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EMPLOYMENT RESEARCH

Climate Change and Occupational Health: Can We Adapt?

Marcus Dillender, W.E. Upjohn Institute

ARTICLE HIGHLIGHTS

- *In many settings, people have demonstrated capacity for substantial adaptation to regular exposure to extreme temperatures.*
- *Workers laboring outdoors and away from air conditioning may not be able to avoid adverse health effects of extreme temperatures.*
- *Hot days have more severe effects in warmer climates than in cooler climates.*
- *Avoiding exposure to extreme temperatures appears to be easier for workers when extreme temperatures are rare.*

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The greenhouse gases accumulating in the earth's atmosphere are poised to raise global temperatures considerably in a relatively short period of time. While using air conditioning and limiting outdoor exposure may help mitigate the adverse effects of high temperatures, these approaches are not feasible in all situations. In particular, the hundreds of millions of workers around the world exposed to outdoor temperatures as part of their jobs may face additional adaptation challenges relative to the rest of the population. Despite considerable attention devoted to understanding the impact of temperature on a variety of outcomes and behaviors, little is currently known about the effect of temperature on workers' health.

I assess the effect of temperature on occupational health by combining worker injury and illness reports with weather information at daily frequencies. I find that both high and low temperatures have adverse effects on occupational health. In contrast to research on temperature and mortality, I find no evidence that the ability to adapt to high temperatures has led to hot days having less severe effects on occupational health in warm climates. Instead, I find that hot days have more severe effects in warm climates, which suggests that avoidance practices may be easier when extreme temperatures are rare. In essence, construction workers in states like Michigan and Wisconsin can avoid working or avoid doing their most dangerous work on the rare day above 95°F degrees. But in states like Arizona or Texas, days over 95°F are common, and working on these days cannot be avoided.

To determine how avoiding extreme temperatures may relate to the differential occupational health effects I find, I examine the

effect of temperature on weekly hours worked in temperature-exposed jobs. The results indicate that high temperatures reduce hours more in cooler climates, and low temperatures reduce hours more in warmer climates. This pattern is consistent with greater difficulty in avoiding temperature extremes

Workers who labor outdoors may face additional challenges in adapting to high temperatures relative to the rest of the population.

helping explain why hot days are more harmful to occupational health in warm climates.

These findings highlight that the ease of adapting to high temperatures varies across settings. Much research finds that people in warm climates have been able to adapt to regularly being exposed to high temperatures. The ability to adapt means that using current estimates of the effects of temperature likely overstates some costs of climate change. But my study suggests that workers who labor outdoors may face additional challenges in adapting to high temperatures relative to the rest of the population. The adverse effects of high temperatures on workers may grow as high temperatures become more common.

Possible Effects of Temperature on Occupational Health and Unknown Capacity for Mitigation

Extreme temperatures can push the body's core temperature outside of healthy ranges. High temperatures can increase heart and respiratory rates, reduce blood pressure, and damage internal organs, which can lead to sunstroke, syncope,

Climate Change and Occupational Health: Can We Adapt?

cramps, exhaustion, and fatigue, as well as acute cardiovascular and respiratory failure. As fatigue is often a contributing factor for injuries, high temperatures also have the potential to increase injury rates.

include frostbite and hypothermia. As cold weather causes muscles to tighten and restricts blood flow, cold temperatures can lead to muscle strains and sprains as well as other injuries. At temperatures below 32°F, ice may form, which may increase the prevalence of falls or motor vehicle accidents.

While both high and low temperatures have adverse health effects, people have demonstrated a substantial capacity to adapt to their climates. Research has found that hot days have less severe effects in warmer climates than in cooler climates, largely because the higher frequency of hot days in warmer climates has led to greater investments in air cooling technology in these places.

Two factors, however, complicate mitigation efforts for workers, especially those laboring outside.

First, since air conditioning, of course, doesn't work outdoors, there are currently no widely available technological solutions to protect workers from extreme hot temperatures. Second, workers may find it more difficult to avoid temperature extremes than nonworkers: construction workers, police, and letter carriers, among others, often have fixed schedules that require them to work outside regardless of the elements. Thus, it is unclear that workers will be able to mitigate the adverse health effects of extreme temperatures.

