US Working Hours and Carbon Dioxide Emissions

Working Hours and Carbon Dioxide Emissions in the United States, 2007–2013

Jared B. Fitzgerald, Juliet B. Schor, and Andrew K. Jorgenson, *Boston College*

The well-established association between economic output and carbon emissions has led researchers in sociology and related disciplines to study new approaches to climate change mitigation, including policies that stabilize or reduce GDP growth. Within this degrowth approach, working time reduction is a key policy lever to reduce emissions as well as protect employment. In the United States, the abdication of responsibility for mitigation by the federal government has led to the emergence of state climate leadership. This study is the first to analyze the relationship between emissions and working hours at the state level. Our findings suggest that over the 2007–2013 period, state-level carbon emissions and average working hours have a strong, positive relationship, which holds across a variety of model estimation techniques and net of various political, economic, and demographic drivers of emissions. We conclude that working time reduction may represent a multiple dividend policy, contributing to enhanced quality of life and lower unemployment as well as emissions mitigation.

Introduction

There is now unequivocal evidence that the planet is warming as a result of human activities, as reported by the most recent United Nations Inter-Governmental Panel on Climate Change (IPCC 2014) report, and the 2017 National Climate Assessment from the US Government Global Change Research Program (USGCRP 2017). The impacts of warming and climate destabilization include increased severity of storms and other weather events, heightened water scarcity, sea-level rise, species extinctions, ocean acidification, and biodiversity loss. The most important human activity contributing to climate change is the burning of fossil fuels and the associated release of greenhouse gases (GHGs) into the atmosphere, most notably carbon dioxide (CO_2). According to the US Environmental Protection Agency (2015), CO_2 emissions from the burning of fossil fuels comprise the majority of the nation's total GHG emissions.

Despite the scientific consensus on anthropogenic climate change and the contributions of GHG emissions, the current US presidential administration is aggressively attempting to reverse mitigation efforts domestically and globally. President

Corresponding author: *jared.fitzgerald@bc.edu*

Social Forces 96(4) 1851–1874, June 2018
doi: 10.1093/sf/soy014
Advance Access publication on 22 March 2018

Trump, who has said that climate change is a "hoax" concocted by China, supports policies that will increase the consumption of fossil-fuels, accelerate GHG emissions, and exacerbate the potential threats of climate change (Greenfieldboyce 2016). He has signaled his intention to withdraw the United States from the Paris Climate Accord, is attempting to scrap the EPA's Clean Power Plan, and has placed opponents of climate change policy and deniers of climate science in key positions in government. These include Rex Tillerson, the former CEO of Exxon Mobil, as Secretary of State, and Scott Pruitt as the Administrator of the Environmental Protection Agency. Administration actions, combined with the strong presence of climate deniers among Republican congressional members, suggest that meaningful federal actions to reduce fossil-fuel consumption, lower GHG emissions, or combat climate change are unlikely for the foreseeable future. To be sure, even before the election of President Trump, federal action on climate change was inadequate. While President Barack Obama professed concern about climate change, relatively limited progress was achieved until the later years of his presidency (Lavelle 2016). Under the current US administration, there is active hostility to climate change mitigation.

In light of federal opposition, state-level policies are likely to become more important. After President Trump's announcement that he intends to withdraw the United States from the Paris Climate Accord, hundreds of sub-national entities pledged to honor the commitments from that accord, and 12 states have formed the US Climate Alliance (Domonoske 2017). These promises are subsequent to a history of significant climate policies at the state and regional level. In 2012, California implemented a cap-and-trade program aimed at reducing statewide GHG emissions to 80 percent of 1990 levels by 2050 (California Environmental Protection Agency 2015). Similarly, the Regional Greenhouse Gas Initiative (RGGI) was established in 2009 as a regional cap-and-trade program for power plant emissions in Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont (Regional Greenhouse Gas Initiative 2017). However, if states are to take leading roles in combating climate change, they will need research on innovative policies to reduce state-level emissions.

