive synergies taking place within their space.

This discussion suggests that private sector workers, especially if the labor market is competitive, will be better protected from heat and pollution exposure. An alternative point of view, advanced by Alchian and Kessel (1962), emphasizes the quiet life of government service that governments can spend "other people's money" on upgrading workplace amenities. By upgrading workplace attributes, public sector workers might be better protected against environmental risks.[3] In China, the public sector faces no incentive to cut costs and it has a set budget. Government officials are known to receive generous side compensation such as greater job security, better pensions, and cheap apartments in expensive cities such as Beijing. Also, when governments provide health-care or higher education at subsidized prices, Chinese officials' access to these services for themselves and their families brings substantial financial gains. Building on the core argument of Alchian and Kessell (1962), those who seek the "quiet life" may receive better work conditions in the Chinese public sector featuring fewer working hours and less stress than their private sector counter-parts. Ultimately, it is an empirical question whether pollution and heat have equal effects on the productivity of public and private sector workers.

3. The Judicial Labor Market in China

Our empirical work studies the productivity of highly educated public sector workers in China. In China, the civil service is a very popular sector for young people who value its job security and benefits. People want to be judges because it is stable safe work and it offers government housing and it is not a stressful life. As indicated in the following Table A1, judges work shorter than

[3] "Public utility managements, whether or not they are also stockholders, will engage in activities that raise costs even if they eat up profits. Management will be rational (i.e., utility maximizing and efficient) if it uses company funds to hire pleasant and congenial employees and to buy its supplies from salesmen who have these same virtues. They cost more, of course, but how does the regulatory commission decide that these are unjustifiable expenditures—even though stockholders would prefer larger profits (which they aren't allowed to have) and customers would prefer lower product prices? Office furniture and equipment will be of higher quality than otherwise. Fringe benefits will be greater and working conditions more pleasant. The managers will be able to devote a greater part of their business time to community and civic programs. They will reap the prestige rewards given to the "statesman-businessman" class of employers. Vacations will be longer and more expensive. Time off for sick leave and for civic duties will be greater. Buildings and equipment will be more beautiful." (Alchian and Kessel 1962).

private sector workers with similar human capital work. The civil service pays relatively low salaries.[4]

Before the entrance exam, the employing agency first checks that candidates have met the minimum requirements (e.g., age, education, and Party membership) and then sends those who qualify and receive approval to sit for the exam.[5] Upon passing the exam, each applicant will further undergo two years of training before being appointed as an acting judge and then gradually move up a hierarchical ladder. His/her first career post is an appointment to one of the local courts as a chief judge. Some of the best judges are appointed to the higher level courts.

A judge's annual evaluation depends on a broad set of performance scores during within-court competitions between colleagues for promotion to vacancies within the courts. In order to motivate judges to work harder, many courts publish the unvarnished quantitative rankings of each judge within a court. This creates a tournament where judges are competing against each other (Lazear and Rosen 1981). In 2011, the Supreme People's Court (the SPC) issued an official document to guide the assessment of judges' court performance.[6] The key criteria used are the absolute number of cases completed or handled, the appeal rate and remand rate for retrial.[7]

Longer case durations will lead to fewer cases being handled or completed within a given year. Below, we will test how outdoor heat and dirty air affects a judge's deliberation time. The average judge in our sample is exposed to dirty air and hot days on 34.1% of the days he/she works. The

[4] Chan and Ma (2011) posit that although the basic pay of civil servants is lower than that of the workforce in other sectors, the total compensation for civil servants is higher than the pay for workers in many other sectors. Ko and Han (2013) analyzes the differences in job motivations between public and private job seekers based on a survey of 329 students from 4 Chinese elite universities. They find that university students who possess a higher level of public service spirit, value high social status and pursue less stressful life prefer to choose public sector jobs. There is no statistical evidence to support that female students are more likely to choose public jobs than are male students.

[5] The exam has become fiercely contested in recent years. In 2018, 1.66 million job seekers had been approved to sit for the exam, and an average of 58 applicants applied for each post and competition for some posts is particularly intense (see http://ah.huatu.com/zt/gkrstj/ for more data in details). The exam of application for judge officers requires that all applicants have at least four-year college education in legal studies, or non-legal studies with professional legal training.

[6] The Chinese document can be found at http://www.court.gov.cn/zixun-xiangqing-2298.html.

[7] The current promotion policy is lack of priority target with veto power. Judges generally will therefore not lose their jobs based on their performance on one criterion, especially if mistakes only occur in a small proportion of cases handled. However, judges are still motivated to avoid possible mistakes. For example, when judges are appealed against, they make trouble for the court leaders. These "troublemakers" would leave a bad impression on the directors, which would adversely affect their career prospects.

marginal effect of such disamenties on productivity is large enough to affect promotion rates.[8] This discussion highlights that judges have strong career concerns to reduce the impact of pollution and heat on their productivity and they must be aware of the causal relationship.

4. The Empirical Framework

We seek to measure how a judge's case duration is affected by pollution and heat. The length of time taken is an interesting outcome variable because it measures cognition and the ability to make decisions.

Our main empirical specification is presented in equation (1):

$$Y_{ijscdt} = \beta_0 + \beta_1 P_{ijCT} + \beta_2 W_{ijCT} + \beta_3 M_{ijCT} + \beta_4 X_{ijscdt} + \gamma_j + \theta_s + \delta_t + \varphi_{ct} + \varepsilon_{ijscdt} \quad (1)$$

where Y_{ijscdt} is the case duration (between the date when a case was assigned to a judge and the date when the right case was adjudicated by that judge) of case *i*, belonging to crime type *s*, assigned to the judge *j* sitting in court *c* on sentencing day *d* of year *t*. P_{ijCT} (or W_{ijCT}) is the daily average reading from air pollution (or meteorological) stations located within prefecture *C* where judge *j* worked on case *i* over the case duration *T*. By observing the judicial decisions across many locations allows us to capture the effects of acute exposure to pollution and heat on the case *i*'s duration (see Table A2). In equation (1), we use the fluctuation in daily maximum temperature and air quality to identify the effect of heat and pollution on case duration. Given that we do not observe each judge's private self-protection effort, it is important to note that the marginal productivity effects we estimate are net of any adaptation investments by the individual or the entity that designed the building where the judge works.

The physical attributes of China's courthouses merit some discussion. The workplaces in China's public sector have been required to be standardized since 1987 when the National Development Reform Commission first issued the Government Office Space Standards. The

[8] Hot days are defined as those days when daily maximum temperatures are warmer than 26 degrees Celsius (79 degrees Fahrenheit), which are known to trigger an avoidance response (Graff Zivin and Neidell 2014; Seppanen et al. 2016). Polluted days are defined as those day when ambient $PM_{2.5}$ exceed the World Health Organization safe limit (i.e., 25 μg/m^3 24-hour mean).

standards applied to government office accommodation occupied by all general government agencies and were revised three times in years 1996, 1999 and 2014 respectively. As required, the standards for lighting, acoustics, ventilation, and central heating and cooling systems shall be applied to enhance the work environment and to support a sustainable design objects. In 2003, the Supreme People's Court specifically issued China Court Facilities Standards (CCFS) defining the minimum space and the functional, technical, and security requirements for the design of court facilities.[9] The revised standards were endorsed in 2011 and additionally regulates the courtrooms to cap air-conditioning at certain degrees both in summer and winter.[10] Though the CCFS aims at providing good quality space for each judge to work in, considerable variation exists due to the differences in court funding in different regions.