Approach and Findings of Study

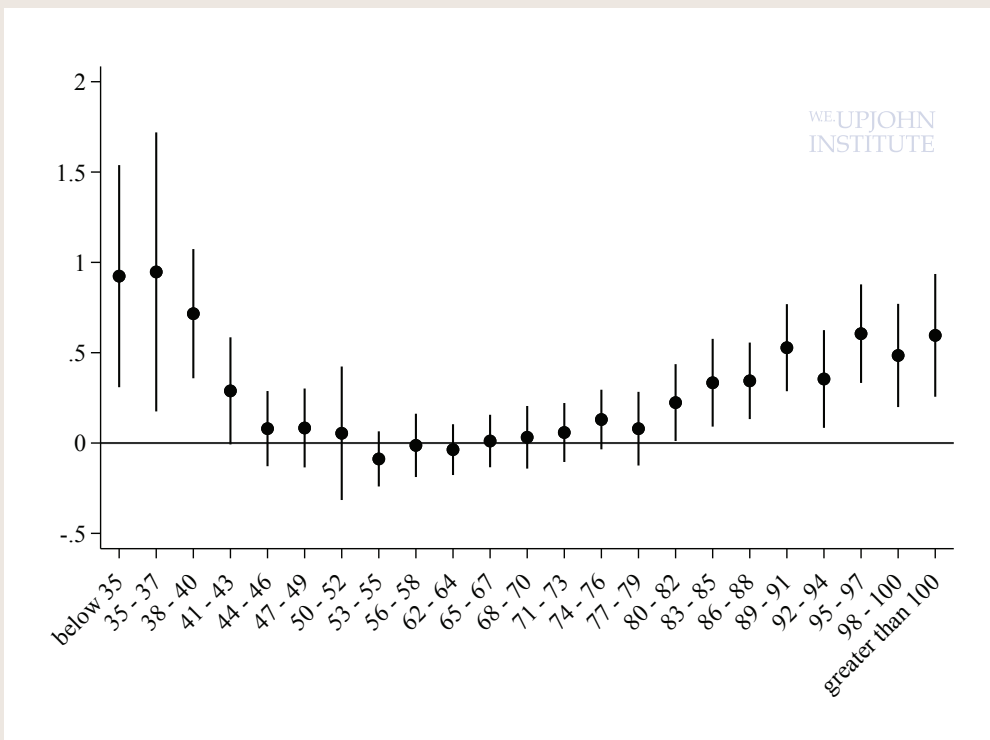
To assess the effects of temperature on occupational health, I construct two data sets with occupational health outcomes matched to weather information. The first draws on workers' compensation administrative data from Texas and consists of daily metropolitan-area claim rates matched to daily weather data from the National Climatic Data Center. To consider the effects of temperature on occupational health for climates outside of Texas, a relatively hot state, I also use data on injuries and illnesses from the mining industry that measure daily injury rates for various outdoor, above-ground mining sites across the United States, along with the weather experienced at the site each day.

After controlling for seasonality and fixed differences across metropolitan areas, I estimate the effect of temperature on occupational health measures through plausibly random, short-run fluctuations—abnormally hot or cold days. Using the Texas data set, I find evidence that both high and low temperatures are detrimental to workers' health (see Figure 1). A day with a high temperature of between 86°F and 88°F increases claim rates over the next three days by 2.1 to 2.8 percent relative to a day with a high temperature of between 59°F and

Focusing solely on temperature-related illnesses severely understates the total effect of temperature on workers' health by neglecting temperature's large effects on injury rates.

Cold temperatures cause veins and arteries to narrow, blood to become more viscous, and the body to lose heat, which depletes energy. The direct adverse effects of cold temperatures

Figure 1 The Effect of Temperature on Workers' Compensation Claims per 100,000 Workers



NOTE: The graph displays estimates of the effect of temperature on workers' compensation (WC) claim rates along with 95-percent confidence intervals. All estimates are relative to when daily high temperatures are between 59°F and 61°F. The sample includes 154,968 observations, where each observation is a metropolitan area-day. The underlying workers' compensation claim data are from Texas between 2006 and 2014 and contain 1,916,590 individual claims. SOURCE: Author's calculations.

