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Tracy, Joseph S.; Kahn, Matthew E.

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## A Prospective Economic Analysis of OSHA's Heat Injury and Illness Prevention Rules

Joseph Tracy American Enterprise Institute Matthew E. Kahn University of Southern California, Hoover Institution

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#### A Prospective Economic Analysis of OSHA's Heat Injury and Illness Prevention Rules

Matthew E. Kahn and Joseph Tracy<sup>1</sup>

#### Abstract

During the Biden Administration, the Occupational Safety and Health Administration (OSHA) proposed new rules to protect workers from heat exposure. The intent of this regulation was to improve worker quality of life and reduce health impacts. In this paper, we explore the trends in heat-related worker injuries and the likely unintended consequences of this proposed regulation. By pointing out these "Peltzman Effects", we seek to highlight the existing data gaps that limit the regulator's efforts to improve worker quality of life and the opportunities for market-based mitigation of these heat-related risks.

<sup>&</sup>lt;sup>1</sup> Matthew E. Kahn is the Provost Professor of Economics at the University of Southern California and a Visiting Fellow at the Hoover Institution. <u>kahnme@usc.edu</u>. Joseph Tracy is a Senior Fellow at the Daniels School of Business at Purdue University and a non-resident Senior Fellow at the American Enterprise Institute. <u>joestracy@gmail.com</u>. We thank Boyden Gray PLLC for providing funding for this research. All errors are our responsibility.

#### Introduction

During the Biden Administration, the Occupational Safety and Health Administration (OSHA) proposed new rules to protect workers from heat exposure. The intent of this regulation was to improve worker quality of life and reduce health impacts. In this paper, we explore the trends in heat-related worker injuries and the likely unintended consequences of this regulation. By pointing out these "Peltzman Effects", we seek to highlight the existing data gaps that limit the regulator's efforts to improve worker quality of life and the opportunities for market-based mitigation of these heat-related risks.

We share OSHA's goal of protecting vulnerable workers, but we reject the claim that the proposed regulations will achieve this goal at low cost, or that they will significantly benefit the workers who choose to work in these exposed industries and jobs.

OSHA argues that its "light-touch" approach taken so far has not sufficiently reduced heatrelated job risks. OSHA justifies its proposed new rules by combining a statistical argument (that heat kills and injures) with an economic argument that, due to market failures, many U.S. firms are not investing enough to protect workers from their job hazards. The basic argument is that workers accepting jobs featuring extreme heat exposure are both unaware of the extent of this exposure and how the heat may affect their health and well-being both in the short run and in the long run. In this case, a type of "false advertising" takes place as workers take jobs that offer a given wage, but they are unaware of the health dangers inherent in taking such a job.<sup>2</sup>

In our prospective analysis of this major rule change, we present a critical analysis of the existing statistical literature that claims to study the causal effects of heat exposure on worker safety. These studies fail to account for worker heterogeneity and worker choice. Put simply, workers systematically choose what jobs they work at. Their choice depends on many factors including; what local job opportunities are available to them, how susceptible are these individuals to such heat, and the degree to which these workers are aware of the effects of heat on their health and the pro-active steps they can take to offset these negative impacts?

We explain how the research of the Nobel Laureate James Heckman informs our analysis of the OSHA regulatory design. In justifying its choice of regulations, OSHA implicitly assumes that all workers of a given race and age are identical and equally affected by heat exposure.

In the spirit of Sam Peltzman's research on the "unintended consequences" of regulation, we present a microeconomic analysis of how workers and firms will be affected by this regulation (Peltzman 1975). Whether vulnerable workers are likely to gain from such regulation hinges on whether the regulated firms have market power in the output and labor markets. We present a detailed analysis of this claim and contrast it with the predictions from microeconomics in cases where the regulated firms instead face perfect competition in both the output and the labor markets. We argue that in those less competitive labor markets that OSHA is most intent on regulating, the costs of the regulation will more likely be shifted to workers. This is an example of an unintended consequence that is common with regulation.

To preview our main findings, the death count from on-the-job heat is already very low. OSHA reports that there were 43 heat-related job fatalities in 2022. (BLS, 2024) OSHA reports an average of 34 heat-related job fatalities per year over the period from 1992 to 2022 (BLS, 2024)

<sup>&</sup>lt;sup>2</sup> https://www.federalregister.gov/d/2024-14824/p-68

Over this period, heat-related job fatalities represented less than 1 percent of all job fatalities. OSHA claims that heat-related fatalities are significantly undercounted. We discuss the research paper that OSHA relies on to substantiate this claim and argue that this conclusion is unjustified.

OSHA has pointed to several empirical studies to make its case that the current "business as usual" approach can be improved through the proposed government interventions. As we discuss below, these empirical studies ignore many economic incentive effects that determine sorting of workers across employers, employer investments in safety, and worker efforts to self-insure.

In support of its rulemaking, OSHA points out that many American workers are exposed to high heat as they work in outdoor jobs in agriculture and construction as well as indoor jobs in factories and warehouses. The typical worker in these industries is often less educated and more likely to be a minority, and some have pre-existing medical conditions that make them more susceptible to heat related illnesses and risk of death. The U.S. workforce is aging, and more American adults are obese and have rising rates of Type 2 diabetes and other chronic health conditions that put them at greater risk from heat exposure.

While OSHA intends to improve worker quality of life, the proposed rule ignores basic lessons from economics. Our economic analysis demonstrates that the benefits from this regulation will be lower and the costs will be higher than OSHA anticipates. In their discussion, OSHA systematically downplays how firms and workers react to incentives.

Firms have incentives to take proactive steps to protect workers because they will have to pay a wage premium ("combat pay") if workers find their job quality of life to be worse than their other alternatives. Otherwise, at the margin, employees will quit and move to another job. Turnover is expensive as firms have to undertake searching and on-boarding replacement employees. In addition, firms also benefit from putting in place efficient practices that help to maintain worker productivity on hot days. (For example, to reduce pacing.)

The joint decisions of workers and firms together determine a worker's actual exposure to extreme heat. Workers typically have a degree of choice over where they live and work, what job they take and what shifts they agree to work. They have a strong self-interest in figuring out whether the work conditions at a specific employer are too onerous for them. They do this both through job search before joining a firm, as well as on-the-job learning. If workers discover after being hired that a job environment is worse than they anticipated (and that they are compensated for), then they have an incentive to quit and look for a new job. Workers who agree to work an afternoon summer day's shift that is predicted to reach a high temperature can also take measures to protect themselves from the heat.

An extensive economics literature has established that jobs with unpleasant attributes must pay higher wages to attract and retain workers (a "compensating wage" differential). Areas with extreme heat exposure will also feature lower rents because people can move to more pleasant places. In this sense, workers who live and work in extremely hot places are compensated with higher wages and lower rents (Gyourko and Tracy 1991). With the extra purchasing power, they can purchase market inputs (foods, cooling equipment to protect themselves) as well as save to be able to cover the costs of moving to a different market.

In the absence of new regulations, there are reasons to believe that the adverse health and productivity effects of heat exposure will decline further rather than worsen over time. Design

progress in cooling equipment is accelerating and the price of these improved products is declining. Innovations in equipment design can reduce the exertion required by workers that accentuates heat-related health risks. Personal monitoring devices can alert workers when they should take a break. Put simply, outdoor workers want to be productive and maintain their health and quality of life. There are enough of these individuals and employers that their aggregate demand for better solutions is triggering endogenous innovation. The private sector is the engine of adaptation as long as entrepreneurs anticipate that aggregate demand is rising (and government stays out of the way).

The benefits of OSHA's new proposed rules depend on what would be the worker safety time trend in the absence of the new regulations. The value added from OSHA's rules will likely be small and declining over time. Heat-related injuries (HRIs) are a small category of overall workplace injuries indicating a limited scope for positive impact. There is also no evidence of a rising trend in this category of injuries which raises the question of why a significant change in OSHA's approach is needed at this time. There is no existing or impending "crisis" in HRIs that calls for new forceful regulation. This does not imply, however, that there are no constructive steps that OSHA can take to reduce job-related heat exposure health risks.

The costs of these proposed regulations are likely to be borne by small firms. Large firms have more adaptation strategies for coping with new regulations and can spread out the fixed compliance costs over a larger number of projects. The same regulations impose larger relative costs on smaller firms. In this sense, the introduction of new rules could differentially benefit larger firms creating barriers to entry (and operation) for new firms. At the same time, new firms generate more job growth and provide a dynamism to local economies as well as a path of upward economic mobility associated with starting and growing a firm.

We conclude our study with an alternative lighter touch regulatory proposal for how OSHA can better achieve its stated goals at lower social cost. OSHA is proposing regulations while facing considerable uncertainty about the firms and the workers it is regulating. The OSHA rule makers have not been clear about the Frank Knight "knowledge problem" and their lack of an understanding of the inner workings of the firms that they are regulating. Asymmetric information issues arise as firms know much more about their day-to-day operations than the regulators. The preponderance of small employers in industries such as construction will hinder effective regulatory action. The collective knowledge of markets vastly exceeds that of OSHA, giving markets an inherent advantage at finding efficient solutions.

We view the major market failure in this setting to be the dissemination of low-cost, high-quality information about daily outdoor job risks. Thus, we propose that OSHA play the role of an "honest broker" in conveying trustworthy information about job attributes that are tied to industries and places. We also emphasize that the cost of regulation depends not only on the design of OSHA's rules, but also on how OSHA implements its rules.