Environmental sociologists have devoted considerable attention to identifying the anthropogenic drivers of climate change (e.g., Dietz et al. 2015; Dunlap and Brulle 2015; Jorgenson 2006, 2014; Jorgenson and Clark 2012; Knight and Schor 2014; Longhofer and Jorgenson 2017; Rosa, York, and Dietz 2004; Shandra et al. 2004; York 2012). Much of this research finds a positive relationship between economic growth and GHG emissions. The continued strength of the link between economic growth and GHG emissions has led some researchers to study the potential of working hours reductions to reduce emissions. The literature identifies two main effects of working time on emissions. The first is via the size and growth of GDP—higher hours yield higher output, *ceteris paribus*. The second is that working hours affect household time use and consumption patterns, both of which, in turn, affect emissions (Jalas 2002, 2005; Schor 2010). Working hours reductions are also seen as a way to slow GDP growth that provides significant benefits in the form of more free time and less stress. Working hours have been a topic of interest among a group of economists and other social scientists who argue that a policy of either steady-state (i.e., Daly 1996, 1999) or economic contraction, that is, de-growth, is necessary to achieve deep de-carbonization (Jackson 2009a, 2009b; Martinez-Alier 2009; Sachs, Loske, and Linz 1998; Victor 2008). This approach has been directed toward wealthy countries, with their disproportionately high standards of living and attendant carbon emissions (Knight, Rosa, and Schor 2013a; Sachs 2008; Sachs, Loske, and Linz 1998; Schor 1991).

Uncertainties about the future of work also suggest that working time reduction may be an increasingly important policy tool. Advances in artificial intelligence (AI) and automation may have substantial effects on employment. Recent evidence suggests that manufacturing employment has already declined due to increased automation (Acemoglu and Restrepo 2017; Autor 2015). Given that a large number of jobs are likely to become obsolete, an important question is whether there will be sufficient offsetting from new kinds of work and economic growth to accommodate workers who are displaced by technological change. Some analysts suggest that we may be in a period of long-term stagnation that will reduce the absorption of displaced workers (Gordon 2016; Schor 2010). In addition, the rate of GDP growth necessary to re-employ displaced labor may be too high to meet emissions targets, given the strong link between GDP and GHG emissions.

Sociologists and economists have modeled the impact of working hours on various environmental outcomes, and find that longer average working hours are associated with higher carbon emissions, fossil-fuel consumption, and ecological footprints (Fitzgerald, Jorgenson, and Clark 2015; Hayden and Shandra 2009; Knight, Rosa, and Schor 2013a, 2013b; Rosnick and Weisbrot 2007; Schor 2005). The two pathways of impact noted above have been termed the scale and composition effects (Schor 2010). The scale effect refers to the impact of working hours on the size (or scale) of the economy via GDP growth. Compositional effects measure the influence of time availability on the carbon intensity of household consumption and activity choices.

Previous research on working hours and environmental outcomes is either national or cross-national, but such relationships can also be examined at smaller scales. In this study, we assess the association sub-nationally, at the US state level. We examine the relationship between state-level carbon emissions and average weekly working hours for all 50 US states from 2007 to 2013.

Conducting the analysis at the state level is important for at least three reasons. First, an analysis at this scale may prove to have more policy significance, particularly in the United States, where a number of states already have crafted working time policies (Messenger and Ghosheh 2013). While the federal government has the ability to enact meaningful and wide-ranging working time policies, little has been changed since the 1938 Fair Labor Standards Act, which institutionalized the 40-hour workweek and the minimum wage. Second, examining socio-environmental relationships in sub-national contexts is important because it cannot be assumed that relationships found at national and cross-national levels will operate similarly at smaller scales. Finally, the absence of linked individual-level or household-level data that combines time use, activity and consumption patterns, and emissions data has meant that studies at such micro levels are rare and limited in the questions they can ask.

Literature Review

Economic Growth and the Environment

A central question in environmental sociology is the role of economic growth in causing carbon emissions and other types of pollution. For example, ecological modernization theory (EMT) argues that modern societies shift from a focus on economic rationality to a focus on ecological rationality, which is expected to result in a reduction in the environmental impacts of economic activity (Huber 2009; Mol, Spaargaren, and Sonnenfeld 2014). EMT theorists posit that state intervention and reformed state-market relations foster the spread of ecological rationality, which leads to more sustainable technologies and practices (Mol and Janicke 2009). In contrast, other sociologists contest the view that economic growth will yield environmental sustainability. York, Rosa, and Dietz (2003, 286) argue that there is a "relentless commitment to growth inherent in modern, particularly capitalist, production systems," and that growth is a main driver of environmental degradation. Furthermore, many scholars argue that in a growth-centric society technological advancements are unlikely to bring about sustainability, due in part to "rebound effects" or what has been termed the "Jevons paradox" (Jevons 1865; Grant, Jorgenson, and Longhofer 2016; Foster, Clark, and York 2010; York and McGee 2016).