61°F. A day with a high temperature of over 100°F increases three-day claim rates by 3.5 to 3.7 percent. Cold temperatures are at least as injurious. A day with a high temperature of under 35°F increases three-day claim rates by 3.4 to 5.8 percent relative to a day with a high temperature of between 59°F and 61°F.

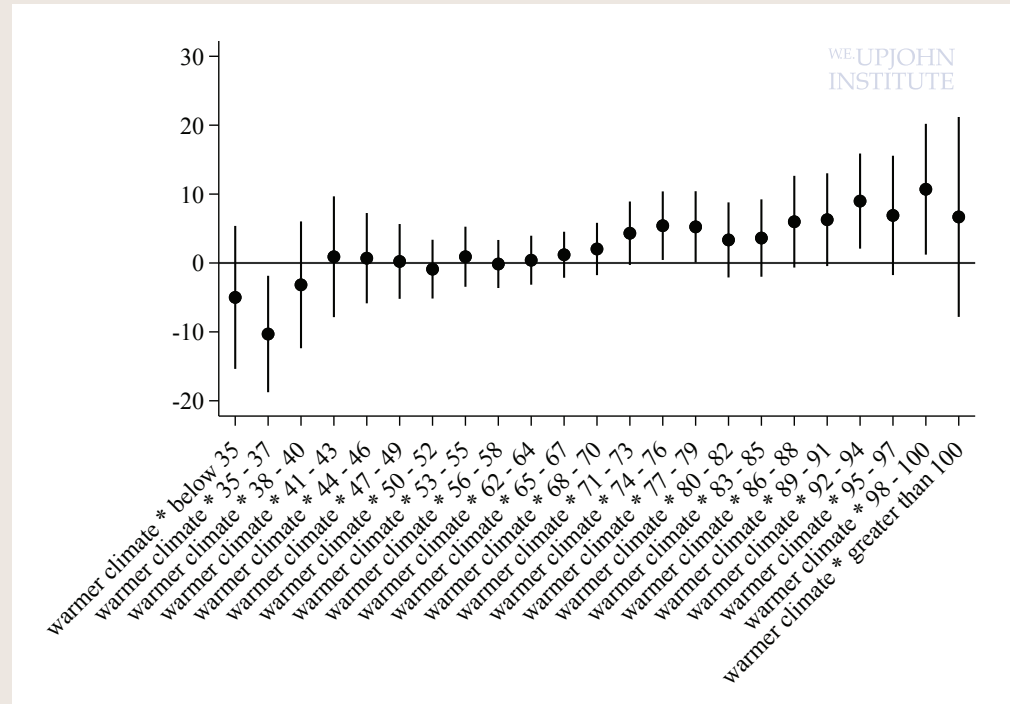
While extreme temperatures have long been thought to affect occupational health through creating conditions in which illnesses can arise, the impact of temperatures on injuries has received little attention beyond speculation. However, the estimates from the current study indicate that all of the increased claims from low temperatures and approximately 80 percent of the increased claims from high temperatures are for injuries. Focusing solely on illnesses typically thought of as temperature-related may thus severely understate the total effect of temperature on workers' health.

With the mining data, I test for heterogeneous effects of temperature based on a site's temperature norms. Whereas adaptation and acclimation hypotheses would predict that the adverse effects of a hot day would be smaller in warmer climates, the estimates from the mining analysis suggest that a hot day has more detrimental effects on occupational health in warmer climates than in cooler climates (see Figure 2).

These results provide strong evidence that extreme temperatures affect occupational health. While people have been able to adapt to high temperatures through air conditioning, many workers have not been as fortunate. Instead, finding that hot days are more harmful in warmer climates suggests that the potential for workers to avoid extreme temperatures may be more limited in places where such temperatures are common.

I explore this possibility using data on weekly hours worked from the monthly Current Population Survey. Again controlling for seasonality and

Figure 2 The Differential Effect of Temperature on Injuries per 100,000 Workers for Sites in Warmer Climates



NOTE: The graph displays estimates of the effect of temperature on WC claim rates, along with 95-percent confidence intervals, for warmer-climate areas relative to colder-climate areas, and relative to the base differential between areas when the daily high temperatures are between 59°F and 61°F. The sample includes 2,615,672 site-days. The underlying injury data come from Mining Safety and Health Administration logs between 2006 and 2014 and contain information on 13,013 injuries. SOURCE: Author's calculations.

fixed differences across metropolitan areas, I find that hot (or cold) days have different impacts on work hours for temperature-exposed workers depending on whether the prevailing climate is warmer or cooler. An additional day above 90°F decreases weekly hours worked more in cooler climates than in warmer climates, while an additional day with a high below 40°F decreases weekly hours worked more in warmer climates than in cooler climates. Thus, workers may better be able to avoid rare extreme temperatures than common extreme ones.