## Government Regulation Is Unlikely to Have Caused the Long-Run Trend in Rising Worker Safety

OSHA was created in April 1971, but improvements in worker safety have consistently taken place over the course of the 20th century, and there is no clear evidence indicating that OSHA accelerated this progress.

Our standard of living improves as our death risk declines. The value of past and new regulations hinges on whether they play a causal role in accelerating safety progress or simply take place during a time of improving safety.<sup>3</sup> If we observe worker death risk declining during a time when regulation is increasing, do we necessarily conclude that regulation caused the progress?

In recent decades, every facet of daily life has become safer. Airplane fatalities per mile of flying have plummeted (Rose 1992). Death rates from natural disasters have declined sharply and especially in nations with rising incomes (Kahn 2005). As people grow richer, their willingness to pay for safety increases (Costa and Kahn 2004, Viscusi 1993). This translates into a greater demand for safer foods, better medical care and better products. The private sector has a strong incentive to offer such products at the lowest price. As workers acquire more human capital they demand to be safer on the job, and firms who seek to attract and retain trained workers have an incentive to invest in workplace safety.

Against this background,-an important question is how to tease out the signal of rising regulation's contribution to this ongoing safety trend. Over the years, OSHA has enacted many regulations. What is the convincing evidence that OSHA's efforts have caused significant gains in worker safety? The missing data problem is that we do not have access to a control group that would allow us to observe what the U.S. worker safety rate would have been in the absence of such regulation.

It is useful to get some historical perspective on safety in the workplace. There are significant challenges in collecting work-related injuries in a consistent manner over time. The best data relate to workplace deaths (Gray and Mendeloff 2023). Workplace deaths are also the most severe in terms of consequences. Figure 1 shows data on workplace fatalities from 1942 to 2018.

<sup>&</sup>lt;sup>3</sup> In a 2011 speech, Sam Peltzman argues that government regulators often take credit for progress that was taking place for reasons other than their efforts. The observed progress fuels their efforts to enact even more regulations!

www.aei.org/wp-content/uploads/2011/10/Peltzman-Lecture.pdf.



Figure 1. Workplace Fatalities per 100,000 Employees, 1942 to 2018

This figure highlights three points.<sup>4</sup> First, there was no "crisis" in terms of significant increases in workplace fatality risk leading up to the creation of OSHA in 1971. On the contrary, by this metric workplace safety was improving for three decades prior to OSHA. Second, it is quite possible that the creation of OSHA did not meaningfully improve on this pre-existing trend in workplace safety (Viscusi, 1979). Finally, since 2010 it appears that the fatality risk has bottomed out in a range of 0.03 to 0.035 per 1,000 workers.

In thinking about the motivation for OSHA to consider expanding its role in heat-related injuries, the first question is how important are heat-related deaths as a share of all workplace deaths. Figure 2 shows data on this share from 1992 to 2018.

Notes: Data for 1942-1970, Williams and Barth (1973); 1970-1990, National Safety Council (1994); 1980-1995, Marsh and Layne (2001); 1992-2018, Brown (2020)

<sup>&</sup>lt;sup>4</sup> The BLS created the Census of Fatal Occupational Injuries (COFI) in 1992 to improve the workplace fatality data. There are a few years of overlap and the COFI data is higher than the previous data for these years.





Sources: Work-related deaths: EPA's Climate Change Indicators in the United States: <u>www.epa.gov/climate-indicators</u>;Heat related deaths: https://www.epa.gov/climate-indicators/closer-lookheat-related-workplace-deaths

While there has been an upward trend in the share of heat-related workplace deaths since 1992, note that with the exception of 2011 the share remains under 1 percent. This suggests that, even if OSHA's proposed regulations reduced heat-related deaths, this would have little effect on the overall workplace fatality rate shown in Figure 1. OSHA does not regulate mining (MSHA does), and this graph excludes transportation workers and farming. According to BLS they have the highest fatality rates per hour worked.

Construction is one sector where OSHA may be particularly worried about heat-related injuries. Figure 3 shows the heat-related fatality rate in Construction since 1992.



Figure 3. Heat-Related Fatalities Per 100,000 Employees in Construction

Again, there is no evidence of a recent crisis in the heat-related death rate in Construction. While there is year-to-year variability, there is no strong upward trend over the past 30 years that would indicate the need for a forceful intervention by OSHA.

During the Biden Administration, many government agencies have focused on anticipated climate change as a reason for expanding government rules and regulation. In proposing the new rules, OSHA may be trying to get ahead of an anticipated challenge in the coming decades. This prospective approach overlooks the fact that research in climate change adaptation over the course of the 20<sup>th</sup> century points to a remarkably optimistic trend as the death rate on hot days has plummeted across the United States (Barreca et. al. 2016). The diffusion of air conditioning as Americans grew richer and as air conditioners improved in quality and declined in price has played a key role in sharply reducing the mortality risks associated with heat exposure.

While climate change could accentuate the problem of heat-related injuries and deaths, the extent of rising heat across the United States over the next 75 years is subject to huge uncertainty (Koonin 2024). Climate modelers are now emphasizing the more moderate RCP 4.5 scenario over the more severe RCP 8.5 scenario.<sup>5</sup> This means that the world's atmospheric carbon dioxide level will rise less than was previously expected. In addition, there is considerable uncertainty over the climate sensitivity effects caused by rising carbon dioxide levels. <sup>6</sup>

At the same time, the geography of U.S. extreme heat exposure is well-understood, as are demographic trends. Areas further from the Oceans and in the Southwest (such as Texas, Arizona and Nevada) face greater heat risk and growing populations and workforces. Workers who are more susceptible to the heat (and aware of these risks) will have stronger incentives to avoid locating in these areas. Such self-protection efforts reduce the social benefits of OSHA regulation focused on mitigating the effects of climate change on worker safety. As we discuss below, an unintended consequence is that attempts by OSHA to head off this challenge may in fact exacerbate it by interfering with the process of adaptation.

#### Why Heat Avoidance Progress Will Continue Even If OSHA Does Not Increase Regulation

The Figures presented above indicate that great progress occurred in protecting workers well before OSHA was created. The marginal benefits of OSHA regulation are lower if our economy is already reorganizing to "beat the heat". There is objective evidence that adaptation to the heat is already taking place and that most is not due to regulation at the Federal or state level. A majority of the reported heat incidents have been from California and Texas. Thus, it is informative to study what has taken place in California in the absence of federal mandates. Park et al. (2021) study job related injury rates per worker (not per hour exposed) on hot days versus cooler days. They find that the effect of a 90° day fell by a third between 2000 and 2018. They estimate that new state policy accounted for only roughly 30 percent of observed decline in heat-related injuries—the larger balance may reflect adaptation. The menu of market products that facilitate adaptation grows over time. Consider the rise of air-conditioned mail delivery trucks. In a recent article in the New York Times, mail delivery workers in Phoenix and other hot

<sup>&</sup>lt;sup>5</sup> rogerpielkejr.substack.com/p/neither-desirable-nor-possible

<sup>&</sup>lt;sup>6</sup> Lewis (2022)

cities celebrated the fact that their new mail trucks have air conditioning. This transition took over ten years to achieve.<sup>7</sup>

Over time, the logic of the Boskin Report is relevant (Boskin 2005). Quality improves over time and real prices (quality adjusted) decline. This means that one's cooling purchasing power increases over time allowing workers to increasingly be able to protect themselves from the heat. As an example, Amazon now offers for \$79.99 the FlexiFreeze Ice Vest.<sup>8</sup> This is just one of many examples of a free-market adaptation innovation. Amazon sells many other cooling products at affordable prices. For profit firms anticipate the opportunity created by rising demand for heat exposure and they are responding by innovating (Acemoglu and Linn 2004). OSHA is implicitly assuming that the private sector innovation is not targeted to helping people adapt to the heat. This "passive victim" mindset is rejected by common sense and by the growing menu of market products that are offered at ever more affordable prices.

#### Evaluating OSHA's Annual Estimated Benefits

OSHA estimates that the total yearly benefits from its proposed regulations will be \$9.179 billion. Three factors are important to this estimate. First, OSHA's estimate that heat-related fatalities are under-reported by a factor of 14 and HRIs by a factor of 7.5. Second, that their proposed regulations would reduce heat-related fatalities by 95 percent and HRIs by 65 percent. Finally, that the appropriate value of statistical life for each saved heat-related fatality is \$13.77 million and the appropriate value of a statistical injury is \$116,588.

The estimated annual benefit of \$9.179 billion should be thought of as a "potential" not an "expected" annual benefit. OSHA assumes 100 percent compliance when estimating the effectiveness of its regulations. As we discuss below, the expected annual benefit will likely be dramatically lower than OSHA's estimated potential benefit. Each of the three assumptions used by OSHA to calculate the potential benefit is unsubstantiated by the research they cite and dramatically overestimates the annual benefit. We examine each of these factors.

#### OSHA's Under Count Hypothesis

#### Heat-Related Job Fatalities

OSHA's efforts to implement the new regulations are partially based on its belief that more and more vulnerable workers are exposed to rising heat and, combined with its belief that the BLS data sharply under-counts the status quo, morbidity and mortality risk caused by heat.

OSHA claims that the traditional death-certificate-based method of counting job-related heat fatalities undercounts the true rate by a factor of 14. This claim is based on Weinberger et al. (2020) who study all deaths for 297 counties in the U.S. over the period from 1997 to 2016. The authors merge in disaggregated (4x4m) mean daily temperatures. They then estimate the correlation between heat and fatalities. Using this estimated correlation, they calculate that there are 5,608 "excess deaths" each year associated with heat. OSHA extrapolates this finding to the entire U.S. using the total population of counties not included in the study to conclude that there

<sup>&</sup>lt;sup>7</sup> <u>www.nytimes.com/2024/11/26/us/usps-new-mail-trucks.html</u>

<sup>&</sup>lt;sup>8</sup>/www.oteplace.com/en/blog-the-power-of-a-cooling-vest-for-outdoor-workers

are 9,045 heat-related excess deaths per year. Comparing this to the official measure of heatrelated deaths gives the undercount factor of 14.