To the best of our knowledge, there was no air filtration system installed in China's courtrooms to reduce air pollution exposure before 2019. People are more likely to invest in self-protection when they anticipate high levels of ambient pollution (Moretti and Neidell 2011). To address this issue, M_{ijCT} is added and defined as the daily average Baidu search index on "mask" of prefecture C where judge j worked on case i over T. The value of M is positively correlated with people's search volume for the key word "mask" in a prefecture on a given day. Thus, it captures the contemporaneous aggregate interests on mask purchase in a prefecture. This mask variable is not at the individual level of a judge. Instead, it is a geographic aggregate variable that captures the area's overall average self-protection against pollution dynamics.

In estimating equation (1), we recognize that are likely to be other case-level factors that influence the timing of the case settlement. To make the criminal cases more comparable, X_{ijscdt} is included as a vector of covariates including both legal (e.g., offense severity and prior record) and extra-legal factors (e.g., attitude of defendants in courtroom) that might predict the criminal case duration (see Table 2 for the variables we use as controls). To mitigate endogeneity concerns, a set of fixed effects are also added in our regressions. The vector γ_i contains the judge-specific fixed effects to control for the idiosyncratic tendencies of each judge. Since judges may have different

[9] The design criteria are applicable to new court building projects and court renovation projects or building system upgrades in existing court buildings.

[10] As required in the 2011 CCFS, in the winter, the air conditioning system should be able to maintain the building temperature at no more than 20 degrees Celsius. In the summer, air conditioning should maintain an indoor temperature at no less than 26 degrees Celsius.

sentencing policies for different crimes, crime type fixed effects θ_s are added as further controls. The vector δ_t includes the year fixed effect. φ_{ct} is a vector of county by month fixed effects that allow for different seasonal patterns by county (e.g., the seasonal variation of wind direction). ε_{ijscdt} is an error term. To address the potential heteroscedasticity and serial correlation, we cluster the standard errors at the judge level. As a robustness exercise we will show that clustering by judge-year and court-month has little effect on the results.

By estimating Eq. (1), we also test for several dimensions of heterogeneity. Recent experimental economics research has documented that the capacity to engage in sophisticated thinking is reduced by pollution (Chew et al. 2018). We are able to test this hypothesis because we have classified the court cases by their degree of complexity. Cases featuring greater complexity requires a higher level of mental acuity for its resolution (Rohwedder and Willis 2010). We test whether the decision time in these cases is longer on hotter and more polluted days. We test for this by adding two proxies for case complexity in *X*. The first is a dummy variable equal to one if a verdict mentions that that case was handled via the simple procedures, and zero otherwise. The second is the total number of word count of each verdict.

In studying the relationship between judicial performance and pollution and heat factors, China's justice system's features allow us to avoid several identification challenges. First, within the same lower court, each defendant's case is in principle randomly assigned to a judge who presides over the trial, plea bargaining, and sentencing process.[11] The judge is also unaware of the details of the upcoming cases. Second, in terms of case duration, it takes on average months since the filing of the claim to case resolution. Despite adjudications being made indoors, the judge in charge would conduct on-site investigations to determine the real reasons for the litigation. They might be exposed to heat and pollution both indoors and outdoors before they make the final decisions. Third, individual judges have a high degree of personal discretion and independence in the way in which they evaluate files.[12] Finally, given the extremely heavy caseload on the judge's

[11] The Chinese document can be found at http://www.court.gov.cn/zixun-xiangqing-13520.html.

[12] China's legal system is a civil law system, as opposed to a common law system, with only statutory law. Judges' decisions are usually not accompanied by written legal opinions explaining their reasoning. Moreover, judicial decisions do not have any legally binding precedential effect on other cases. Thus, the interpretations by the Supreme People's Court are important guides for judges. However, many interpretations are replete with vague passages that provide neither predictability nor transparency. Therefore, judges have a great deal of flexibility in implementation.

docket, judges only sit in one courthouse. Trial court decisions are generally final because appeals are only available on limited bases, occur infrequently, and seldom lead to reversal in China.[13]

5. Data

Our main data source is online transcripts of judicial decisions.[14] These documents first become available online in late 2013 in a handful of courts, and coverage widened over time. We collect over 9.7 million criminal and civil cases adjudicated between 2014 and 2016 by 135,924 judges across China. The final dataset used in this paper consists of approximately 61.8 percent of all criminal first instance cases and 27.2 percent of civil first instance cases adjudicated over the years 2014 to 2016 (see Table 1 for more information).

*** Insert Table 1 about here ***

Air pollution data are published daily by the China's Ministry of Environmental Protection. The data for 2013 to 2018 cover 1,497 monitoring stations across all 337 prefectures. Weather data are collected from China Meteorological Data Sharing Service System (http://cdc.cma.gov.cn/). Those data contains daily readings from 820 weather stations in China during the 2013 to 2018 period. The pollution and meteorological variables are aggregated to the prefecture level by averaging the daily readings of all the monitoring stations within a prefecture. Less than 10% of the observations were dropped due to missing meteorological and pollution information.

The remote sensing fire points come from the MODIS active fire product in the Fire Information for Resource Management System at NASA. The MODIS active fire product detects fires in 375m pixels that are burning at the time of satellite overpass under relatively cloud-free

[13] In our sample, the appeal rate against the verdict of the court of first instance is about 10.6%, and 17.7% of judgments on appealed verdicts were reversed or commuted. These percentages are highly consistent with those (i.e., 11.1% and 18.3% respectively) documented in China Law Yearbook 2015-2017.

[14] In the late 2013, the Supreme People's Court promulgated Regulations on Publishing Verdicts of Peoples' Courts Online. According to this document, verdicts of peoples' courts at various levels should be published online except for those (1) involving state secrets or individual privacy; (2) involving juveniles; (3) resolved through mediation; and (4) other "improper" situations. See http://wenshu.court.gov.cn/ for the data source.

conditions using a contextual algorithm. We aggregate the original hourly data into daily data at prefecture level. The Baidu Index used in this paper is a data product analogous to Google Trends, which measures the search frequencies of the selected terms. We collect daily Baidu Index data on the Chinese keyword "*kouzhao*" (mask) in the 337 matched prefectures with the judicial data in 2013-2018.