Implications

These results are relevant for assessing the costs of climate change, as they indicate that the health effects of extreme temperatures extend beyond

the commonly hypothesized illnesses to also include injuries. Although research has shown that people can adapt to warmer climates—suggesting that current estimates of damages from high temperatures likely overstate some costs of climate change—the results from this study highlight that workers who have to be outside as part of their jobs may face additional challenges in adapting to high temperatures.

This article draws on research from an Upjohn Institute working paper, which can be found at https://research.upjohn.org/up_workingpapers/299.

Marcus Dillender was a senior economist at the Upjohn Institute and is now an assistant professor at the University of Illinois at Chicago.

The Importance of Informal Work in Supplementing Household Income

Katharine G. Abraham and Susan N. Houseman

In recent years, the media has widely reported the rise of the so-called gig economy comprising short-term, independent contractor and informal work, which includes work for online platforms. Such work by its nature comes with little job security. In addition, because these workers are not employees of the organization for whom they work, they are not entitled to employer-provided benefits, nor are they covered by employment laws such as those setting minimum wages or by social insurance programs such as unemployment insurance and workers' compensation.

Concerns about the number of people engaged in such arrangements prompted the Bureau of Labor Statistics to field its Contingent Worker Supplement (CWS) in 2017, the first time it had done so in 12 years. Yet, the CWS uncovered no growth since 2005 in the share of workers whose main job was in the alternative arrangements measured by the survey; the share reporting that they were in independent contractor arrangements actually fell.

A common interpretation of these data has been that policymakers

and researchers should focus on the predominant work arrangement—wage and salary or employee jobs—to understand the problems facing American workers, including slow wage growth among lower- and middle-class workers and rising earnings inequality. In part because the CWS measures only the work arrangement on an individual's main job, however, the CWS may not provide a complete picture of nonemployee work. Other evidence shows that online platform and other nonemployee work is especially common as a secondary work activity. To the degree that Americans use this type of work to make ends meet when experiencing financial distress or income shortfalls, it may be a reflection of broader problems with their primary jobs.

Our research uses unique data from the Federal Reserve Board's Survey of Household and Economic Decisionmaking (SHED) to study informal, nonemployee work as a secondary work activity. Using these data, we are able to examine the socioeconomic characteristics of individuals engaged in a variety of

types of informal work, the nature of employment in these individuals' main jobs, why they hold side jobs, and the contribution of secondary work to their incomes.

Survey of Household and Economic Decision Making

The SHED asks respondents about their work activities during the past month. Activities are categorized as employed for someone else, self-employed or working for themselves, temporarily laid off from a job to which they expect to return, not employed but looking for work, and not employed and not looking for work. An individual may report multiple statuses. If respondents report working for someone else or being self-employed during the past month, they are asked about the nature of their "main" job—full-time employee, part-time employee, consultant or contractor, or self-employed or a partner. In 2017, part-time employees were asked whether they preferred full-time hours, and we label these individuals involuntary part-time (although this may include some individuals who are not available to work full-time as would be required under the definition of involuntary part-time work used for BLS statistics). Individuals who report being employees or a consultant or contractor on their main job are asked who determines their work schedules and, in cases where their employer determines their schedules, how far in advance they are told what it will be.

Everyone—employed or not employed during the past month—is asked whether they have engaged in any of 11 (2016) or 12 (2017) different types of "occasional work activities or side jobs" during the month. The survey is thus well designed to capture informal work activities that are secondary to a primary job. The survey groups informal activities into three broad categories:

- 1) personal services, such as child care, dog walking, house sitting, or

ARTICLE HIGHLIGHTS

- According to a Federal Reserve survey, nearly 30 percent of respondents reported informal work for pay in the prior month, ranging from online work to personal services to selling goods.
- Informal work plays a particularly important role in the household finances of minorities, the unemployed, and those who report financial hardship.
- Independent contractors, other self-employed, and those with unpredictable work schedules are especially reliant on informal work to supplement their income, possibly symptomatic of inadequate or unstable earnings associated with these types of work.