There is now a considerable body of sociological research that examines the relationship between economic growth and carbon emissions and other environmental harms, both nationally and cross-nationally (e.g., Jorgenson 2006; Jorgenson and Clark 2012; Rosa, York, and Dietz 2004; York 2012). EMT scholars have found some evidence for their claims, but this research is typically at lower levels of analysis, such as the household, business, or economic sector (e.g., van Koppen and Mol 2009). When examining environment and development relationships at higher levels of analysis, studies find little evidence of the "decoupling" of growth and environmental harms, particularly for global pollutants such as carbon and methane emissions (Jorgenson and Birkholz 2010; Jorgenson and Clark 2012; Knight and Schor 2014; Longhofer and Jorgenson 2017). In part, findings hinge on whether scholars are considering "relative" or "absolute" decoupling (Jorgenson and Clark 2012). Absolute decoupling refers to situations in which an environmental measure, such as the level of emissions, is stable or declines in relation to an increase in the economic variable. In other words, growth in GDP is no longer associated with any increase in emissions. Relative decoupling, on the other hand, occurs when the increase in the environmental harm measure is less than the growth rate of the economic variable. Because climate change mitigation requires absolute reductions in CO_2 emissions in a short time frame, relative decoupling is likely to be insufficient. As such, relying on economic growth as a mitigation strategy could be a dangerous proposition.

The Argument for Economic Degrowth

The failure of wealthy countries to decouple output and emissions has led some scholars to call for a rejection of growth-centric policy and discourse. The lineage of this conversation is the "limits to growth" discussions of the 1970s (Meadows, Randers, and Meadows 2004). More recently, Rockström et al. (2009) attempted to restart that discussion with a global assessment that identifies planetary boundaries which, if crossed, might make the planet unsuitable for humans. Drawing on these, and similar scientific analyses of climate change, a group of critical scholars argues that major systemic changes, in particular a primary focus on reducing economic growth, are necessary to avoid ecological catastrophe. Arguments of this type go by a variety of terms, such as steady-state economics, sufficiency, a-growth, and degrowth (Alcott 2008; Daly 1996; Jackson 2009a, 2009b; Kerschner 2010; Martinez-Alier 2009; Princen 2005; van den Bergh 2011). Taken together, these perspectives represent a middle ground between ecological modernization theory, which has faith in environmentally enhancing growth, and approaches that emphasize the continuing threat from GDP growth on account of its failure to decouple from GHG emissions.

Pioneering ecological economist Herman Daly (1996, 1999) has argued for a steady-state economy. In Daly's account, growth should only occur up to a desirable level, beyond which it is both ecologically and socially damaging. However, other than arguing for limits to GDP, Daly does not call for radical structural changes to the market economy. Similarly, advocates of "sufficiency" believe there is a point beyond which human societies have enough and further accumulation and growth is not only wasteful but harmful to the environment (Princen 2005). Jeroen C. J. M. van den Bergh (2011) takes a more agnostic position, which he calls a-growth, arguing that because GDP growth harms the environment and is not a good measure of social welfare, "one has to be indifferent or neutral about economic growth" (van den Bergh 2011, 885). Others scholars argue that even the steady state is not an aggressive enough goal for wealthy nations. They argue that degrowth is necessary to bring consumption and production to levels that satisfy both ecological sustainability and global equity. Economic contraction in wealthy countries will open up "ecological space" for Global South nations that require growth to improve well-being and reduce poverty (Rice 2007; Hayden 1999, 2014; Martinez-Alier 2009, 2012; Sachs, Loske, and Linz 1998; Schneider, Kallis, and Martinez-Alier 2010; Victor 2008). Advocates also stress that degrowth needs to be planned (Alexander 2012; Martinez-Alier 2009). While unintended contraction of the economy is emissions reducing (e.g., York 2008), unexpected economic downturns have unacceptably high economic, political, and social costs.

Proponents of degrowth also typically align with a larger literature that questions the relationship between economic growth and increases in human well-being in wealthy countries. Researchers have found that for many countries, there is an income level beyond which increases fail to produce higher quality of life or well-being (Alcott 2008; Brady, Kaya, and Beckfield 2007; Daly 1999; Dietz 2015; Easterlin 1995; Jackson 2009a; Jorgenson 2014; Martinez-Alier 2009; Schor 2010). While there is still debate about these findings (i.e., Stevenson and Wolfers 2008), including the income level beyond which no further increases in well-being result, the bulk of the evidence supports a weak relationship between well-being and income among the non-poor. Daly (1999) interprets this research as showing that wealthy countries have reached the stage of "uneconomic growth," in which the social and environmental costs of economic growth outweigh the benefits of production.