The criminal sentencing data are used in our baseline regressions primarily because the cases are numerous and the outcomes are easy to classify. The documents typically include several paragraphs that sketch the arguments made by the litigants and the ruling of the judges. For each criminal case that is prosecuted, a record is made of key case details including the defendant's characteristics (e.g., juvenile defendants), case traits (e.g., crime type), severity of crimes, outcomes (e.g., sentence length), the court in which sentencing occurs, name of the judge, and so on. In order to circumvent any potential confounding effects that may arise from multiple convictions or offenses, we exclude cases with more than one count of conviction and single events with more than one-person offense.[15]

Table 2 provides the definition and basic summary statistics of all variables used in this paper. In terms of case duration, for each criminal case handled in the basic court, it takes on average 36 days since the filing of the claim to case resolution. Figure A1 further provides the density distribution of the criminal case duration, the primary outcome of our interest. As anticipated, the distribution is positively skewed in that many criminal court cases are settled relatively early on, within 60 days.

*** Insert Table 2 about here ***

6. Empirical results on the Performance of Judges

6.1 Baseline Estimates

[15] We remove observations with erroneous dates (too far in the past or in the future).

The basic results are summarized in Table 3.[16] Column 1 presents results based on including a set of fixed effects and weather controls. The results show both heat and air pollution prolong a case's duration. In columns 2-4, we add additional controls. This significantly increases the explanatory power of the regressions. The impact of heat and air pollution on case handling time is robust to the inclusion of the additional variables. In column 3, we present our preferred specification with the Baidu Mask Index as an additional control. We find that a 1% increase in $PM_{2.5}$ leads to 19.8 % increase in the case handling time. These findings based on data from China are qualitatively similar to the findings of Hayes and Saberian (2019) based on U.S justices' decisions in asylum hearings. In contrast to their study, we test whether pollution and heat increase the judicial decision time. This is our proxy for public sector worker productivity.[17]

The adverse impact of $PM_{2.5}$ was not widely known to the Chinese populace before 2013.[18] Beginning in 2013, the Chinese prefectures started to monitor and publish daily levels of $PM_{2.5}$.[19] By the end of 2014, all prefectures were posting real-time disclosures of daily $PM_{2.5}$ levels. To warn residents how bad it is on any given day, the seriously polluted cities were required to launch a four-color alert system by the end of 2014 when more cities announced their first-ever red alert for heavy smog.[20] In column 4 of Table 3, we add an interaction term between log ($PM_{2.5}$) and *Post2014* (i.e., a dummy variable which takes a value of 1 if the year is 2015 or 2016 and 0 otherwise). The statistical significance of the interaction terms indicates that the judges have gotten

[16] The empirical results using $PM_{2.5}$ from 7AM to 7PM rather than over the full day are similar in both sign, magnitude, and statistical significance. Of the legal variables included in the regressions, all have a statistically significant influence on the judge's ruling time. These results are available on request.

[17] In Hayes and Saberian's study (2019), an immigration judge typically determines multiple cases indoors on a given day. Our sample includes all types of criminal and civil cases. A judge typically takes a few days to make the final decision on a case. Meanwhile, despite adjudications being made indoors, some judges in charge would conduct several on-site investigations to determine the real reasons for the crime. Therefore, our targeted judges might be more exposed to heat and pollution before they make the final decisions. Finally, China's legal system is a civil law system, as opposed to a common law system, with only statutory law, not case law. Judges' decisions are usually not accompanied by written legal opinions explaining their reasoning. Moreover, judicial decisions do not have any legally binding precedential effect on other cases. Thus, the interpretations by the Supreme People's Court are important guides for practicing procurators, lawyers, and judges. However, many interpretations are extremely elusive.

[18] One evidence is that before 2013, the Baidu Index on "$PM_{2.5}$" was close to zero indicating that the Chinese population was generally unaware of this pollutant.

[19] In 2013, 74 Chinese prefectures started publishing data on $PM_{2.5}$ levels.

[20] The alert system is with red being the highest pollution level, followed by orange, yellow and blue. The yellow alert and above will trigger a series of compulsory emergency responses including the suspension of construction operations, the restriction of heavy pollution vehicles or the suspension of production in smokestack industries.

better at adapting to $PM_{2.5}$ over time now that they are aware of the threat starting in 2015. However, the size of this estimated coefficient is relatively small. This suggests that even in recent years that judges have had limited success in offsetting their pollution exposure.

In columns (1-4) in Table 3, we view the temperature variable to be a control variable. In column (5), we test for the non-linear relationship between temperature and the decision time. We categorize each day's maximum temperature into the following categories; <5°C (the reference category), ⩾5°C (41°F) but <12°C (53°F), ⩾12°C but <28°C (82°F), ⩾28°C but <32°C (89°F), and ⩾32°C. These cut points represent the approximate 10^{th}, 25^{th}, 75^{th} and 90^{th} percentiles of the empirical temperature distribution for those prefecture-dates from which we have observations in our sample.[21] We find an asymmetric relationship between temperature and decision time. The decision time at 5-12 degrees Celsius is 18.4% higher than at the reference temperature range. This decision time steadily climbs until 28 degrees Celsius, and then falls at even higher temperatures. This pattern is consistent with the claim that China's government effectively uses air conditioning during times of high outdoor temperature and this indoor cooling is associated with an improvement in a judge's workplace performance.[22]

*** Insert Table 3 about here ***

6.2 The Effects of Heat and Pollution by Judge Age and Case Complexity

In recent years, economists have explored the role of cognition in decision making. Some of this research is related to lifecycle savings behavior and studies the cognitive dynamics of older people (Rohwedder and Willis 2010; Smith et al. 2010). This literature tests whether older people make worse decisions. A second literature examines how pollution affects decision making in complex laboratory experiments (Chew et al. 2018).

[21] Models with smaller size bins for temperature yield strikingly similar results.

[22] In most of Chinese cities, the outdoor temperature bar for air conditioning in summer is set at 28 degrees Celsius. According to the heating policy, Northern China enters its heating season when the average daily temperature falls below 5 degrees Celsius.

In this section, we use our rich micro data to explore how pollution and heat affect decision times for young and older judges and we explore how a case's complexity affects the marginal effects of heat and pollution. Columns 1-2 of Table 4 present our heterogeneity results by judge age. We find that older judges are more influenced by heat and pollution. This finding is consistent with the existing literature (Teitelbaum, 2006; Cristensen and Szmer, 2012). In columns 3-6, we divide the full sample by case complexity. We find that it takes judges more days to make a decision on complex cases when it is hot and polluted outside.[23] These results are consistent with recent experimental research by Chew et al. (2018) who find that "a haze-induced increase in risk aversion may induce workers to exercise greater care thereby reducing their work pace in order to minimize the rate of defects and the variability of their compensations".

*** Insert Table 4 about here ***

In Table 5, we have also explored how pollution and heat affect the probability that a case is appealed by the defendants or is remanded by the higher courts. We view these as indicators that the judge did not perform well in adjudicating the trial. We find that the probability of both outcomes is marginally increased when the judge is exposed to more pollution. This finding is in accord with our case complexity findings. Judges appear to have more trouble making "good decisions" when exposed to more pollution.