There are several problems with OSHA's line of reasoning. First, the Weinberger et al. (2020) study estimates a correlation between heat and deaths. This does not indicate that heat caused these deaths. There can be many risk factors that are linked to fatalities and are correlated with heat. All of the effects of these "left-out" risk factors are mis-attributed in the Weinberger et al. (2020) study to heat. For example, if people drive more in warmer weather, then driving-related fatalities would increase even if the risk of a driving-fatality per mile driven is unchanged. An implication is that Weinberger et al. (2020) significantly overstate deaths that are caused by heat.

OSHA does not provide any evidence that the counties not included in the Weinberger et al. (2020) study are similar to the counties included in the study. This is assumed when OSHA extrapolates the 5,608 to 9,045 excess deaths using county population. Importantly, the Weinberger et al. (2020) study examines *all* deaths not the subset of job-related deaths. OSHA assumes that the undercount factor of 14 based on all deaths also holds for job-related deaths. Again, they provide no evidence to substantiate this claim. In fact, OSHA points out this problem 89 Fed. Reg. at 70,966:

"However, it is unclear if this ratio could be applied to CFOI estimates of occupational heat-related fatalities, as it is not clear what proportion of these excess deaths occurred among workers."

Job-related heat fatalities are likely better measured than overall heat-related fatalities. This is due to more careful monitoring and record keeping—for example, due to workers' compensation and mandatory reporting to OSHA of any on-the-job fatality. Death certificates provide a more accurate estimate in that there must be evidence that heat played a key role in the death.

OSHA's claim of an undercount of job-related heat fatalities by a factor of 14 based on Weinberger et al. (2020) is unsubstantiated given the results reported in the study.

#### Heat-Related Job Non-Fatal Injuries

More severe injuries are less likely to be under-counted than less severe injuries. The more severe the consequences from a work-related injury, the more likely the current data collection efforts will record this incident. Severity attracts attention—with fatalities being the extreme case in point. Thus, a severity-weighted index of work-related injuries is going to be more accurate that an unweighted count of work-related injuries. That is, the injuries that currently are most likely to go unreported are not those that offer the best prospects that the benefits of prevention outweigh the cost of prevention. However, OSHA assigns the same value of statistical injury to each heat-related non-fatal injury. We discuss this more below.

The BLS annual Survey of Occupational Injuries and Illnesses (SOII) provides national estimates of workplace injuries and illnesses that are consistently collected across states. The survey is collected from around 176,000 private-industry establishments. Responding employers report information from their OSHA recordkeeping documentation to SOII. For cases that involve at least 1 day away from work after the date of the incident, information is also provided on the demographics of the worker, the nature of the injury/illness, and details regarding the event.

Researchers have criticized SOII as undercounting from 20 to 70 percent of the "true" number of workplace injuries and illnesses. Ruser (2008) indicates that there are several reasons that can create a disparity between SOII and other data on injuries such as workers' compensation. First, there are differences in scope across different data collections. For example, SOII does not include self-employed, household and small-farm workers that are not covered by the Occupational Safety and Health Act of 1970. Second, there can be differences in the types of injuries/illnesses that are reportable across different data systems.

Any comparison between SOII and alternative data sources needs to make sure that cases are selected on an "apples to apples" basis. This is a difficult challenge that many of the empirical studies do not undertake. Ruser (2008, page 28) makes the important observation

"The quality of the undercount estimates depends critically upon how well the SOII cases are matched to workers' compensation cases and how well the researchers can adjust for differences between the SOII and workers' compensation data."

When Ruser's concerns are addressed, the SOII data matchup much better with workers' compensation data. For example, Wuellner et al. (2016) use Washington State workers' compensation data from 2003 to 2011 for the 44,634 establishments that participated in SOII. They find that 50.4 percent of the workers' compensation cases must be excluded since they lacked evidence of missed days of work. That is, the largest source of an undercount are low severity cases. An additional 7.2 percent of cases were excluded based on location data indicating an establishment not surveyed by the BLS. A final 1 percent were excluded for other reasons such as mismatch in reporting of the timing of the injury/illness. Once these adjustments were made, on a sampling weighted basis the SOII data captured 70 percent of the workers' compensation cases. This does not indicate that serious heat-related injuries are in fact significantly more prevalent than the SOII data would indicate.

OSHA's claim that non-fatal on-the-job heat-related injuries are undercounted by a factor of 7.5 does not hold up to careful analysis—especially focusing on those injuries that were not minor in nature.

#### The Effectiveness of OSHA's Proposed Regulations

OSHA uses a variety of studies of single and multiple interventions to evaluate the potential effectiveness of their proposed regulations. The most relevant studies are field studies involving work that would most likely be covered by OSHA's proposed regulations. OSHA concludes from their survey of the research that their proposed regulations would on average prevent 95 percent of heat-related on-the-job fatalities and 65 percent of on-the-job HRIs.

There are two basic flaws in OSHA's analysis the supports these two conclusions. The first problem is an implicit assumption about full compliance. Since OSHA applies these effectiveness rates to their grossed-up fatalities and HRIs (that is adjusting for their estimates of undercounting), they are assuming 100 percent compliance [page 70967]. As we discuss in more detail below, if firms were unwilling to voluntarily adopt all of OSHA's measures, then it will be impossible for OSHA through inspections to achieve anything close to full compliance.

The second problem is that OSHA is mistaking the overall effectiveness as the marginal effectiveness. The overall effectiveness would be the reduction in heat-related on-the-job fatalities and injuries in an environment where firms were currently not following any of the

requirements in the proposed regulations. The marginal effectiveness is the reduction in heatrelated on-the-job fatalities and injuries given the actions that firms are currently taking to protect workers from heat. Even in a world of full compliance, the marginal effectiveness will be lower than the overall effectiveness.

Many firms, especially larger firms, are already adopting many of the practices that OSHA wants to make mandatory. These large firms also account for a sizeable fraction of the workers that would be covered by OSHA's new regulations. This significantly reduces the likely marginal effectiveness of OSHA's proposed regulations—and consequently the estimated annual benefit.

A third consideration is that the estimated benefits of various remediation practices found in research studies likely overstate the marginal benefits in practice. This gets back to our point on heterogeneity in firms and workers that is unobserved to researchers. As we noted earlier, the market has much more information than any researcher or regulator. The benefits of any remediation technique will vary across firms. It is likely the case that firms that have not adopted a technique (these are the firms that determine the marginal effectiveness) have chosen not to do so since their benefits from adoption are lower than the average. Requiring these firms to adopt the technique will not produce the average benefit.

#### The Value-of-Statistical Life and Injury Appropriate for OSHA

#### Value of Statistical Life

OSHA indicates that it is using a common value of statistical life (VSL) developed by the Department of Transportation. In 2023 dollars, this is \$13.77 million. They apply this value to each potential on-the-job heat-related death that will be avoided by their proposed regulations.

One way to proxy the economic value of life is the value of the lost output to the economy from an individual dying. A proxy for the annual value of this output is the individual's earnings. Workers with more human capital and higher earnings have a higher value of life for an economy. More recent estimates of VSL are based on a revealed preference approach based on what individuals are willing to pay to reduce or eliminate risks. A frequent application is to estimate compensation wage differentials for job-related risks.

OSHA takes its VSL estimate from the Department of Transportation (DOT). In their guidance, the DOT explains why they use a single VSL for all estimated fatalities avoided through transportation regulation:

"Safety regulations issued by the Department of Transportation typically affect a broad cross-section of people, rather than more narrowly defined subgroups. For that, and other policy reasons, we do not consider variations in VSL among different population groups in this guidance." DOT (2021), page 3

However, OSHA's proposed regulations will affect specific groups of workers who are not a cross-section of the population. The annual earnings by workers who will be most affected by OSHA's proposed regulations are likely to be below the U.S. average annual earnings. OSHA acknowledges this when they state "...HRIs and heat-related fatalities are concentrated among low-income workers." 89 Fed. Reg. at 70,999 This is especially true for the workers who OSHA claim will benefit the most since they are trapped in their jobs—such as undocumented immigrants—and are exploited by their employers. Recalculating the VSL based on the workers

who will actually be covered by OSHA's new regulations would significantly reduce the estimated VSL.

OSHA should calibrate its VSL used in its benefit estimation for the characteristics of the workers likely affected. One way would be to adjust the VSL by income differences. Costa and Kahn (2004) estimate an income elasticity of VSL of 1.5 to 1.6. Viscusi and Ziliak (2010) estimate an income elasticity of 2.24 for low-income workers and 1.23 for high income workers. Another dimension of adjustment is the immigrant status of workers. Hersch and Viscusi (2010) estimate that immigrants have a VSL that is 60 percent of the value for native born U.S. workers. Among immigrants, those of Mexican descent have even lower VSL. These adjustments would significantly lower the VSL appropriate for OSHA.

Another consideration in calculating the VSL is how long an individual is expected to live and work absent the fatal injury. As we have mentioned, many workers who suffer a heat-related fatality have other significant health problems such as obesity, diabetes or heart disease. This means that their risk of death from other causes is higher than for the average individual, which shortens their expected years of future work. Taking this into account would further lower the estimated VSL appropriate for OHSA.