- disabled adult or elder care services
- 2) online activities, such as on Amazon Services, Mechanical Turk, or Fiverr; renting out property online, such as a car or residence; selling goods online; or driving using a ride-sharing app such as Uber or Lyft (2017 survey only)
- 3) offline sales and other activities, such as selling goods or services at flea markets, garage sales, or consignment shops

If participants in the SHED survey report any side jobs during the prior month, they are asked why they work these jobs, including whether it is primarily for income; how important these jobs are to their household income in the prior year; the share of household income usually accounted for by these jobs; and the number of hours usually worked in these jobs. Participants also are asked to assess their financial well-being, selecting one of four descriptions that best captures their situations—difficult to get by, just getting by, doing okay, or living comfortably.

We pool data from the 2016 and 2017 SHED surveys, whose module questions on informal work are comparable in the two years. Our analysis is based on a sample of over 18,000 responses. Although the fact that SHED respondents are participants in an online survey panel may mean that the incidence of informal work in the SHED is higher than in the population at large, there is no reason to doubt the picture the survey paints regarding what types of people engage in informal work and why.

Who Takes Side Jobs and Why

According to the SHED, informal, secondary work activities are quite prevalent, with 28.1 percent of respondents reporting that they had engaged in one of more of these activities in the prior month. Although online activities were the most commonly reported, with 15.0

percent engaging in online work in the prior month, the percent who reported doing side jobs in personal services and offline sales and miscellaneous activities was also relatively high at 13.0 and 10.6 percent, respectively (see Figure 1).

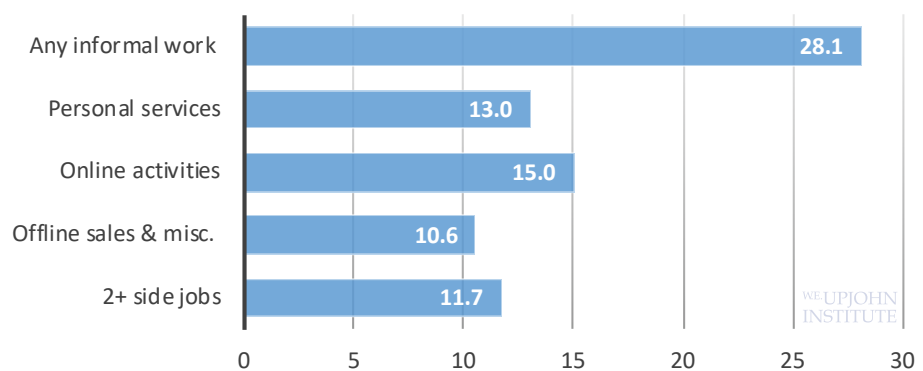
Of all respondents, 18 percent, or roughly two-thirds of those with side jobs in the prior month, reported that the primary reason for working these jobs was to earn money. For a sizable minority, these jobs are an important source of income. Among those polled, 10.7 percent said that income from informal work was important to their income in the past year, 9.6 percent said that income from such work usually accounted for at least 10 percent of their household income, and 7.1 percent reported usually working at least 20 hours or more in side jobs during a month. Over 40 percent of those reporting side jobs, or 11.7 percent of respondents, cited two or more types of side jobs in the prior month.

The prevalence of informal work and its importance as a source of income differ significantly across groups in the population. Minorities and lower-income individuals are more likely to report that they work in side jobs to earn income, that the income from these jobs was an important source of household income in the prior year, and that it accounted for

at least 10 percent of their household income. The reliance on income from side jobs also declines with age. For example, 15.8 percent among those aged 25–34 report that income from side jobs was an important source of income during the prior year, compared to 4.7 percent among those aged 65–74.