*** Insert Table 5 about here ***

6.3 Additional Results

To further explore our identifying assumptions, we report a battery of robustness checks. As discussed before, a judge's court performance is annually evaluated. Thus, there might be an

[23] Table A3 shows the asymmetric inverted U-shaped relationship between temperature and decision time for these different groups.

aggregate time constraint such that the judge must allocate time with an eye on meeting his obligations within a year. To further allow for autocorrelation in a judge's decisions in each year, we cluster the standard errors by judge-year in column 1 of Table 6. In some local courts, judges also could receive monthly internal newsletters assessing the relative court performance of individual judges. Therefore, individual judges' self-evaluation against peers in the same court might also influence judges' decisions. In column 2 of Table 6, the standard errors are clustered by court-month. In the above both two cases, the level of significance of the estimated coefficients is unchanged.[24]

In column 3, we present the results limiting our sample to those top five common offences (see Table A4). Column 4 excludes "less active" judges who adjudicated less than 100 cases throughout the time of study. We find very similar evidence under these sample restrictions. In column 5 of Table 6, we replace $PM_{2.5}$ measures with Air Quality Index (AQI).[25] Again, our results remain consistent. Heat and air pollution may be measured with errors due to sporadic monitoring stations. In column 6, we focus on courts within 10km of their corresponding both air quality and meteorological monitoring stations. The results show a similar effect in terms of statistical significance and magnitude.

Ideally, we would observe the particulate level each day where the judge lives and works. Instead, we observe the air pollution level at the prefecture level. Variation in air pollution within a city on a given day raises issues of classical measurement error. To address this concern, for each prefecture, we calculate the daily total number of fire points within its administrative boundary.[26] Then we calculate its value mean during the case duration as an IV for $PM_{2.5}$. As indicated in column 7, Cragg-Donald (CD) Wald F-statistic for weak identification is much larger than the

[24] The level of significance of the estimated coefficient is also unchanged when the standard errors are clustered by judge and by prefecture.

[25] In 2013, an AQI was developed by collecting daily values of pollutants, including sulfur dioxide, nitrogen dioxide, carbon monoxide, suspended particulates less than 10 μm *i*n diameter (PM_{10}), fine particulates ($PM_{2.5}$), and ozone, all measured at the monitoring stations. This is a notable shift from the previous measure (air pollution index, or API), which only focused on primary pollutants such as SO_2, NO_2, and PM_{10}. All 337 prefectures were required to disclose their once classified air quality data by 2015. The AQI scale ranges from 0 to 500. It is further divided into six ranges 0-50, 51-100, 101-150, 151-200, 201-300, and 301-500 which are categorized as good, moderate, unhealthy for sensitive groups, unhealthy, very unhealthy, and hazardous, respectively.

[26] In China, a large amount of the crop straws has been burned without being recycled or processed. The burned proportion of straws is about 4 times more than the world average. The straw burning could lead to very high concentrations of pollutants such as particulate matter ($PM_{2.5}$ and PM_{10}).

most stringent Stock-Yogo critical value of 16.38, which indicates that our IV is not week. The coefficient becomes larger in magnitude while remaining statistically significant at the 1% level as compared to the OLS estimates.

*** Insert Table 6 about here ***

To draw a general conclusion regarding the heat and air pollution effects on case duration, in Table A5, we further examine that to what extent the results generalize to other judicial settings. Our results indicate that a judge's exposure to heat and dirty air will take him more time to finalize the judicial decisions.

7. Heat and Pollution's Effects on the Productivity of Other Government Sectors

We recognize that our empirical work has focused on the productivity of an elite subset of public sector workers. In this section, we present additional evidence on the productivity of China's public sector based on two other indicators. We collect the message data from the official portal of people.cn where the government bulletin board (the biggest one in China) enables local leaders nationwide (i.e., party chiefs and governors) to communicate with netizens. This bulletin board is formally responsible for responding to citizen complaints, requests, suggestions and consultations to government agencies or municipalities. We use the number of days it takes the government to complete a service from the time the request is posted on the bulletin board as the second proxy for the public sector worker productivity. Second, in 1983, China set up the first 12345 hotline as a single point of contact for requesting all non-emergency city services and is available to both residents and visitors.[27] Dialing 12345 in a city connects a caller to the local government switchboard where trained frontline operators will route the calls to the specific agents

[27] Alternatively, citizens should call 110 when they face the emergency and need helps from the governments. The 12345 hotline operates 24 hours a day and 365 days a year. It is in analogous to the 3-1-1 service supported in many communities in the U.S. and Canada.

according to the customized rules to run the operation.[28] We use the number of days it takes the 12345 hotline to complete a service from intake to resolution as another indicator of public sector worker productivity.[29]

Table 7 presents our empirical results. We estimate a version of equation (1) where we change the dependent variable to reflect the length of time to respond to requests. The estimates presented in column (1) imply an elasticity of 0.243 for $PM_{2.5}$, and a unit increase in daily maximum temperature increases the service time by 0.468 percent.[30] Column 3 presents estimates of the same regression, but with 12345 calls as the outcome indicator. The service time is quite elastic with respect to $PM_{2.5}$. The estimated heat effect is positive but statistically insignificant. In columns (2) and (4) we find evidence of an inverted U shape between service time and outdoor temperature. When it is extremely hot outside, service time is quicker than when it is merely hot outside. This suggests that air conditioning is helping these public sector workers to be productive. In Table 7's columns (5) and (6), we test whether the demand for government services is higher on more polluted, hotter days. Perhaps surprisingly, we find little evidence of a large effect of pollution on the demand for government services.

*** Insert Table 7 about here ***

In Table 8, we compare our pollution elasticities to other estimates reported in the literature. In general, our $PM_{2.5}$ elasticities for the public sector judges are larger than other estimates reported based for private sector firms in China or U.S estimates. The outdoor farm worker elasticity in the U.S is close to our estimated elasticity but this highlights the limited ability exhibited by the Chinese public sector to offset the pollution challenge.

[28] For example, call center managers will send tasks to the municipal general office that will delegate the tasks by assigning tags to their team agents based on their skill sets, and the area of expertise.

[29] Though almost all prefecture city governments have opened the 12345 hotline, many only publish few examples on their official portals. We therefore restrict our data to cases from each city's website (80 ones in total) at least documenting over 1,000 ones per year (see Figure A2 for the spatial distribution of our sample prefectures).

[30] Restricting our sample to cities with more observations does not appreciably change our estimate.

*** Insert Table 8 about here ***

8. Conclusion

During polluted days, judges in China do not perform as efficiently. We find that a 1% increase in $PM_{2.5}$ leads to a 19.8 % increase in the case handling time. Such judges have trouble ruling on more complex cases and are more likely to make decisions that are appealed and over-ruled. The public sector's productivity is less affected by extreme heat and this suggests that air conditioning has been effective in offsetting this challenge. These findings contribute to the emerging environmental economics literature exploring the productivity costs for urban workers due to environmental exposure. Given China's high levels of pollution and hot summers, this setting offers substantial variation to test how educated elite civil servants adapt to extreme conditions.