#### Value of Statistical Injury

As we noted earlier, OSHA applies the same VLI to each prospective on-the-job heat-related injury that they estimate that their proposed regulations will prevent. In calculating the total number of these injuries, they assume an undercount by a factor of 7.5. As we discussed, the actual undercount of injuries that involve at least one day of missed work is more likely in the range of 30 percent.

More than half of uncounted on-the-job HRIs involve injuries that did not involve a day or more of missed work. These are the most prevalent HRIs that OSHA may prevent, yet OSHA applies a VSI of \$116,588 to each of these injuries. In addition, 35.8 percent of non-fatal HRIs involve only 1 day of missed work and 81.2 percent involve 5 or fewer days of missed work. Applying the same VSL to all injuries makes no economic sense. The aggregate VSI should reflect the distribution of severities.

For larger firms, their workers are likely to be covered by workers' compensation. In this case, the worker will be compensated for medical expenses and missed days of work. If the firm's premiums are experienced rated, these costs will be reflected in the firm's premium. This means that the VSI is already being incorporated by the firm. Including these HRIs in OSHA's calculations involves double-counting.

Medical costs associated with an injury do not vary by the worker's human capital. However, the value of lost workdays does depend on a worker's earnings. The lower earnings for workers likely to be covered by OSHA's proposed regulations imply both a lower VLS and VSI. This implies that for the more serious HRIs that involve lost work days, OSHA is overestimating the benefits from reducing their frequency.

OSHA acknowledges that workers exposed to heat risks differ from the average population of workers. They indicate "...workers from low-income households are disproportionately exposed to heat-related hazards." [page 70994]. In addition, Park et al. (2021) estimate that HRIs increase relatively more for lower income workers as temperatures rise above 90°F.In summary,

for each of the three components that go into OSHA's estimate of the annual benefit from their proposed regulations OSHA is inflating the value. The undercount is lower than what OSHA assumes, the marginal effectiveness is lower than what OSHA assumes, and the VLS and VSI are lower than what OSHA assumes. The likely value of the annual benefit if the new regulations are approved will be significantly lower than \$9.179 billion.

#### **Evaluating OSHA's Annual Estimated Costs**

OSHA focuses its analysis exclusively to estimating the compliance costs to firms from the new regulations. The assumption by OSHA is that if these costs are less than 1 percent of a firm's revenues, then the regulations are not burdensome. Implicitly, OSHA is also assuming that when this 1 percent threshold is met that firms will comply with the regulations without any intervention by OSHA in terms of inspections. OSHA's analysis indicates that with only a few exceptions the 1 percent threshold will be met.

OSHA also argues that even in the case where their regulations would be a significant burden to a firm that there is a "free lunch" option available.

"If the costs of complying with the proposed standard were onerous, limiting employee exposure to the outdoors during times of extreme heat would be a costless method to comply with the standard and could possibly result in these employers being fully exempt from the standard." [page 70976]

OSHA seems to have forgotten about the concept of "opportunity cost" taught in Introductory Economics.

As discussed above, OSHA assumes full compliance in calculating their annual benefit. If firms did not voluntarily adopt the practices now required by OSHA, it is unlikely that they will simply adopt them unless there is some risk of detection and sanction. OSHA will have to target small firms to have any hope of reducing HRIs. However, this segment of the market is the most difficult to use a regulatory approach. Regulations rely on inspections and fines to create incentives for compliance. Two facts highlight OSHA's problem with HRIs—the vast number of small employers and the concentration of high heat in a few months of the year.

OSHA estimates that their proposed regulations would affect approximately 2.0 million small employers. They would need an army of inspectors to generate any reasonable probability for inspecting a high percentage of small employers during a year. However, OSHA cannot spread these inspections out over the year, since it is useless to inspect an employer for how it manages hot weather during the middle of winter. This means that OSHA needs a large enough army of inspectors to cover a high percentage of small firms in a concentrated period of time. This type of large-scale operation also needs advanced scheduling. However, extreme hot days don't necessarily follow a schedule even during traditionally hot months. Redeploying inspectors across markets on short notice based on real-time weather monitoring is an impossible task. Another question is what would this army of inspectors be doing during the 9 to 10 months out of the year where inspections are unhelpful? How else would they be used? Like actual armies—the most practiced skill is waiting.

Suspending disbelief for a moment and assuming inspectors manage to be at the correct worksites on the correct hot days and they observe the employers' degree of regulatory

compliance, how effective will fines be for improving compliance? Current fines and the threat of escalating future fines incentivize compliance best when employers are engaged in a "repeated-game" with OSHA. However, small employers, especially in Construction, can dissolve and reconstitute themselves on a regular basis. This reduces the efficacy of fines to induce compliance.

Would larger fines address this problem? There are two reasons why this is unlikely to help. First, if a small employer declares bankruptcy as a result of a fine, a larger fine will have little marginal financial impact. Second, inspectors may be reluctant to impose a larger fine if the inspector believes the large fine is "unfair." Deterrence depends on the expected fine. Larger fines may not result in commensurately higher expected fines if the larger fines induce a lower rate of being imposed.

It doesn't take a skilled engineer like Elon Musk to point out the problem with OSHA vastly expanding its regulatory mandate to solve a problem that has already largely been solved, using an approach that is grossly inefficient, and where the costs are likely to be paid for by workers. The better strategy is for OSHA to dodge their new effort rather than having Musk's DOGE shut down their efforts!

#### A Description of the New Heat Regulation

Here we provide a direct quote from OSHA describing the regulations.

#### "What workers would be covered?

Anyone working outdoors or indoors in general industry, construction, maritime and agricultural sectors where OSHA has jurisdiction. That includes many occupations where we know workers are at high risk of heat hazards, such as farm workers, restaurant workers, construction workers, delivery drivers and many more. For outdoor work, employers would need to track the local heat index (temperature + humidity) forecasts, or measure the heat index or the "wet bulb globe temperature" (WBGT). For indoor work, employers would need to identify work areas with hazardous heat exposure, and to develop and implement a monitoring plan for those areas by measuring the heat index or WBGT.

A heat index of 80°F is the initial heat trigger. At or above this initial heat trigger, an employer would be required to: ensure workers have readily accessible, cool drinking water (at least 1 quart per hour); allow paid rest breaks if needed; at outdoor work sites provide one or more readily accessible break areas with shade or air-conditioning if in an enclosed space, like a trailer, vehicle or structure; at indoor work sites provide one or more readily accessible break areas with air-conditioning or increased air movement and, if appropriate, de-humidification; implement an acclimatization plan for the first week of work for new and returning employees; and communicate regularly with employees.

At or above the high heat trigger, when there is a heat index of 90° F, an employer would also be required to: provide paid rest breaks – a minimum of 15 minutes every two hours (a meal break – whether paid or unpaid – may also serve as a rest break); set up an observation system

to check employees for the signs and symptoms of heat-related illnesses; and maintain effective two-way communication with employees who are alone at a work site at least every 2 hours."<sup>9</sup>

#### Our Critique of The Scientific Justification for this Regulation

The proposed regulation will reduce worker exposure to extreme heat hours. It is crucial to have an estimate of the benefit of such a marginal change in time allocation. This then needs to be compared to the marginal cost. We argue that OSHA cannot answer this based on the observational studies that have been conducted. We present a critical review of the scientific basis for OSHA's proposed rules.

Every introductory statistics student is taught that correlation does not imply causation. In this section, we argue that the observational studies that OSHA relies on present interesting correlations, but these estimates are conditional on many factors and reflect fundamental self-selection issues such that one cannot generalize from these results to make any sweeping conclusions. Put simply, vulnerable subgroups may be self-selecting into the high-heat jobs and their subsequent health challenges mainly reflect a selection effect rather than a treatment effect.

In making the case for introducing the new rules, OSHA points to a series of observational studies documenting a positive correlation between heat and morbidity and mortality loss.

One example of such a study is Petitti et. al. (2013). This empirical study is set in Maricopa, AZ. The methodology uses a case-control matching approach where workers of the same age, race and gender are assigned to each other as "twins". The researchers then compare the fatality rates differentials across occupations for the different demographic groups. This type of observational study implicitly assumes that one's age, race and gender is sufficient information to create "twins". Note that these coarse categories reveal nothing about genetic traits of individuals, ongoing chronic conditions or diet and habits. To repeat this point, this typical study matches on easy to collect observable attributes but implicitly assumes that those who are exposed to high heat are identical to those who are not exposed to high heat on unobservables such as whether the person has Type 2 Diabetes. The authors point out several problems with their own research design. First, they rely on death certificate information to know a person's occupation. This is notoriously error prone. Second, they admit that their results are consistent with the selection hypothesis. Here is a direct quote: "The fact that the highest risk of heatassociated death in association with agriculture occupations was observed in men age 65 years or more raises the possibility that occupation may be a marker for the risk of heat-associated death and not due directly to work in agriculture or work out of doors." (Petitti et. al. 2013).

To illustrate one of the data challenges that arise in disentangling the causal effect of heat from selection effects, we present a simple numerical example. Heterogeneity in the health status of workers who are exposed to hot days complicates the estimation of the underlying heat risk,  $\beta$ . Consider a simple example with just two types of workers—those in good health and those in poor health. Assume that healthy workers make up 80 percent of the workers who are exposed to hot working conditions. As shown in Figure 4, for each level of heat exposure the fatality risk is lower for healthy workers. Assume that both types of workers will quit when their personal risk

<sup>&</sup>lt;sup>9</sup> See: https://blog.dol.gov/2024/09/03/8-things-to-know-about-oshas-proposed-heat-rule

level reaches 0.03. For workers in poor health this occurs at 8 days of hot weather per year. For workers in good health this occurs at 12 days of hot weather per year.<sup>10</sup>



Figure 4. Estimating Heat Fatality Risk With Two Health Types of Workers

The actual relationship between heat exposure and risk of fatality is illustrated as a linear spline where the risk increases faster at 10 or more days of exposure in a year.