Given their position between EMT and more radical critics of capitalism, it is to be expected that degrowth advocates have been criticized from both sides—for being politically unrealistic (Milanovic 2017; Pollin 2015) and for failing to be sufficiently critical of capitalism (i.e., Foster 2011). Alternatively, one can view degrowth as an attempt to harness both structural changes *and* normative alterations in individual and household behaviors. Degrowth policies are a middle ground that can limit some of the ecological and social harms of capitalism short of a full system overhaul. Degrowth policies are also important steps that may foster further systemic transitions beyond capitalism and toward economic systems of greater social equity and ecological justice. In this vein, degrowth scholars have argued for policies and goals such as reductions in income inequality and ecological tax-shifting (Martinez-Alier 2009). Additionally, because economic degrowth calls for reductions in production, most accounts recognize that one result will be increased unemployment (Schor 2005; Victor 2008). In response to this recognition, a foundational component of the degrowth paradigm is a reduction in working hours.

Working Time Reduction

Historically, two factors that have mitigated technologically induced unemployment are GDP growth and reductions in working hours (Schor 2010). In degrowth scenarios, GDP growth is no longer available to absorb labor. Therefore, to avoid the unemployment impacts of economic contraction, working hours reductions are considered to be a key policy tool for avoiding mass unemployment (Hayden 1999; Schor 1991; Victor 2008). The need for working hours reduction is further suggested by an emergent narrative that most degrowth authors have not yet addressed: that artificial intelligence (AI) and labor automation will substantially raise the rate of technological displacement of labor (Acemoglu and Restrepo 2017; Autor 2015; Brynjolfsson and McAfee 2014). From self-driving cars to IBM's Watson, there have been rapid developments in AI in recent years that some observers believe could result in high levels of unemployment as they contribute to further automation (Brynjolfsson and McAfee 2014; Frey and Osborne 2017). In one of the few existing studies of recent automation, Acemoglu and Restrepo (2017) find that, within commuting zones, the addition of one industrial robot displaces six workers. On the other hand, many are optimistic about the future of employment. Indeed, the conventional wisdom among economists is that economic growth will be sufficient to create new jobs and maintain employment numbers, either as complements to the displaced tasks or in other sectors.

The optimistic view assumes that rapid economic growth is both desirable and possible. If substantial growth is either not forthcoming (for economic reasons), or not feasible (on climate or other ecological grounds), then alternative policies will be necessary to avoid high unemployment and its attendant social problems. One potential route is reductions in working hours, which can contribute to job creation by spreading current levels of working time among more workers (Schor 1992). We say "can" because the size of the employment effect will depend on how hours reductions affect the supply and demand of labor, via changes in wages and productivity. This is a complex question and beyond the scope of the present study. However, under reasonable assumptions, there will be some positive employment effects of working hours reductions. Working time reductions can also yield ecological benefits, such as lower carbon emissions and other reduced environmental pressures (Fitzgerald, Jorgenson, and Clark 2015; King and van den Bergh 2017; Knight, Rosa, and Schor 2013a, 2013b; Schor 2005).

Schor (2010) notes that there are two main channels through which working time affects ecological outcomes: scale and composition effects. The scale effect describes a response in which higher working hours yield a higher level of economic output, income, and consumption. Over time, productivity increases are not taken in the form of more leisure, but rather more production. This production in turn becomes income, which is subsequently spent. Shifting preferences then accommodate the long hours and higher spending, a process Schor (1992) has termed the "work and spend cycle," highlighting that working time is a key factor in consumer culture. Generally, the scale effect can be understood as the contribution of working time to economic growth.

The composition effect is the impact of working time net of its contribution to GDP. It is theorized as a household-level decision effect, and is based on models of household behavior that incorporate both income and time availability (Becker 1965). Households with shorter working hours and more time affluence are hypothesized to live less ecologically intensive lifestyles, while those with time scarcity are thought to be more ecologically intensive. In the case of transportation, households with greater time affluence can opt for public transportation, which is usually more time intensive but less ecologically intensive (Jalas 2002, 2005; Jalas and Juntunen 2015; Kasser and Brown 2003). However, it is also the case that time-rich households may engage in more ecologically intensive activities such as travel.

Given the importance of working time in the degrowth framework, researchers are paying increasing attention to analyzing working time and environment relationships (Fitzgerald, Jorgenson, and Clark 2015; Hayden and Shandra 2009; King and van den Bergh 2017; Knight, Rosa, and Schor 2013a, 2013b; Rosnick and Weisbrot 2007; Schor 2005). The first study on this topic was Schor's (2005) exploratory analysis of 18 OECD nations, where she found that working hours are positively associated with nations' ecological footprints. Rosnick and Weisbrot (2007) compared working hours and energy consumption in the United States and Western Europe and found that if the United States were to reduce its working hours to Western European levels, energy consumption would decline by 20 percent. Alternatively, if Western Europe were to increase working hours to mirror those in the United States, the region would consume 25 percent more energy. Building on Schor's (2005) analysis, Hayden and Shandra (2009) performed a cross-sectional analysis examining the impact of working hours on the ecological footprints of 45 countries, and find a positive association.