In contrasting our public sector estimates with some recent private sector estimates, we find that our implied elasticities are larger than the private sector elasticities. While we acknowledge that we examined just one sector of the Chinese government, we believe that our findings open up the possibility of exploring the general Alchian and Kessell (1962) hypothesis that the public sector uses "other people's money" to provide high quality workplace work conditions. Future research should study how organizational design and labor market competition affects the empirical "cause and effect" relationship between pollution, climate and work place productivity.

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Table 1

Sample Size and Share of the Total Population

Year	Case type	Population size (millions)	Our sample			
			Initial sample		Final sample	
			Size (millions)	Share of population (%)	Size (millions)	Share of population (%)
2014	Criminal	1.0	0.8	77.3	0.7	64.4
	Civil	8.0	3.6	44.9	1.9	23.9
2015	Criminal	1.1	0.8	69.2	0.7	62.1
	Civil	9.6	3.5	36.9	2.6	27.1
2016	Criminal	1.1	0.9	80.2	0.7	59.0
	Civil	10.8	6.2	57.2	3.2	29.7
Sum	Criminal	3.2	2.4	75.6	2.0	61.8
	Civil	28.3	13.3	46.9	7.7	27.2

Notes: Data on populationi size are from Law Yearbook of China in various years. All our results in this paper are estimated on the final sample and thus our results should be interpreted with this sample in mind. The initial data processing removes: (1) cases without judge's name; (2) cases missing the exact date when they were assumed jurisdiction; (3) cases with erroneous dates (i.e., too far in the past or in the future); (4) cases handled in cities where meteorological or pollution information are missing; (5) cases handled in special courts (e.g., military, maritime, railway and forestry courts); (6) criminal cases with more than one count of conviction and single events with more than one-person offense; (7) written orders and notices of entry judgement.

Table 2

Variable Definition and Descriptive Statistics

Variable	Definition	Mean	SD
Panel A. Decision/service variables			
Criminal Case Handled in a Basic Court	No. of days over *T1* when a criminal first instance case was handled by a criminal judge working in a basic court	35.94	43.55
Criminal Case Handled in a Higher Court	No. of days over T1 when a criminal first instance case was handled by a criminal judge working in an intermediate court	107.49	103.63
Civil Case Handled in a Basic Court	No. of days over *T1* for a civil first instance case handled by a civil judge working in a basic court	69.54	91.53
Case_Appeal	=1 if the criminal first instance is appealed to a higher court; =0 otherwise	0.11	0.31
Case_Reverse	=1 if the criminal first instance is remanded to a retrial; =0 otherwise	0.02	0.14
Government Bulletin Board Service Time	No. of days it takes the government to complete a service from the time the request is posted on the bulletin board at people.cn.	33.11	43.45
Governemnt Bulletin Board Daily Request	No. of requests daily posted on the bulletin board at people.cn.	3.89	8.85
12345 Hotline Service Time	No. of days it takes the government to complete a service from the time the 12345 hotline is received	12.77	18.33
12345 Hotline Daily Calls	No. of calls that the 12345 hotline daily received	18.26	41.83
Panel B. Environmental variables			
PM2.5	Average daily PM2.5 concentration over *T1* ($\mu g/m^3$)	54.67	30.12
AQI	Average daiy Air Quality Index over *T1*	81.63	35.98
Fire_Point_Count	Average daily no. of active fire points detected by NASA over *T1*	4.90	16.32
Daily_Max_Temperature	Average daily maximum temperature over *T1* (℃)	15.72	9.69
Wind_Speed	Average daily wind speed over *T1* (0.1 m/s)	22.01	8.66
Rainfall	Average daily rainfall over *T1* (0.1 mm)	66.02	78.88
Baidu_Mask_Index	Average daiy Baidu mask index over *T1*	58.34	69.05
Panel C. Criminal case control variables			
Word_Count	Total no. of word count of a verdict (1,000 word counts)	6.29	6.20
Simple_Procedure	=1 if the case is handled via the simple procedures; =0 otherwise	0.58	0.49
Special_Offender	=1 if a defendant is under age or with mental illness or disabiled; =0 otherwise	0.03	0.18
Offense_Record	=1 if a defendant has a prior offense record; =0 otherwise	0.03	0.16
Multi_Offender	=1 if the offender has been convicted of one or more offenses punishable by a term of imprisonment during the past five years; =0 otherwise	0.27	0.44
Severity	=1 if the offense committed is very atrocious and cruel; =0 otherwise	0.11	0.32
Huge_Amount	=1 if the offender gets great pecuniary gain from the offence; =0 otherwise	0.14	0.34
Surrender	=1 if the offender volutarily surrenders himself; =0 otherwise	0.44	0.50
Contrition	=1 if the offender clearly shows he is remorseful for his actions; =0 otherwise	0.34	0.47
Statement_Real	=1 if the offender confessed his guilt in the courtroom; =0 otherwise	0.74	0.44
Compensate	=1 if the offender is ready and willing to compensate the victim; =0 otherwise	0.15	0.36
Understand	=1 if the offender recieves victims' unwillingness to press charges; =0 otherwise	0.28	0.45
Attorney	=1 if "effective assistance of counsel" *(caina bianhuyijian*) was literally raised among the claims for relief; =0 otherwise	0.15	0.35

Notes: *T1* stands for the period between the date when a case was assigned to a judge and the date when the case was adjudicated by that judge. All the environmental variables are measured at prefecture level.

Table 3

Testing for the Effects of Heat and Pollution on Productivity

	Log(Decision_Time)				
	(1)	(2)	(3)	(4)	(5)
Log($PM_{2.5}$)	0.293***	0.177***	0.198***	0.211***	0.181***
	(0.006)	(0.004)	(0.004)	(0.006)	(0.004)
Daily_Max_Temperature/100	0.431***	0.387***	0.260***	0.256***	
	(0.045)	(0.033)	(0.033)	(0.033)	
Baidu_Mask_Index/100			-0.162***	-0.163***	-0.158***
			(0.006)	(0.006)	(0.006)
Log($PM_{2.5}$) ×Post2014				-0.018***	
				(0.006)	
Daily_Max_Temperature 5℃- 12℃					0.184***
					(0.006)
Daily_Max_Temperature 12℃-28℃					0.310***
					(0.007)
Daily_Max_Temperature 28℃-32℃					0.195***
					(0.008)
Daily_Max_Temperature ≥32℃					0.037***
					(0.008)
Year dummy	Yes	Yes	Yes	Yes	Yes
Judge dummy	Yes	Yes	Yes	Yes	Yes
Crime type dummy	Yes	Yes	Yes	Yes	Yes
Weather condition controls	Yes	Yes	Yes	Yes	Yes
Court dummy ×Month dummy	Yes	Yes	Yes	Yes	Yes
Offender demographic controls		Yes	Yes	Yes	Yes
Legal factor controls		Yes	Yes	Yes	Yes
Case complexity controls		Yes	Yes	Yes	Yes
Adjusted R square	0.460	0.681	0.682	0.682	0.685
No. of clusters	20,794	20,794	20,794	20,794	20,794
No. of obs	1,810,095	1,810,095	1,810,095	1,810,095	1,810,095

Notes: In column 5, daily maximum temperature colder than 5℃ is the omitted reference group. The weather condition controls are the daily rainfall and wind speed for each prefecture. Reported in parentheses are robust standard errors clustered by judge. ***, ** and * represent statistical significance at the 1%, 5% and 10% levels of confidence, respectively.