The health status of workers is unobserved to researchers, so they cannot control for this heterogeneity in their statistical analysis. Instead, a researcher can estimate the average fatality risk at each exposure level of hot days. This average fatality risk/exposure relationship is shown in Figure 5.

<sup>&</sup>lt;sup>10</sup> While our example is meant to be illustrative, Dailly et. al (2018) report estimates of the impact of heat on Guatemalan sugarcane workers who do and do not have impaired kidney functions.



Figure 5. Average Observed Fatality Risk With Heterogeneity in the Health Status of Workers

The estimated heat exposure/fatality risk does not reveal the true risk relationship for either type of worker. That is, it does not identify  $\beta$  in our simple model outlined in the Appendix, nor does it identify the differential risk due to health status ( $\theta$  in the model). In addition, the estimated risk declines at 8 days of exposure per year. The decline in the estimated health risk would be difficult to explain in a world where all workers are similar. With heterogeneity, this decline is due to the shift in the composition of the workforce as the workers in poor health quit this line of work. This simple example illustrates the challenge of unobserved heterogeneity in economic analysis that has been the focus of Heckman's research.

The Appendix details the employer/worker-level data that would be required to estimate the health risk associated with stressful work on a hot day. The data requirements go way beyond the data currently available to researchers. To the extent that employers have identified other more efficient modifications, they may drop or reduce these efforts due to the imposed new regulations. A second challenge is how regulation would affect the sorting of workers by health status across employers/sectors. If the new regulations made workers with health risks more willing to work in jobs such as Construction, then this would change the composition of workers in the direction of higher HRIs.

How much these regulations reduce worker heat exposure depends on what would be their heat exposure under "business as usual". Why are workers exposed to heat? If it is hot outside for 8 hours, this does not mean that workers are exposed to eight hours of heat that day. Some jobs are inside, other jobs have regular breaks or the timing of work can be shifted to miss out on the peak heat hours.

What we are interested in estimating is how the probability of a workplace injury/fatality changes for an additional hour of exposure to high heat on the job. If we run a regression where our dependent variable is the number of annual fatalities in a location divided by the average number of workers in that location/year and our explanatory variable is the total number of hot days in that location/year, this will not estimate the necessary risk relationship. This would only be the case if every hot day was a workday, every worker is otherwise healthy and was exposed to the heat for the full day while engaging in stressful work, employers make no attempt to mitigate the heat-related risks and workers make no efforts to protect themselves from the heat. To the extent to which any or all of these conditions do not hold, the data analysis will not uncover the desired risk relationship.

Douglas Parker has served as the Director of OSHA since November 2021 and is well aware of his agency's data gaps in enacting this regulation. In a transcript from an interview in 2022, at the 16:47 mark he said;

"We have been struggling with how we can use our data to better inform our activities and work smarter uh and it begins with sort of understanding the nature of the issue and so we've been working with our data BLS data Census Data um you know American Community survey data and looking at how we can overlay different data points to get an understanding of where vulnerable workers are, what industries they are in, what is the relationship between our various enforcement and Outreach and other activities, and where those workers are both geographically and in terms of their industry um where complaints come from and, more importantly, don't come from so that we can get an understanding of where there might be barriers to that where our information is limited because a lot of data on this is limited, there's not simply not good data um at a at a granular level um connecting a lot of demographic characteristics with say worker injuries I mean there's simply outside of fatalities it's it's somewhat limited it is and so um we're looking at how we can connect the dots with the available data that we have to see how we can do a better job where there's where there are areas that we are missing"

#### **OSHA's Over-Emphasis on Correlation Studies**

Facing major data gaps, OSHA relies on correlation studies to make the case for the benefits of regulation. OSHA must rely on such observational studies because it cannot implement randomized control trials where it exposes a group of workers to extreme heat. Intuitively, a "gold standard" randomized treatment design would take a group of outdoor workers and randomly assign them to a treatment group and a control group. The treatment group would engage in stressful tasks in 90-degree day conditions. The control group would not engage in these tasks or be exposed to the heat. Such a treatment/control experiment would allow the heat researcher to observe the average treatment effect of unmitigated heat exposure for those who participated in the experiment.

Without having access to such randomized experimental data, OSHA relies on correlationbased papers for different populations. An example is Heinzerling et al. (2020). This paper calculates conditional heat related injury rates per 100,000 California workers in the recent past. For example, firefighters have a HRI rate that is 7 times larger than Protective Services workers', and men have an injury rate that is 2 times higher than women. This is useful descriptive research documenting how injury rates vary as a function of demographic and occupational risk factors. However, this type of analysis does not identify the differences in heatrelated risks facing these different workers.

While OSHA recognizes the fundamental data gaps in the observational literature studying the heat and injury/mortality relationship, the regulator continues to imply that causality can be inferred from observational correlation studies. This descriptive research cannot identify the key

risk of interest which is the extent to which heat causes an injury/death to a healthy worker engaged in stressful work for an employer making no effort to mitigate the risks. The empirical researchers simply do not have the necessary data to uncover these behavioral adjustments to the day-to-day heat challenge. OSHA glosses over this fundamental point in its scientific review of the literature.<sup>11</sup>

As a simple illustration, look at our earlier Figure 4. It displays two different mortality gradients for the two types of people. The fundamental choices these different people make generates Figure 5. Figure 5 represents an example of what empirical researchers can collect data on. Our point is that from Figure 5, you cannot "reverse engineer" these data to recreate Figure 4. OSHA's regulators ignore this fundamental point. When people differ with respect to their capacity to cope with heat and when they are aware of this fact and systematically make exposure choices based on this fact, the observer learns little about these people from studying population averages. The Nobel Laureate James Heckman has emphasized this point in a series of papers.<sup>12</sup>

# Low Quality Data Limits OSHA's Ability to Measure the Benefits of Its Heat Exposure Regulations

The Director of OSHA openly admits that his agency is proposing new regulations while relying on highly incomplete data. Current data allow one to measure if a worker died, but for such a worker it is very difficult to know how many hours this worker was exposed to what degree of actual heat while engaged in what degree of stressful work and with the benefit of what mitigations. In this section, we describe the large number of choices and margins of adjustment that must be quantified to demonstrate the marginal risk increase caused by an extra hour of heat exposure. Why? The regulation aims to reduce this exposure, so knowing the marginal risk is important for determining what the benefits will actually be for different workers.

Here we spell out the extremely challenging data problem facing OSHA in understanding this marginal risk and making the case for additional regulations. As we detail below, current data does not allow OSHA to separate variation in heat related injuries (HRIs) into the contribution of heat (the key focus of OSHA), mitigation efforts by employers, self-protection by workers and pre-existing health status of workers. As a result, it is impossible for OSHA to calculate the marginal health benefits from any additional regulations and the associated marginal costs. The bottom line is that OSHA should be humble in recognizing its limited knowledge and that the collective knowledge of markets is much more extensive. This suggests focusing on "market-based" approaches.

The object of interest is the death risk to a healthy worker doing a stressful job with no mitigation on a "hot" day. As discussed in the Appendix, this requires location/date-specific information on "hot" days, how many workers an employer had doing stressful tasks on these days, any preexisting health risks by these workers, and any mitigation efforts by the employer. No study estimating heat related health risks has had access to this level of detailed data. Consequently,

<sup>&</sup>lt;sup>11</sup> www.osha.gov/sites/default/files/Heat-NPRM-Final-Background-to-Sum-Ex.pdf

<sup>&</sup>lt;sup>12</sup> See for example Heckman et al. (2006)

no study has estimated the marginal risk of heat exposure to an otherwise healthy worker, which we denote as  $\beta$ .

What are the likely biases to the estimate of  $\beta$  given current data limitations? Only a fraction of an employer's workers will be doing stressful work on a hot day. Implicitly assuming that all of the firm's workers are "at risk" will result in a downward bias to the estimate of  $\beta$ . Employers may be using a variety of mitigation efforts. Implicitly assuming that there is no employer mitigation will also result in a downward bias to the estimate of  $\beta$ . On the other hand, not all workers who may be exposed to heat are healthy. Implicitly assuming only healthy workers are doing stressful tasks on hot days would result an upward bias to the estimate of  $\beta$ . The net bias depends on the prevalence of each of these three factors.

Since mitigation, health risks and heat exposure interact in the risk relationship, we need individual level data on these factors to carry out the estimation. Even if we know the average mitigation for employers in a location, the fraction of workers with health problems and the fraction of workers in a location across employers doing stressful work on a hot day, this will not necessarily give us an unbiased estimate of  $\beta$ . For example, if the three risk factors are positively correlated, then controlling for the averages of the risk factors in our regression will result in an upward bias in our estimate of  $\beta$ .

More typical is that researchers do not have any data on employer mitigation efforts, the fraction of employees with health problems, or the fraction of employees that are engaged in stressful work on a hot day. An example is Park et al. (2021) who use California Workers' Compensation data on the number of work-related injuries in a zip code on a date over the period from 2000 to 2018. Indicators for date-specific different temperature ranges are merged in at the zip code level. There is no scaling by employment or hours on that day in that zip code. The authors interpret the coefficient estimates on the temperature range indicators as estimates of the marginal heat-related injury risk.