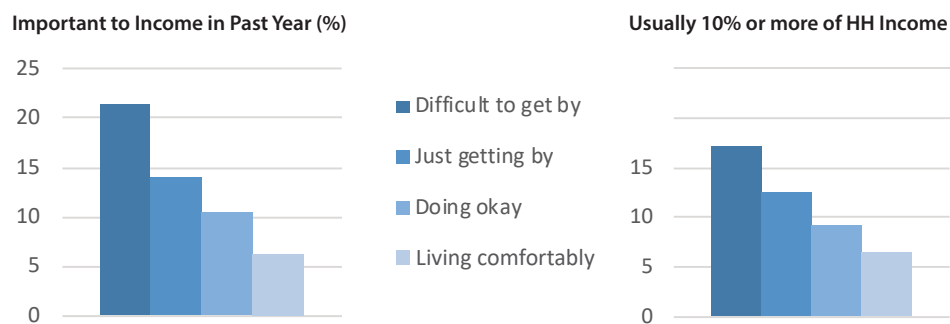
Figure 2 illustrates the close correspondence between individuals’ financial well-being and their reliance on income from side jobs. Compared to those who report living comfortably, those who find it difficult to get by are about 15 percentage points more likely to report that side jobs were an important source of income in the prior year (21.5 percent versus 6.4 percent), and about 11 percentage points more likely to report that incomes from these jobs usually account for at least 10 percent of household income (17.3 percent versus 6.4 percent). A sizable minority of those indicating that they are just getting by also report that side jobs were an important income source (14.0 percent) and usually account for at least 10 percent of household income (12.4 percent). Similarly, the share reporting that they worked in two or more types of side jobs in the prior month increases with financial stress. Whereas 9.4 percent of those living comfortably reported at least two side jobs, 19 percent of those finding it

Figure 1 Informal Work in Past Month (%)



SOURCE: Authors’ calculations using SHED data.

Figure 2 Importance of Informal Work to Income by Financial Well-Being (%)



SOURCE: Authors' calculations using SHED data.

difficult to get by and 13.4 percent of those just getting by reported multiple side jobs.

Main Jobs and Side Jobs

The data also reveal a linkage between employment status, the characteristics of an individual's main job, and the importance of side jobs for income. As shown in Figure 3, those in various self-employment arrangements rely more heavily on informal or side jobs for income. Over 20 percent of those who describe themselves as being self-employed, a sole proprietor, a partner, or a consultant or contractor on their main job also report that informal work was an important source of their household's income during the preceding year, and over 20 percent indicate that at least 10 percent of their

household's income usually comes from such side jobs. In addition, a sizable minority of the unemployed and the underemployed rely on income from informal work. About 25 percent of the unemployed said that income from side jobs was important to their income in the prior year and usually accounted for at least 10 percent of their income; the corresponding shares were about 20 percent for involuntary part-time employees.

With the advent of scheduling algorithms, many workers, particularly in retail and other services jobs, receive short notice of their weekly work schedules. While allowing firms to more closely match workers' schedules to their needs, these practices mean that workers' hours and incomes often vary from week to week, shifting risk

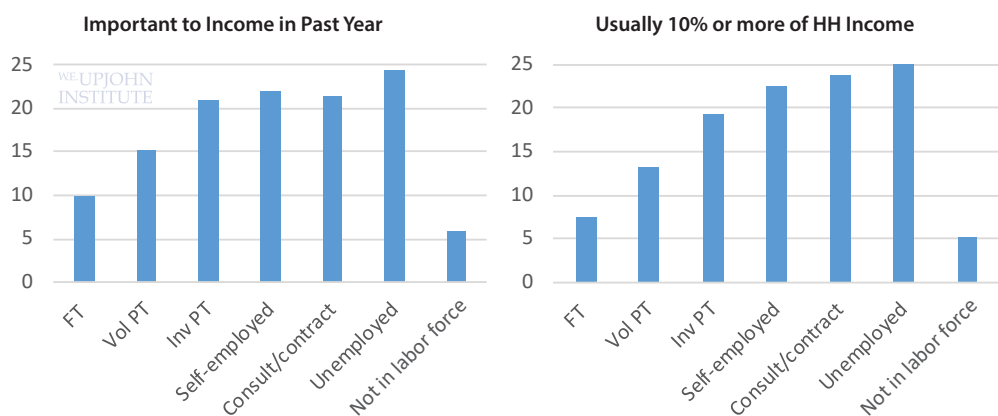
onto workers. A sizable minority of SHED respondents with unpredictable work schedules rely on informal work to supplement income from their main job. Compared to those with stable work schedules or considerable advance notice of their work schedules, those who typically receive two weeks or less notice about their schedule from their employer are 5–8 percentage points more likely to say that income from informal work is important and usually accounts for at least 10 percent of the household income.