Table 4

Heterogeneous Effects of Heat and Pollution on Productivity by Judge Age and Case Complexity

	Log(Decision_Time)					
	Judge Age		Complexity Measure A		Complexity Measure B	
	Young	Old	Simple	Hard	Simple	Hard
	(1)	(2)	(3)	(4)	(5)	(6)
Log($PM_{2.5}$)	0.110***	0.212***	0.153***	0.416***	0.200***	0.369***
	(0.009)	(0.005)	(0.005)	(0.009)	(0.007)	(0.008)
Daily_Max_Temperature/100	0.150	0.297***	0.246***	0.717***	0.021	0.572***
	(0.112)	(0.036)	(0.062)	(0.057)	(0.066)	(0.052)
Baidu_Mask_Index/100	-0.068***	-0.189***	-0.115***	-0.353***	-0.149***	-0.323***
	(0.006)	(0.007)	(0.005)	(0.015)	(0.007)	(0.011)
Judge dummy	Yes	Yes	Yes	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
Crime type dummy	Yes	Yes	Yes	Yes	Yes	Yes
Weather controls	Yes	Yes	Yes	Yes	Yes	Yes
County dummy ×Month dummy	Yes	Yes	Yes	Yes	Yes	Yes
Offender demographic controls	Yes	Yes	Yes	Yes	Yes	Yes
Legal factor controls	Yes	Yes	Yes	Yes	Yes	Yes
Case complexity controls	Yes	Yes				
Adjusted R square	0.431	0.677	0.400	0.366	0.489	0.477
No. of clusters	3,901	19,303	16,705	16,617	16,047	18,422
No. of obs	229,966	1,577,901	1,059,142	746,321	913,164	892,003

Notes: In columns 3-4, a case is assumed to be simple if the verdict mentions that that case was handled via the simple procedures. In columns 5-6, a case is assumed to be simple if the verdict word count is below the average of our whole sample. The weather condition controls are the daily rainfall and wind speed for each prefecture. Reported in parentheses are robust standard errors clustered by judge. ***, ** and * represent statistical significance at the 1%, 5% and 10% levels of confidence, respectively.

Table 5

Testing for the Effects of Heat and Pollution on Criminal Judical Results

	Case_Appeal	Case_Reverse
	(1)	(2)
Log($PM_{2.5}$)	0.004***	0.002***
	(0.001)	(0.001)
Daily_Max_Temperature/100	0.032***	0.003
	(0.010)	(0.004)
Baidu_Mask_Index/100	-0.004**	-0.002***
	(0.002)	(0.001)
Dependent variable mean	0.107	0.019
Judge dummy	Yes	Yes
Year dummy	Yes	Yes
Crime type dummy	Yes	Yes
Weather controls	Yes	Yes
County dummy ×Month dummy	Yes	Yes
Offender demographic controls	Yes	Yes
Legal factor controls	Yes	Yes
Case complexity controls	Yes	Yes
Adjusted R square	0.191	0.073
No. of clusters	20,801	20,801
No. of obs	1,816,737	1,816,737

Notes: The weather condition controls are the daily rainfall and wind speed for each prefecture. Reported in parentheses are robust standard errors clustered by judge. ***, ** and * represent statistical significance at the 1%, 5% and 10% levels of confidence, respectively.

Table 6

Additional Tests of the Effects of Heat and Pollution on Productivity

	Log(Decision_Time)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Log($PM_{2.5}$)	0.198***	0.198***	0.179***	0.205***		0.167***	2.148***
	(0.004)	(0.006)	(0.005)	(0.005)		(0.009)	(0.012)
Daily_Max_Temperature/100	0.260***	0.260***	0.317***	0.250***	0.145***	0.233***	2.846***
	(0.032)	(0.083)	(0.042)	(0.040)	(0.033)	(0.080)	(0.023)
Baidu_Mask_Index/100	-0.162***	-0.162***	-0.156***	-0.161***	-0.156***	-0.329***	-0.496***
	(0.005)	(0.008)	(0.007)	(0.007)	(0.006)	(0.022)	(0.004)
Log(AQI)					0.207***		
					(0.005)		
Judge dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Crime type dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Weather controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County dummy ×Month dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Offender demographic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Legal factor controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Case complexity controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2SLS: Fire point IV							Yes
Adjusted R square	0.682	0.682	0.662	0.677	0.682	0.675	
No. of clusters	41,961	31,168	18,981	6,717	20,794	3,144	
No. of obs	1,810,095	1,810,095	1,195,448	1,429,124	1,810,095	311,337	1,810,095
CD Wald F-statistic							86,698

Notes: In column 1, standard errors are clustered by judge-year. In column 2, standard errors are clustered by court-month. In columns 3-7, standard errors are clustered by judge. In colum 3, data are limited to those top 5 most frequently committed crimes in our sample. In column 4, the regression sample is limited to those judges who adjudicated as least 100 cases throughout the time of study. In column 6, data are limited to courts within 10km of their corresponding both air quality and meteorological monitoring stations. Column 7 reports the IV estimation results. The weather condition controls are the daily rainfall and wind speed for each prefecture. ***, ** and * represent statistical significance at the 1%, 5% and 10% levels of confidence, respectively.

Table 7

Testing for the Effects of Heat and Pollution on Other Government Sectors

	Log(Service_Time)				Log(No. of Case Received)	
	Government Bulletin Board		12345 Call		Government Bulletin Board	12345 Call
	(1)	(2)	(3)	(4)	(5)	(6)
Log($PM_{2.5}$)	0.243***	0.239***	0.179***	0.187***	0.012*	-0.006
	(0.022)	(0.022)	(0.029)	(0.033)	(0.007)	(0.013)
Baidu_Mask_Index/100	-0.105*	-0.116**	-0.173***	-0.170***	-0.068	0.137
	(0.056)	(0.055)	(0.054)	(0.049)	(0.054)	(0.237)
Daily_Max_Temperature/100	0.468*		0.269		0.031**	0.114***
	(0.272)		(0.323)		(0.014)	(0.027)
Daily_Max_Temperature 5℃- 12℃		0.306***		0.223***		
		(0.039)		(0.057)		
Daily_Max_Temperature 12℃-28℃		0.522***		0.366***		
		(0.053)		(0.086)		
Daily_Max_Temperature 28℃-32℃		0.397***		0.389***		
		(0.062)		(0.109)		
Daily_Max_Temperature ⩾32℃		0.075		0.165*		
		(0.071)		(0.098)		
Case type dummy	Yes	Yes		Yes		
Year dummy	Yes	Yes		Yes	Yes	Yes
Weather controls	Yes	Yes		Yes	Yes	Yes
Prefecture dummy	Yes	Yes		Yes	Yes	Yes
Prefecture dummy ×Month dummy	Yes	Yes		Yes	Yes	Yes
Adjusted R square	0.182	0.194	0.246	0.252	0.535	0.637
Year coverage	2014-2018	2014-2018	2014-2018	2014-2018	2014-2018	2014-2018
No. of clusters	292	292	80	80	292	80
No. of obs	548,890	548,890	1,497,236	1,497,236	153,974	77,807