It is important **not** to interpret these as estimates of the  $\beta$  of interest. Rather, these are simple correlations between local work-related injuries and local temperature ranges that also reflect any mitigation efforts, employee health problems and the amount of stressful work that is carried out on those days. Consequently, these estimates cannot be used to evaluate the costs versus benefits of different interventions. In addition, given that the underlying risk factors may change over time and across locations, the estimates from this approach can vary from sample to sample even if the underlying risk  $\beta$  is constant. The causal effect of heat exposure on each type of person also is likely to vary by local air pollution, PM2.5 levels. This further complicates attributing deaths to heat exposure alone.<sup>13</sup>

Up until now, we have assumed that all workers are equally sensitive to heat exposure. In reality, OSHA is justifying its regulations by arguing that some groups such as overweight individuals and Type 2 diabetics face a greater marginal health effect from heat exposure. If workers with these conditions are aware of their risks from heat exposure, then they should be less likely to work in these jobs unless they have no other choices (Heckman et al. 2006). We

<sup>&</sup>lt;sup>13</sup> Rahman et al. (2022) and Bell et al. (2024). See also <u>keck.usc.edu/news/risk-of-death-surges-</u> when-extreme-heat-and-air-pollution-coincide/

return later to the topic of increasing worker awareness of risks and choices of jobs as an alternative to regulation.

To summarize, OSHA is regulating under conditions of ignorance and uncertainty. It faces fundamental data gaps. These data gaps limit the agency's ability to rigorously test the causal claim that heat exposure causes significantly higher fatality risk. The positive correlation between injuries per hour and outdoor temperatures could reflect selection factors concerning who are the workers working in these jobs. What pre-existing conditions do they have? Would these same workers suffer similar health conditions even if they were not exposed to high heat? In short, is the observed heat-sickness correlation generated by a selection effect (what types of workers are exposed to extreme heat) versus a causal effect of heat on health outcomes. There is likely significant heterogeneity in underlying heat-related injury risk across detailed industry/occupation groups. If the mix of hours across these groups shifts with temperature, then this can induce changes in the heat-related injury counts that are unrelated to health-related risks. While the selection hypothesis increases the challenge for justifying OSHA's proposed regulation, it does raise the possibility of successfully using a "lighter regulatory touch" to protect vulnerable workers. We return to this point below.

#### An Evaluation of Two Specific OSHA Claims

In justifying the proposed regulation, OSHA assumes that reduction in pacing offsets about 70 percent of the cost of mandatory rest breaks. If this claim is transparently true, then profit maximizing firms should already be offering these breaks. Many firms searching for solutions while competing for workers and customers drive knowledge acquisition. Firms in competitive markets that do not incorporate this knowledge will go out of business. This is why, as we indicated earlier, the collective knowledge of markets will always exceed that of OSHA.

Second, OSHA has claimed that the relationship between the heat index and productivity losses is linear. While this conjecture simplifies the analysis, we know of no logical basis for why this type of relationship would be true. As the temperature rises above  $32^{\circ}F_{7}$  snow melts, but this is not a linear relationship. As shown in the model presented above (details in the Appendix), what is crucial is how workers and firms jointly respond to the rise in the heat index. These responses interact and will cause the observed relationship to deviate from the underlying relationship in a non-linear fashion.

If workers understand the heat risk to their health, then they will require a compensating wage differential if the firm does not mitigate the risk. If a firm is aware that unprotected exposure to an hour of 90°F heat sharply reduces worker productivity, then the firm has an incentive to compare the combined loss from reduced productivity and higher wages to the cost of mitigation. If mitigation is less expensive, then the firm will increase its profits by voluntarily protecting the worker. In this case, the statistical researcher never observes the worker's productivity "fall off the cliff". To repeat our point, we expect that there is a convex relationship between lost productivity and exposure to unprotected high heat but, because this relationship is known, the firm and the worker take proactive steps to mitigate these effects thereby "flattening the curve."

#### A Microeconomic Analysis of the Likely Economic Impacts of the Proposed Regulation

If OSHA insists on regulating heat-related risks, then what might be the unintended consequences? There are two interesting cases to consider–when employers face an elastic supply of labor and when they face an inelastic supply of labor. Start with the case that employers face an elastic supply of labor (that is, if firms tried to reduce wages a significant fraction of their workers would quit). If employers require workers to be exposed to heat-related risks, they will have to pay a higher wage, or workers will choose alternative jobs. Employers will not be able to shift the costs of OSHA's new regulations onto workers. However, to the extent that the regulations reduce heat-related risks, wages will decline. Employment will also decline due to the higher costs facing firms. While the intent of the regulations was to improve workers' welfare, their economic surplus declines.<sup>14</sup> This is due to the decline in employment as well as the fact that some workers preferred the earlier higher wage in exchange for the heat risks.

Now consider the case where there is an inelastic supply of labor. In this case, the regulatory cost is shared between employers and workers depending on relative labor demand and supply elasticities. If workers lack good alternative job opportunities, then employers will be able to shift much of the regulatory cost onto workers through lower wages. In this case, the imposed regulatory solution will likely be inefficient and workers will bear the cost. The cost will consist mainly of lower wages to compensate employers for the regulatory costs rather than employment declines.

The important point is that in less competitive markets where OSHA believes that its regulations will benefit workers the most, workers will end up paying a large share of the costs. The shifting of the cost of the regulations from employers to workers is an unintended consequence. The key issue is that OSHA's regulations are treating a symptom, rather than the source of the problem. The source is the inelasticity of labor supply to these employers. This is what needs to be addressed, and then the market will produce a more efficient reduction in heat-related risks without the regulations and with employers bearing more of the costs.

This is not a new issue for regulators. As emphasized by Sam Peltzman, regulations often have unintended consequences. Past research has documented that the Americans with Disabilities Act regulations resulted in lower-employment of people with disabilities. (Acemoglu and Angrist, 2001). In a similar spirit, this regulation may not benefit the workers who were supposed to benefit from it.

Consider the construction sector. If substituting machines for labor is difficult in many construction tasks, then there is likely a degree of inelasticity of demand for construction labor. On the supply side, if there are many builders that workers can switch between, then there is likely a relatively high labor supply elasticity. This would suggest that much of the cost of regulation is on builders (or passed through to their customers). However, if minimum wages are binding for some types of construction jobs, then even in the case of an inelastic supply of labor this restricts the ability of builders to attempt to pass on the cost of additional job safety through lower wages.

<sup>&</sup>lt;sup>14</sup> By "economic surplus" we mean the difference between what workers' are willing to accept for a job and the wage that is actually paid. We sum this difference across all employed workers.

If heat-offsetting capital is really cheap to buy (such as a great fan), then even in the absence of regulation the firm will acquire this capital. If mitigation methods are cost-effective, then requiring them through regulation would seem to provide little marginal benefit. Firms and workers would have a joint incentive to acquire and use these methods without a regulation. Disreputable builders might be able to exploit illegal immigrants who would find it relatively <sup>15</sup>more difficult to quit and find alternative work. For these workers, it is not clear if regulations (with a difficult enforcement process) would help this situation. We discuss later an alternative solution for this problem.

If OSHA cares about the distributional impacts of any new regulations, then workers will bear less of the regulatory costs the more competitive the labor market. The irony, then, is that if OSHA argues that regulation is more important in non-competitive labor markets, these are the markets where relatively more of the regulatory costs will be shifted onto workers.

The regulation is less likely to offer benefits in competitive labor markets (since employers are already incentivized to provide mitigation or increase pay to adjust for increased heat risk) and is likely to (on-balance) to harm workers in non-competitive markets (where workers will bear more of the regulatory cost). In our own research on the spatial economics of labor market monopsony, we have documented that housing rents are lower in local markets featuring more monopsony power (Kahn and Tracy 2024). This implies that in areas where workers have fewer employers to choose from, lower rents will give workers the purchasing power to pay for their own heat-shielding equipment and clothes.

#### A More Cost-Effective Strategy for Protecting Vulnerable Workers

Consider the subset of American workers who have chosen to work in an isolated area with relatively few employers and who work in outdoor occupations-doing stressful work in hot conditions. Among these workers, consider the further subset who are overweight or have other pre-existing medical conditions such as diabetes or heart conditions that place them at greater risk of heat-related injuries. Among this group, consider the less educated who on average will earn less. This group is both vulnerable and at risk. How can a compassionate society better protect them?

The first thing to note is that in places with extreme heat and a weak local market, rents will be very low. This increases household purchasing power, allowing such individuals to buy their own self-protection equipment. Also, any lack of awareness of "cause and effect" and how to protect themselves is a temporary, not a permanent condition. They will learn strategies from their more experienced co-workers for better dealing with the heat. For this reason, the most vulnerable time is the initial couple of weeks on the job. Reducing HRIs in this initial period to the level of experienced workers represents "low hanging fruit."

The second thing to note is that large firms with experience-rated workers' compensation premiums have a financial incentive to improve on-boarding and acclimatization of new workers

<sup>&</sup>lt;sup>15</sup> Even some of OSHA's literature seems to support this-- some of the literature suggest that their proposed interventions increase productivity. If this is actually true, employers are already incentivized to implement them. See, e.g., 89 FR 70752 (Chan, particular rest breaks maximize productivity time); 89 FR at 70756 (Foster, fans improve work output in certain low clothing coverage conditions); 89 FR at 70757 (McLellan and Selkirk-- water improves work time);

who must contend with heat. Smaller firms that participate in workers' compensation will not have experience-rated premiums and so do not face the same financial incentives. Very small firms (common in Construction) will not be covered by workers' compensation. Also, compensating wage differentials, to the extent that they exist in the market, are likely to reflect the more persistent level of heat risk faced by more experienced workers, rather than any transitory risks faced by inexperienced new hires.