Knight, Rosa, and Schor (2013a, 2013b) advanced this line of inquiry by examining the relationship between working hours and three environmental indicators for OECD nations from 1970 to 2007. Their findings indicate that changes in working hours are positively correlated with changes in ecological footprints, carbon footprints, and carbon emissions. Fitzgerald, Jorgenson, and Clark (2015) examined the relationship between working hours and fossil-fuel energy consumption for both developed and developing countries. They find that the positive relationship between working hours and energy consumption has increased in magnitude over time for both scale and compositional effects. More recently, King and van den Bergh (2017) analyzed how different scenarios for reducing working hours affect carbon emissions and found that while all scenarios reduce carbon emissions, implementing a four-day workweek is most effective. In contrast, another recent study by Shao and Shen (2017) examined the working time relationship with both carbon emissions and energy use for a small sample of European countries and found that beyond a certain threshold, hours reductions are no longer associated with lower emissions and energy use. However, the small sample size and particular modeling strategy of this study suggest the need for further analysis.

Research has shown that a reduction in working time has social benefits as well, such as higher levels of life satisfaction and happiness, even with attendant reductions in income (Alesina, Glaeser, and Sacerdote 2005; Pouwels, Siegers, and Vlasblom 2008). Perhaps the biggest social benefit of a reduction of working time for individuals is the associated increase in leisure time (Schor 2010). Overall, the existing research suggests that working time reduction potentially offers a triple dividend to society: reduced unemployment, increased quality of life, and reduced environmental pressures.

In this study we advance the existing literature by examining the relationship between working hours and carbon emissions at the US state level from 2007 to 2013. States have historically been able to craft legislation on working time (Messenger and Ghosheh 2013). For instance, some states have "work share" programs that allow businesses to temporarily reduce hours for their employees without engaging in layoffs (National Conference of State Legislatures 2017). These programs allow workers to access partial unemployment benefits while working fewer hours. While California was the first state to implement a "work share" program in 1979, the programs became more widespread after the 2008–2009 economic recession. In 2014, 27 states had a "work share" program (Messenger and Ghosheh 2013; National Conference of State Legislatures 2017). Further, a reduction in working hours in the United States could be particularly effective, as the average American works long hours. According to the Economic Policy Institute (2017), in 1973 the average American worked 1,679 hours a year. By 2007, this number had risen to 1,883, a difference of over 200 hours a year. Hours subsequently declined (due to the recession) to 1,815 in 2010.

Americans also work much more than counterparts in other wealthy nations. They currently work 399, 352, and 304 more hours per year than workers in Germany, the Netherlands, and France, respectively (Conference Board 2017). The divergence between the United States and other wealthy countries can be attributed to a number of factors, including that in the United States full-time work is more prevalent and there is less vacation and holiday time (Bell and Freeman 2001). Higher US levels of income inequality likely play a role as well, as individuals work longer hours in order to meet the consumption standards of the wealthy (Bowles and Park 2005).

Data & Methods

Sample

Our dataset contains annual state-level observations for all 50 US states for the years 2007–2013, resulting in a balanced panel dataset with 350 total observations. Due to limited data availability for state-level working hours, we are unable to include observations before 2007 or after 2013.

Model Estimation Techniques

We estimate both fixed effects and random effects panel regression models to assess the relationship between state-level working hours and carbon dioxide emissions. Each modeling technique has strengths and weaknesses, and using both allows us to evaluate the relationship in different ways. Fixed effects models are more effective at dealing with heterogeneity bias by controlling for time-invariant factors unique to each case. One potential downside to this is that time-invariant factors of substantive interest cannot be included in the analysis because they are perfectly correlated with the fixed effects. Fixed effects models also have a singular focus on within effects, and thus provide more conservative estimates (Allison 2009). On the other hand, random effects models allow for the inclusion of time-invariant factors (such as census region) into the analysis, and random effects models also make more efficient use of the available data by analyzing both between-case and within-case variation.

We estimate Prais-Winsten models with panel corrected standard errors (PCSEs) for the fixed effects models. We estimate two-way fixed effects models by including both state-specific and year-specific intercepts. We also correct for first-order autocorrelation (i.e., AR(1) correction) within panels and treat that AR(1) process as common to all panels, as we have no theoretical basis for assuming otherwise (Beck and Katz 1995). While we report the models with a common AR(1) correction, the results remain substantively the same when the models are estimated using a panel-specific AR(1) correction instead. For the random effects models, we also include year-specific intercepts and the common AR(1) correction. We estimate all models with Stata software (Version 13).