Conclusion

Informal work plays a particularly important role in the household finances of minorities, the unemployed, and those who report financial hardship. Reliance on informal work for income also varies strikingly by work arrangement. Those in self-employment arrangements, involuntary part-time employees, and employees with unpredictable schedules are considerably more likely to work side jobs to earn money. The relative importance of informal work to supplement income among those in part-time, precarious, or other alternative work arrangements may be a symptom of the inadequate or unstable hours and earnings often associated with these forms of work.

While informal work can help supplement income from a main job, it rarely comes with workplace benefits. Those most likely to hold side jobs to supplement income, in turn, are the least likely to have critical benefits such as sick pay, health insurance, and retirement plans in their main job. A comprehensive approach is needed to address the lack of access to benefits.

Figure 3 Importance of Informal Work to Income by Employment Status and Employment (%)



SOURCE: Authors' calculations using SHED data.

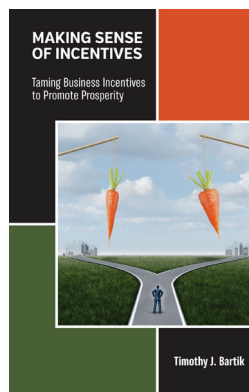
Katharine G. Abraham is the director of the Maryland Center for Economics and Policy and a professor of survey methodology and economics at the University of Maryland. Susan N. Houseman is vice president and director of research at the Upjohn Institute.

Two New Books from the Upjohn Press

Making Sense of Incentives Taming Business Incentives to Promote Prosperity

Timothy J. Bartik

Bartik provides a clear and concise overview of how state and local governments employ economic development incentives in order to lure companies to set up shop—and provide new jobs—in needy local labor



markets. He shows that many such incentive offers are wasteful and he provides guidance, based on decades of research, on how to improve these programs.

“With this book, Tim Bartik has solidified his rank as the leading, trusted expert on economic development incentives and economic development broadly. The role of firm-based incentives has triggered passionate debate, and Bartik responds with rigor, reason, and realism. I hope readers heed the call for needed reforms recommended

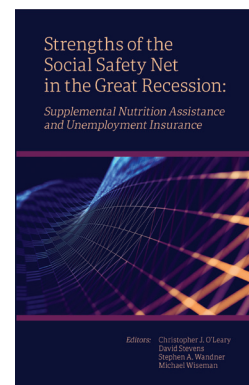
in this timely book.” —Amy Liu, vice president and director, Brookings Metropolitan Policy Program

October 2019. 178 pp. \$14.99 pbk ISBN 978-0-88099-668-6
PDF is free at https://research.upjohn.org/up_press/258/.

Strengths of the Social Safety Net in the Great Recession Supplemental Nutrition Assistance and Unemployment Insurance

Christopher J. O’Leary, David Stevens, Stephen A. Wandner,
and Michael Wiseman, Editors

During the Great Recession, many who lost their jobs became eligible for Unemployment Insurance (UI) and often Supplemental Nutrition Assistance



(SNAP), too. Many already receiving SNAP lost jobs and became eligible for UI. While both programs were stressed, they proved flexible enough to respond to the needs of many of the victims of the recession. But little has been known about how the two programs interact. The papers in this book shows that, indeed, each program has considerable effects on the other and that policies governing them could be altered to better serve recipients of both programs. Following chapters that detail the SNAP and UI programs along with existing research on

their interaction, the editors present chapters using administrative data from six states that reveal how the programs interact and how they can be altered to work more effectively.

July 2019. 430 pp. \$30 pbk ISBN 978-0-88099-663-1
PDF is free at https://research.upjohn.org/up_press/257/.

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“Essays in Labor and Public Economics”

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The establishment of this award further pursues the mission of the Upjohn Institute: to support and conduct policy-oriented research on issues related to employment and unemployment. Dissertations were judged by a panel of economists on the basis of policy relevance, technical quality of research, and presentation.

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