A key to reducing on-the-job HRIs is empowering employers and workers to make better choices. The government can play the role of an "honest broker" by providing information and educating workers about potential risks and mitigation strategies. For example, providing consumer product testing and reviews of new protective products. We also need to look for creative ways to strengthen financial incentives for small employers to adopt "best practices" for heat mitigation.

An optimistic hypothesis that OSHA ignores is the ongoing market innovation in introducing and improving adaptation products. As workers are better informed, they demand better market products that help them to offset their heat exposure. This adaptation progress is likely to accelerate over time. For example, the growth of IT technology leads to widespread cheaper and more accurate sensors and cell phone deployment. Over time, improvements in weather forecasting and the reduction in the cost of sharing such information by smart phone technology have allowed more workers at risk to be aware of extreme weather and pollution days. The knowledge that a heat wave will occur in the next week provides valuable information that helps firms and workers to plan their schedules. Mitigation actions can occur ex-ante as well as in real-time improving their effectiveness and lowering their costs–all without OSHA inspections and fines.<sup>16</sup>

Technological and product innovation will improve the ability of employers and workers to manage high heat more effectively and at lower costs. Light-weight wearables can now monitor real-time environmental conditions and body temperature. These devices can track ambient temperature, radiant heat and relative humidity at the work location.<sup>17</sup> More advanced devices can measure a worker's physiological responses to heat including core body temperature (as opposed to skin temperature) and heart rate. The cost of these devices will continue to decline over time even as their quality steadily improves. These advances offer the prospect that employers can tailor mitigation specifically to individual workers, even when they are not informed about their specific health conditions. Procedures can be put into place on what a worker should do if given an alert from their personal device. Similar progress is being made on protective clothing.<sup>18</sup>

<sup>&</sup>lt;sup>16</sup> If localities have limits on how early work can start on job sites, then scheduling flexibility could be improved by relaxing these constraints on a day with a heat alert. This would allow work to begin earlier when it is still relatively cool and end prior to the hottest part of the afternoon.

<sup>&</sup>lt;sup>17</sup> Most deaths occur when a U.S. National Weather Service heat warnings describing a risk of heat stroke were not in place, Roelofs (2018).

<sup>&</sup>lt;sup>18</sup> A type of "rebound effect" may occur that as these protective technologies improve, workers may spend more time outside doing their jobs. This rebound effect will be less likely to take place if workers of different ages and facing different pre-existing chronic health conditions are aware of their risk exposure. Personal wearables that measure stress and one's pulse and body temperature would provide this realtime information.

If vulnerable workers are increasingly aware of the "cause and effect" relationship as well as outdoor conditions and if the price of adaptation products is declining, then the net effect of outdoor heat on fatality risk should decline over time. This also creates the most optimistic scenario for how to deal with potential long-run climate risks that will vary by location.

#### A "Light Touch" Lower Cost Strategy for Protecting Vulnerable Workers

The intent of this regulation is to protect uninformed, vulnerable workers. The core hypothesis is that these workers are unaware of the risks they face and are "passive victims" with no individual strategies to protect themselves. While a regulator's first instinct is to regulate, an alternative approach is to facilitate private sector solutions. New and small firms may not have as much knowledge about heat risks. Making this information more accessible could help close this knowledge gap. In addition, policies that act to increase the effective labor supply elasticity facing employers in industries where heat risk is relevant would make it more difficult to exploit workers. This would increase compensating wages, thereby leading to more mitigation without more regulation. The stronger is the competition in markets the weaker is the case for additional regulation.

Effective mitigation need not be that costly. Learning on the job as well as acclimatization are both important ways to mitigate heat-related risks. A high percentage of heat-related injuries— especially fatal ones—occur during the first week on the job. More effective "on-boarding" of new workers need not be a long and involved process. In addition, workers can be better trained to recognize a heat-related injury and to quickly provide first-aid. As just noted, there is a mutual interest between employers and workers in this joint production of safety.

As we noted above, experience rating of workers' compensation premiums creates financial incentives for large firms to mitigate on-the-job risks. How do we enhance the financial incentives for small firms to adopt best practices to mitigate job-risks in general and HRIs in particular without costly regulation? One approach is to improve the ability of the labor market to create these financial incentives through compensating wage differentials.

A key is to increase the elasticity of labor supply to these small firms. When firms face an elastic supply of workers, they must either mitigate job-related risks or pay an offsetting higher wage. Otherwise, their workers will quit and work for another employer. This shifts the financial burden of job-related risk to employers in the form of mitigation costs and/or compensating wage differentials. Competition for workers will also drive employers to look for the most efficient risks to eliminate versus compensate workers to bear.

What might be some factors that limit the labor supply elasticity of workers to small employers, especially in Construction where HRIs are a concern. Immigrants make up 30 percent of Construction workers nationally, and more like 40 percent in border states such as California and Texas. An even higher fraction of immigrants likely work at small employers. The supply elasticity for immigrant workers would be higher if all were legally allowed to work. If a worker is undocumented, this might limit the worker's ability to shop around for a better job. Having a work permit would make quitting a bad job for a better job more credible—collectively this increases the labor supply elasticity. These points suggest that immigration reforms could play an important role in reducing protecting workers from heat exposure.

Information asymmetries complicate a household's choice of a contractor to carry out a specific project. To overcome this problem, companies have been established that maintain a list of "good contractors" and provide a guarantee that their work will meet the customer's satisfaction, or they will pay to fix the problem.<sup>19</sup> Contractors have an incentive to be included on the list to get more business. These companies can charge contractors an annual fee for membership that pays for overhead and the expected cost of its guarantee.

A similar concept could be used for builders. In this case, the aim is to overcome the asymmetric information problem facing workers in terms of which builders to work for. Companies could create "Good Builders" lists where workers can find out who are builders that follow best practices for job risk mitigation. Similarly, builders would have an incentive to be on the list as this would provide them with a better supply of applications for openings.

It is possible that these companies could also aggregate these small builders and take out a collective workers' compensation policy. This would create an additional incentive for builders to be on the list in that workers would know that they are now covered by workers' compensation. Builders would pay a payroll pro-rata share of the group insurance premium plus an annual membership fee. The company can discipline builders by dropping any builder who experiences a level of compensation claims relative to payroll that exceeds a specified limit. If the collective size of member builders is large enough, the pooled premium could be experience rated. In this case, as collective claims are reduced due to the use of best practices, premiums for members will be lower.

The Government can take insights from Operation Warp Speed to help encourage even faster technological and product innovation to help deal with heat risks. As already noted, more and faster innovation at lower prices will induce more adoption and risk mitigation. One approach would be to fund "contests" where a specific problem is articulated, how entries will be judged, the time period the contest will be open and the winning prize amount.<sup>20</sup>

These contests would focus industry attention on specific problems to be solved. Entries can come from large firms or small teams working "out of their garages." The "best" entry wins the prize money. To provide even more inducement, if the contest involved an improved product—like a cooling vest—the government could guarantee that it would purchase a specified quantity over a time window. If the contest involved a new technology, the government could guarantee an expedited patent review. The prize money helps to defray development costs for the winner and guaranteed initial sales speeds up production and learning by doing which will drive down the price more quickly. The improved product and lower prices will encourage broader (voluntary) adoption.

#### Conclusion

Our prospective analysis of the OSHA proposed heat rules argues that this regulation is unlikely to offer significant benefits in protecting outdoor, less educated workers. This regulation could

<sup>&</sup>lt;sup>19</sup> See for example <u>The Good Contractors List | Find Good Contractors Nearby</u>

<sup>&</sup>lt;sup>20</sup> Prize money could be a combination of public-sector funding and private-sector donations.

actually reduce the quality of life of such workers by reducing their employment and earnings. This regulation will impose disproportionate costs on small businesses.

The impetus for this regulation is the assumption that the U.S. features many vulnerable workers who will suffer more from heat exposure as climate change occurs. OSHA uses this as a justification to regulate. We believe that the efforts should focus on the extensive margin to educate these workers about the negative health consequences vulnerable workers will suffer if they are exposed to heat. This improved understanding will encourage them to seek alternative employment and/or to invest in their own self-protection. Such individuals are not "passive victims".

OSHA efforts to enact these regulations indicate that its leadership believes that many local labor markets feature exploitation and monopsony power. Combined with rising heat over time, these two trends pose a threat to vulnerable workers. This pessimistic worldview ignores the fact that workers always have choices, they can move or switch firms. The key is for them to have trustworthy information about their work conditions. We endorse a lighter regulatory touch that aims to level the information playing field.

In this paper, we have highlighted the fundamental data gaps that limit OSHA's ability to accurately estimate both the costs and benefits of its proposed regulations. In contrast, the collective knowledge of the market is vastly superior and steadily progressing. This combination favors a partnership between OSHA and the markets to further reduce HRIs in the most cost-efficient manner.

Going forward, OSHA can play a constructive role in accelerating learning about cost-effective ways to reduce worker heat exposure. States such as California already have their own OSHA agencies pursuing decentralized strategies for accelerating heat adaptation. The Federal OSHA should be convening nationwide meetings of OSHA regulators to share best practices and to act as a learning platform to identify cost-effective strategies. The current OSHA Director admits his agency's data gaps. The Federal OSHA could invest in new data collection efforts to enroll a random sample of workers to use wearable devices that record a person's temperature over the course of the day. One possibility for OSHA would be to partner with wearable device manufacturers to collect info from the devices.—similar to cell phone geo-location data collection that is so insightful for studying traffic patterns.