All non-binary variables are transformed into logarithmic form, an established approach in research on the human drivers of anthropogenic emissions and related outcomes (e.g., Jorgenson and Clark 2012; Rosa and Dietz 2012; York, Rosa, and Dietz 2003). For such variables, the regression models estimate elasticity coefficients where the coefficient for the independent variable is the estimated net percent change in the dependent variable associated with a 1 percent increase in the independent variable.

Dependent Variable

The dependent variable is state-level carbon dioxide emissions from fossil fuel combustion, measured in million metric tons ($MMTCO_2$). We gathered these data from the US Environmental Protection Agency in 2016 (EPA 2016). Emissions from fossil fuel combustion represent over 75 percent of all carbon dioxide emission sources (EPA 2015). The EPA's emissions estimates are based on fuel consumption data from the US Department of Energy/Energy Information Administration (EIA). At the time of this writing, the EPA website has been updated and no longer includes access to these data. However, it is possible to access the files through the January 19, 2017, snapshot version of the webpage (EPA 2017). The lead author of this study will share these data upon request.

Independent Variables

The key independent variable in this study is average weekly working hours per worker. We gathered these data from the US Bureau of Labor Statistics (BLS) Current Employment Statistics (CES) database (2016). Each month, the CES surveys approximately 146,000 businesses and government agencies, covering approximately 623,000 individual worksites. The sample of businesses for each month comes from the BLS Longitudinal Database of employer records, which contains data on approximately 9.3 million businesses across the United States (BLS 2016). The working hours data cover all nonfarm private employees, but exclude public employees. While annual working hours would be a preferable measure, these are not available from the CES.

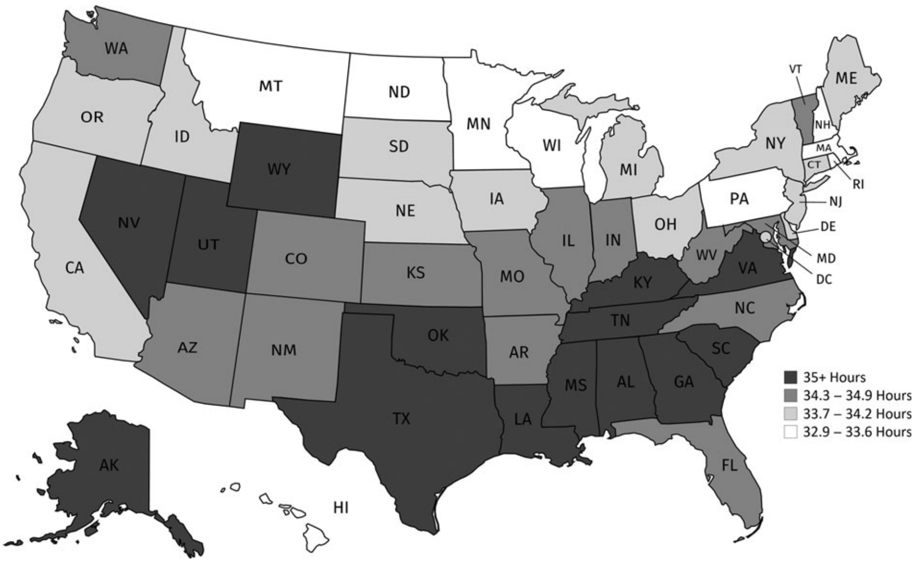
The states with the highest average weekly working hours for the 2007–2013 time period are Texas (36.2), Louisiana (36.1), Wyoming (36.1), Alabama (35.7), and Mississippi (35.6). The states with the lowest average weekly working hours for the same time period are Hawaii (32.9), Wisconsin (32.9), Montana (33), New Hampshire (33.1), and Delaware (33.1). While the differences in weekly hours may appear to be relatively small, over the course of a year they can be considerable. For instance, in 52 weeks of work the average worker in Texas will work 167 more hours, or around four more workweeks, than the average worker in Hawaii. Figure 1 illustrates average working hours for the 2007–2013 time period.