Notes: In columns 2 and 4, daily maximum temperature colder than 5℃ is the omitted reference group. The weather condition controls are the daily rainfall and wind speed for each prefecture. Reported in parentheses are robust standard errors clustered by prefecture. ***, ** and * represent statistical significance at the 1%, 5% and 10% levels of confidence, respectively.

Table 8

Elasticity Comparison with Other Studies Using High-Frequency Individual Output

Reference	Data source	Air	Measure of productivity	Elasticity
Chang et al. (2019)	Two call centers in China	API	Total number of calls per shift	0.023
He et al. (2019)	Two manufacturing sites in China	$PM_{2.5}$	Total output per shift	0.003
Chang et al. (2016)	One pear-packing factory in U.S.	$PM_{2.5}$	Total piece rate earnings per hour	0.080
Graff Zivin and Neidell (2012)	One large farm in U.S.	Ozone	Average pieces collected per hour	0.260
Adhvaryu et al. (2016)	One garment factory in India	$PM_{2.5}$	Actual pieces produced divided by target quantity per hour	0.052
Our paper	All criminal basic courts in China	$PM_{2.5}$	Criminal case decision time	0.198
	The biggest government message board in China	$PM_{2.5}$	Case service time	0.243
	12345 hotlines in 80 prefectures in China	$PM_{2.5}$	Case service time	0.179

Notes: The estimated elasticities in our paper are the ones reported in column 3 of Table 3 and columns 1 and 3 of Table 7, respectively.

Appendix

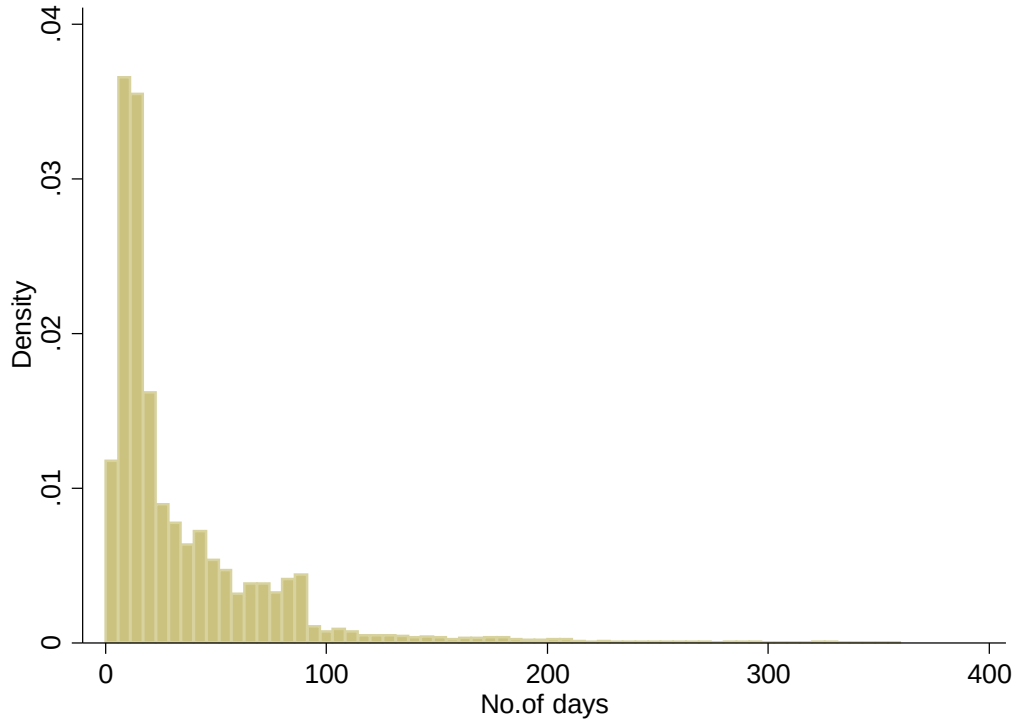

Figure A1 Criminal Case Decision Time

Notes: This figure provides the frequency distribution of the criminal case decision time.

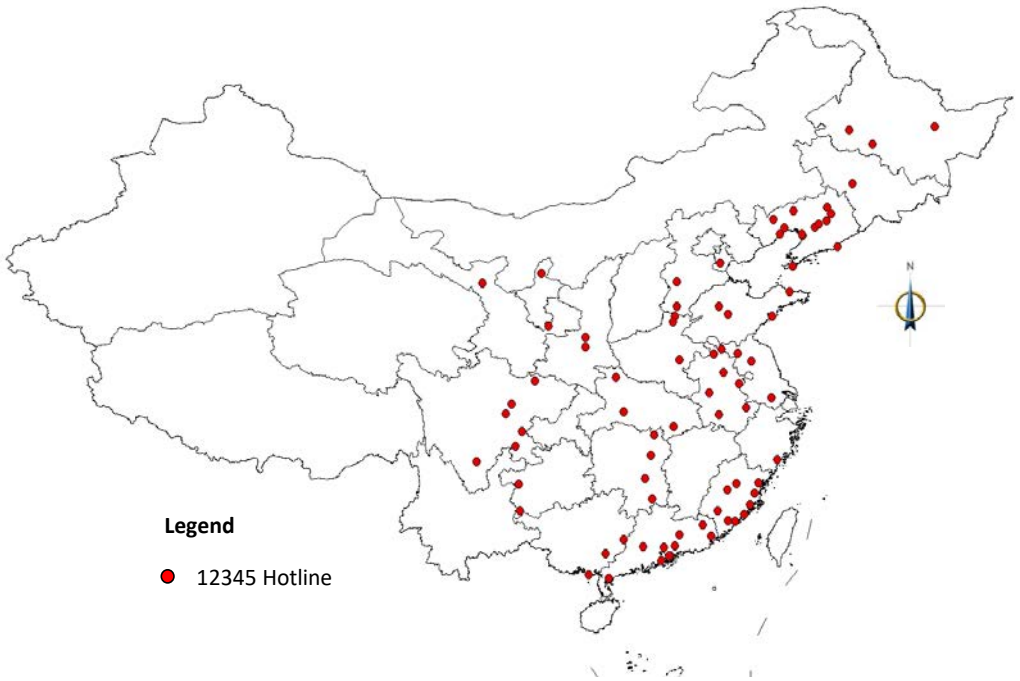

Figure A2 Spatial Distribution of 12345 Hotlines in 80 Prefectures of China

Table A1

Average Hours Per Week Worked and Gender Difference in 2010

Occupation	All working	Male working time	Gender difference	
			Labor	Working time
Judge	41.6	41.4	2.00	0.99
Lawyer	42.0	42.1	2.21	1.01
Banking service clerk	42.0	42.1	1.02	1.00
Computer system analyst	43.2	43.3	3.01	1.01
Insurance sale agent	43.6	43.9	0.74	1.01
Accountant	43.9	44.1	0.37	1.01
Doctor	44.6	45.3	0.74	1.04
Machinery mechanics	45.1	45.3	4.75	1.02
Electrical engineer	44.6	44.5	2.49	0.99
Retail salesperson	50.2	50.8	0.74	1.02
Chefs and head cooks	50.9	51.8	1.97	1.06
Average for all full-time workers	45.2	46.4	1.25	1.06