There is no "crisis" in on-the-job injuries that requires a drastic new direction. The only crisis will be the one that OSHA creates if it rushes headstrong down this regulatory path.

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#### Appendix

#### An Algebraic Expression of the Formal Test For Establishing the Causal Effect of Heat Exposure on HRIs

The object of interest is to measure the extra death risk to a healthy worker doing a stressful job with no mitigation for an extra hour of work in the heat. Through presenting the formal algebra, we seek to highlight the extreme data requirements for answering this question. OSHA regulation has proceeded under the assumption that this marginal effect is large. The bottom line from this appendix is that OSHA cannot know this from the available data.

Define the following variables:

 $I_{ijlt}^{D}$  indicator that takes a value of 1 if worker *i* at employer *j* dies at location *l* on date *t* from a heat-related reason,

 $I_{iilt}^{H}$  indicator that takes a value of 1 if worker *i* is on-the-job and exposed to heat for employer *j* on a hot day *t* in location *l* and engaged in stressful work,  $M_{jt}$  takes a value between 0 and 1 and is the degree of risk-mitigation by employer *j* on hot days

at day t. Full mitigation has a value of 0 and no mitigation a value of 1. For simplicity we assume that employers use the same mitigation efforts across all of their worksites on a given date,

 $\theta_i$  measures the health of worker *i* and takes a value of 1 if healthy and greater than 1 if has a health condition such as diabetes, overweight or heart disease that makes the individual prone to HRI.

 $F_{it}$  is the number of heat-related deaths at employer *j* on date *t*,

 $N_{it}$  is the number of workers at employer *j* on date *t*,

 $\beta$  is the death risk to be estimated.

If we knew  $\beta$  then we could calculate the marginal effect on heat-related death risk due to a change in mitigation efforts. This would be  $\beta \Delta M$ . We could then compare the marginal cost from the additional mitigation to the marginal benefit of a reduced heat-related death risk using an estimate of the value of life.

The "effective" heat exposure is a function of three factors: mitigation efforts by the employer, health status of its workers and being on-the-job doing stressful work on a hot day,  $f(M_{jt}, \theta_i, I_{ijlt}^H)$ . For a healthy worker employed by a firm that takes no mitigation, this simplifies to  $I_{iilt}^{H}$ . This requires knowing if a work-site location and date was a hot day. In addition, we need to know if a worker at employer *j* was engaged in stressful work at that location and date. Controlling for work-site locations, dates of work and mitigation efforts by employers, there will also be heterogeneity across employers in  $I_{iilt}^H$  due to the specific types of tasks workers engage in on that date.

On a hot day, the employer can reduce the risk of HRIs by either reducing stressful work that is exposed to heat (lower  $I_{ijlt}^H$ ), reassigning workers with health conditions (if these conditions are known to the employer) to non-stressful tasks and/or using mitigation efforts for workers

engaged in heat-exposed stressful work such as frequent water/shade breaks and cooling vests (lower  $M_{it}$ ).

To illustrate the challenges in estimating the death risk, we assume that  $f(M_{ji}, \theta_i, I_{ijlt}^H) = M_{jt}\theta_i I_{ijlt}^H$ . If we had worker/firm-level data with work-site/date temperature data, then we could estimate the following regression

$$I_{ijlt}^{D} \!=\! \alpha_{j} \!+ \beta \left( M_{jt} \theta_{i} I_{ijlt}^{H} \right) + \varepsilon_{ijlt}$$

If the employer mitigation variable captures employer-specific contributions to the risk and workers with health risks were randomly matched with employers, then we would expect  $\alpha_j$  to be statistically insignificant. The regression estimates the expected value of the heat-related death indicator variable which is the death risk that we are interested in learning about.

If employers never engaged in mitigation efforts (including task changes) and only employ healthy individuals, then this regression specification would simplify to

$$I_{ijlt}^{D} \!=\! \alpha_{j} \!+ \beta I_{ijlt}^{H} \!+ \varepsilon_{ijlt}$$

That is, we could estimate the heat-related fatality risk by regressing indicators for whether a worker died of a heat-related cause on an indicator for whether that worker engaged in stressful work on a hot day at the worker's location of work.

Using our empirical specification for on-the-job fatality risk due to hot temperatures, the number of heat-related fatalities for employer j at date t can be written as follows

$$F_{jlt} = E\left(\sum_{i}^{N_{jlt}} I_{ijlt}^{D}\right) + \mu_{jt}$$

So, the number of heat-related deaths at employer *j* in location *l* on date *t* relative to the number of workers is given by

$$F_{jlt} / N_{jlt} = \left[ E \left( \sum_{i}^{N_{jlt}} I_{ijlt}^{D} \right) + \mu_{jlt} \right] / N_{jlt}$$

Substituting from above for  $I^{D}_{ijlt}$  into our employer/date heat-related death "rate" we have

$$F_{jlt} / N_{jlt} = \left[ E \left( \sum_{i}^{N_{jlt}} \left( \alpha_{j} + \beta \left( M_{jt} \theta_{i} I_{ijlt}^{H} \right) + \varepsilon_{ijt} \right) \right) + \mu_{jlt} \right] / N_{jlt}$$

$$F_{jlt}/N_{jlt} = \alpha_j + \beta \sum_{i}^{N_{jlt}} M_{jt} \theta_i I_{ijlt}^H / N_{jlt} + \mu_{jlt} / N_{jlt}$$

The first term is the average employer-specific death-risk after taking into account mitigation efforts by employers/workers and task assignments and heat exposure. We would not expect this to be statistically different from zero.

Again, if employers never engaged in mitigation, task shifting and only employed healthy workers, then the employer's heat-related fatality rate would simplify to

$$F_{jlt}/N_{jlt} = \alpha_j + \beta \sum_{i}^{N_{jlt}} I_{ijlt}^H/N_{jlt} + \mu_{jlt}/N_{jlt}$$

The required explanatory variable that we need in this case is the fraction of the employer's workers at a job-site on a hot day that were exposed to the heat and engaged in stressful activity.

The estimation challenge is that we do not have employer-level data on mitigation efforts, which workers at an employer have health risks, or individual worker/employer data on stressful work/heat exposure. The typical assumption is that every worker for an employer on a given date and location is engaged in stressful work and exposed to the heat  $(\sum_{i}^{N_{jlt}} I_{ijlt}^{H} = N_{jlt} I_{lt}^{H})$  on a hot day in location *I* and zero otherwise) and that employers engage in no mitigation efforts so that  $M_{it} = 1$  for all workers/employers.

Furthermore, most empirical estimates of heat-related injury (or death) risk use location aggregated data rather than employer/location data. With our restrictions above, the location-level regression simplifies to

$$\sum_{j|lt} F_{jlt} / N_{jlt} = \alpha + \beta I_{lt}^{H} + v_{lt},$$

where we sum across all employers with work-sites in location *I* at date *t*. That is, we regress the number of heat-related fatalities normalized by aggregate employment (or hours if available) at date *t* in location *I* on an indicator for a hot day in that market. If the heat-related death data is aggregated to a longer time period than a day, then we use the number of hot days in that time period for that market.

An important issue in estimating  $\beta$  with imperfect information is the joint distribution of the three variables that determine the employer heat risk. For example, if they are positively correlated then this will induce a positive bias to  $\beta$  even if we could control for the fraction of an employer's workers who are exposed to heat and the fraction of the employer's workers who have health problems. This reflects the important role of selection bias pioneered by James Heckman.

#### A Specific Example

We show how to use our model to evaluate a very specific regulatory intervention—mandatory rest breaks,  $r_m$ . Let  $P_{rtt}$  be the probability that an employer in location *I* at time *t* voluntarily incorporates rest breaks in its mitigation efforts. Assume that we have worker-level data on heat-related deaths. Using our model above, we estimate the probability that a worker experiences a heat-related on-the-job fatality as the following

$$I_{ijlt}^{D} = \alpha_{j} + \beta \left( M_{jt} \theta_{i} I_{ijlt}^{H} \right) + \varepsilon_{ijlt}$$

What we would like to estimate is the reduction in the probability of an on-the-job heat-related fatality due to mandatory rest breaks,  $\beta \partial M_{jt}/r_m$ . Using our regression specification, the imposition of the new regulation has the following effect.

$$\frac{\partial I^{D}_{ijlt}}{r_{m}} = \beta \theta_{i} I^{H}_{ijlt} \left(1 - P_{rlt}\right) \frac{\partial M_{jt}}{r_{m}}$$

Even with worker-level data, to recover what we are interested in estimating we need to know which firms currently do not incorporate rest breaks in their mitigation efforts, the health status of each worker at covered firms, and whether each worker was engaged in strenuous work on a hot day *t*.

Assuming that we do not have firm-level information on their mitigation practices nor workerspecific health information and exposure to strenuous work on hot days, we can't estimate the effect of rest breaks on reducing the fatality risk from a hot day.

What do we learn from observing the change in the number of on-the-job heat-related fatalities prior to and following the implementation of the new regulation? The more prevalent the use of rest breaks prior to the requirement, the lower will be the observed change in fatalities on hot days. However, this should not be interpreted as rest breaks are not a useful mitigation technique.

An important take-away is that if large employers in covered sectors already have adopted all or most of the new OSHA mitigation practices, then OSHA making them mandatory will have a muted effect on HRIs and fatalities. The marginal effect of the regulations will be lower than the potential effects of the mitigation practices.