As discussed in the literature review, previous research considers the effect of working time on environmental outcomes in two ways: scale effects and composition effects. The scale effect is measured as working time's contribution to GDP. Consistent with previous studies, we test for the scale effect by disaggregating GDP into three parts: working hours, labor productivity, and employment to population ratio (Hayden and Shandra 2009; Knight, Rosa, and Schor 2013a, 2013b; van Ark and McGuckin 1999). In models where we test for the scale effect, we include both labor productivity and employed population percentage as the other components of GDP. Labor productivity is measured as GDP per hour of work. Employed population percentage is measured as the employed population of a state divided by its total population. The data on labor productivity and employed population were also gathered from the BLS (2016). The composition effect is measured net of GDP. State-level GDP per capita data (in chained 2007 dollars) were taken from the US Department of Commerce Bureau of Economic Analysis (2016) database.

Other control variables include total population size (US Census Bureau 2016), manufacturing as a percentage of GDP (US Department of Commerce Bureau of Economic Analysis 2016), and a state's energy production, which contributes to carbon emissions. The state energy production data were collected from the EIA's State Energy Database System (2016). We also control for the working-age population percentage (measured as the percentage of the population aged 15–64) and average household size. These data were obtained from the US Census Bureau's American Community Survey (2017).

In the random effects models, we also include a measure of state environmentalism developed by Dietz et al. (2015). These data measure pro-environmental voting by each state's congressional representatives and are an average of House and

Figure 1. Average weekly working hours per person from 2007 to 2013. Darker shades represent higher average weekly working hours, and lighter shades represent lower average weekly working hours.



Senate scores from the League of Conservation Voters' ratings for each member of Congress. The scores are based on their votes on environmental issues as identified by the League of Conservation Voters from the years 1990–2005. While the data cover a period of time, they are technically time invariant, as they represent a total score for the 15-year period. We also include dummy variables for census region in the random effects models to control for regional variation in carbon emissions, where Northeast is the reference category.

Tables 1 and 2 below provide descriptive statistics and bivariate correlations, respectively. Table 3 lists the states by census region.

Results

Figure 2 is a scatterplot of the association between the percent change in working hours from 2007 to 2013 and the percent change in carbon emissions from 2007 to 2013. These measures are positively correlated with a value of 0.464. North Dakota, Nebraska, and South Dakota are states that experienced relatively high increases in both emissions and working hours over the time period, while Nevada, Montana, Kentucky, and Delaware all experienced relatively large decreases in both emissions and working hours.

The findings for the panel regression analysis are provided in table 4. Models 1 and 3 examine the scale effect of working hours on carbon emissions. These models include working hours, GDP per hour, employed population percentage, total population, energy production, manufacturing as a percentage of GDP, average household size, and the working-age population percentage. Model 3 also includes the dummy

Table 1. Descriptive Statistics

Variable	Obs.	Mean	Std. dev.	Min.	Max.
Total CO_2 emissions	350	4.302397	0.9642756	1.702928	6.569285
Working hours	350	7.488988	0.028757	7.390326	7.569343
Total population	350	15.15232	1.011498	13.18979	17.46439
GDP per capita	350	10.73515	0.1821364	10.34532	11.21572
Employed pop. %	350	3.84682	0.0778464	3.659142	4.006447
GDP per hour	350	4.02969	0.176429	3.684861	4.593245
Manufacturing (% of GDP)	350	2.377933	0.5447595	0.5434929	3.419944
Energy production	350	13.20909	1.65686	7.325808	16.56847
Average household size	350	0.9441615	0.597502	0.7975072	1.153732
Working-age population	350	4.202669	0.019409	4.160444	4.273884
State environmentalism	350	3.822873	0.5703182	1.871802	4.49981

Note: All variables logged (ln).

variables for census region and the state environmentalism measure. Models 2 and 4 examine the composition effect of working hours on carbon emissions. These models include working hours, GDP per capita, total population, energy production, manufacturing as a percentage of GDP, average household size, and working-age population percentage. Model 4 also includes the census region dummy variables and the state environmentalism measure. Models 1 and 2 are the two-way fixed effects Prais-Winsten regression models. Note that in these models, the R-squared statistic is close to perfect. This is largely due to the inclusion of the year-specific and state-specific intercepts. Models 3 and 4 are random effects models with unreported year-specific intercepts. These models also have high R-squared values, which is partly attributed to the inclusion of the year-specific intercepts and the census region control variables.

In models 1 and 3, we find that the scale effect of working hours on carbon emissions is positive and significant. Specifically, in model 1, we find that, over time, a 1 percent increase in average working hours per worker is associated with a 0.668 percent increase in emissions, holding all else constant. In model 3, this finding is substantively the same, where a 1 percent increase in average working hours is associated with a 0.654 percent increase in carbon emissions. In both models, total population is positive and significant, highlighting that population size is an important driver of emissions. Energy production is also positive and significant in both models. In model 1, employed population percentage is also positive and significant. In model 3, we find that the effect of the time-invariant measure for state environmentalism is negative and significant. The Midwest and South regional dummy variables are positive and significant, highlighting regional variation in carbon emissions. The effects of manufacturing as a percentage of GDP, average household size, and working-age population percentage are non-significant in both models.