Note: Gender difference refers to the ratio of total no. of full-time male workers (or a male worker's average working hours per week) to total no. of full-time female workers (or a female worker's average working hours per week).

Data source: China Census 2010.

Table A2

Prefecture-Wise Percentage of Hot and Polluted Days 2013-2018.

	Hot days (%)		Polluted days (%)	
	(1)	(2)	(3)	(4)
January	0.22	0.00	41.22	83.55
February	1.31	0.00	32.56	83.70
March	5.66	0.03	28.91	85.66
April	22.85	1.42	21.45	83.24
May	50.40	9.82	21.09	79.54
June	73.04	27.80	17.10	67.17
July	87.67	55.32	7.39	56.49
August	84.33	48.60	5.09	57.27
September	59.59	19.11	8.24	62.45
October	21.12	2.47	19.28	72.74
November	4.99	0.05	29.05	81.76
December	1.90	1.49	42.62	87.35

Notes: In column 1, the percentage of hot days in a month is defined as the percentage of days with daily maximum temperature over 80 degrees Fahrenheit at prefecture level during that month. In column 2, the percentage of hot days in a month is defined as the percentage of days with daily average temperature over 80 degrees Fahrenheit across at prefecture level during that month. In column 3, the percentage of polluted days in a month is defined as the percentage of days with daily average AQI over 100 at prefecture level during that month. In column 4, the percentage of polluted days in a month is defined as the percentage of days with daily average PM2.5 over the World Health Organization safe limit (i.e., 25 $\mu g/m^3$ 24-hour mean) at prefecture level during that month. All shares reported in this table are weighted by prefecture total population in the year 2010.

Table A3

Heterogeneous Effects of Heat and Pollution on Productivity by Judge Age and Case Complexity

	Log(Decision_Time)					
	Judge Age		Complexity Measure A		Complexity Measure B	
	Young	Old	Simple	Hard	Simple	Hard
	(1)	(2)	(3)	(4)	(5)	(6)
Log($PM_{2.5}$)	0.107***	0.192***	0.142***	0.362***	0.189***	0.317***
	(0.009)	(0.005)	(0.005)	(0.009)	(0.007)	(0.008)
Baidu_Mask_Index/100	-0.068***	-0.185***	-0.113***	-0.346***	-0.145***	-0.316***
	(0.006)	(0.008)	(0.006)	(0.015)	(0.007)	(0.011)
Daily_Max_Temperature 5℃- 12℃	0.061***	0.201***	0.130***	0.323***	0.167***	0.321***
	(0.017)	(0.006)	(0.008)	(0.009)	(0.010)	(0.009)
Daily_Max_Temperature 12℃-28℃	0.096***	0.341***	0.218***	0.589***	0.236***	0.583***
	(0.019)	(0.008)	(0.010)	(0.012)	(0.012)	(0.011)
Daily_Max_Temperature 28℃-32℃	0.073***	0.212***	0.168***	0.320***	0.159***	0.369***
	(0.021)	(0.008)	(0.011)	(0.013)	(0.013)	(0.012)
Daily_Max_Temperature ⩾32℃	0.022	0.038***	0.053***	-0.031**	0.009	0.058***
	(0.023)	(0.009)	(0.012)	(0.014)	(0.014)	(0.014)
Judge dummy	Yes	Yes	Yes	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
Crime type dummy	Yes	Yes	Yes	Yes	Yes	Yes
Weather controls	Yes	Yes	Yes	Yes	Yes	Yes
County dummy ×Month dummy	Yes	Yes	Yes	Yes	Yes	Yes
Offender demographic controls	Yes	Yes	Yes	Yes	Yes	Yes
Legal factor controls	Yes	Yes	Yes	Yes	Yes	Yes
Case complexity controls	Yes	Yes				
Adjusted R square	0.432	0.681	0.402	0.391	0.491	0.490
No. of clusters	3,901	19,303	16,705	16,617	16,047	18,422
No. of obs	229,966	1,577,901	1,059,142	746,321	913,164	892,003

Notes: Daily maximum temperature colder than 5℃ is the omitted reference group. In columns 3-4, a case is assumed to be simple if the verdict mentions that that case was handled via the simple procedures. In columns 5-6, a case is assumed to simple if the verdict word count is below the average of our whole sample. The weather condition controls are the daily rainfall and wind speed for each prefecture. Reported in parentheses are robust standard errors clustered by judge. ***, ** and * represent statistical significance at the 1%, 5% and 10% levels of confidence, respectively.

Table A4

Top 5 common offences in our sample

Rank	Criminal crime	Percent
1	Burglary	21.9
2	Dangerous driving	15.9
3	Assault	11.3
4	Traffic accident	8.5
5	Drug trafficking	8.5
	Sum	66.1

Table A5

Testing for the Effects of Heat and Pollution on Productivity (Other Judicial Settings)

	Log(Decision_Time)	
	Criminal Case Conducted in a Higher Court	Civil Case Conducted in a Basic Court
	(1)	(2)
Log($PM_{2.5}$)	0.586***	0.338***
	(0.046)	(0.003)
Daily_Max_Temperature/100	1.415***	1.141***
	(0.270)	(0.021)
Baidu_Mask_Index/100	-0.353***	-0.211***
	(0.036)	(0.006)
Judge dummy	Yes	Yes
Year dummy	Yes	Yes
Crime/case type dummy	Yes	Yes
Weather controls	Yes	Yes
County dummy ×Month dummy		Yes
Prefecture dummy ×Month dummy	Yes	
Offender demographic controls	Yes	
Legal factor controls	Yes	
Case complexity controls	Yes	Yes
Adjusted R square	0.556	0.777
No. of clusters	1,845	89,798
No. of obs	20,195	7,154,672

Notes: The weather condition controls are the daily rainfall and wind speed for each prefecture. Reported in parentheses are robust standard errors clustered by judge. ***, ** and * represent statistical significance at the 1%, 5% and 10% levels of confidence, respectively.