In models 2 and 4, we also find that the composition effect of working hours on emissions is positive and significant. More specifically, in model 2, we find that a 1

Table 2. Correlation Matrix

	1	2	3	4	5	6	7	8	9	10
1. Total CO_2 emissions										
2. Working hours	0.3991									
3. Employed pop. %	−0.3548	−0.3641								
4. GDP per hour	0.0526	−0.1176	0.0797							
5. GDP per capita	−0.0323	−0.1492	0.4877	0.8777						
6. Total population	0.8446	0.167	−0.3325	0.0551	−0.0214					
7. Manufacturing (% of GDP)	0.3413	0.1038	−0.088	−0.3832	−0.3478	0.3498				
8. Energy production	0.688	0.5071	−0.2058	−0.0229	−0.085	0.3572	0.2136			
9. Average household size	0.2089	0.2387	−0.3768	0.3148	0.1543	0.303	−0.3031	0.0406		
10. Working-age population	−0.0822	−0.0885	0.3205	0.369	0.5182	−0.022	−0.2042	−0.0597	−0.0884	
11. State environmentalism	−0.0743	−0.4706	0.2258	0.0165	0.1177	0.2637	0.1469	−0.4333	−0.2436	0.1422

Note: All variables logged (ln).

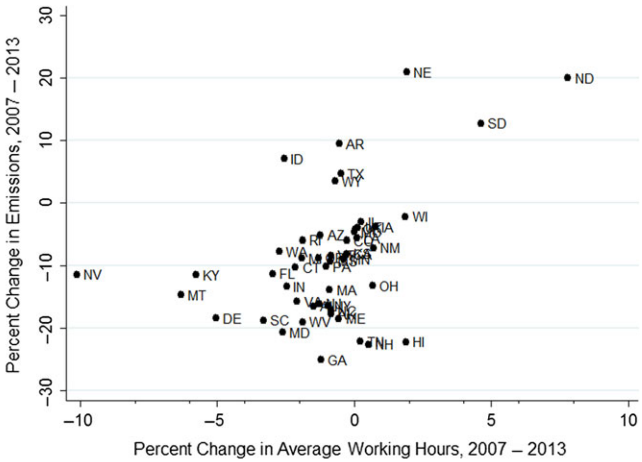
Table 3. List of States and Census Region

Alabama	(South)	Montana	(West)
Alaska	(West)	Nebraska	(Midwest)
Arizona	(West)	Nevada	(West)
Arkansas	(South)	New Hampshire	(Northeast)
California	(West)	New Jersey	(Northeast)
Colorado	(West)	New Mexico	(West)
Connecticut	(Northeast)	New York	(Northeast)
Delaware	(Northeast)	North Carolina	(South)
Florida	(South)	North Dakota	(Midwest)
Georgia	(South)	Ohio	(Midwest)
Hawaii	(West)	Oklahoma	(South)
Idaho	(West)	Oregon	(West)
Illinois	(Midwest)	Pennsylvania	(Northeast)
Indiana	(Midwest)	Rhode Island	(Northeast)
Iowa	(Midwest)	South Carolina	(South)
Kansas	(Midwest)	South Dakota	(Midwest)
Kentucky	(South)	Tennessee	(South)
Louisiana	(South)	Texas	(South)
Maine	(Northeast)	Utah	(West)
Maryland	(South)	Vermont	(Northeast)
Massachusetts	(Northeast)	Virginia	(South)
Michigan	(Midwest)	Washington	(West)
Minnesota	(Midwest)	West Virginia	(South)
Mississippi	(South)	Wisconsin	(Midwest)
Missouri	(Midwest)	Wyoming	(West)

Note: Census region in parentheses.

percent increase in average working hours is associated with a 0.675 percent increase in carbon emissions while holding all else constant. Similarly, in model 4, we find that a 1 percent increase in average working hours is associated with a 0.552 percent increase in emissions. For the control variables, we again find the effects of total population and energy production to be positive and significant. The effect of GDP per capita is non-significant in both models. Previous studies have found GDP per capita (i.e., Knight et al. 2013a, 2013b) to be significant when examining the composition effect. This null finding is possibly due to our relatively small sample size, which limits the statistical power of the models. It should be noted that in models without energy production as a control, the positive effect of GDP per capita on emissions is significant. In model 4, the estimated effect of state environmentalism is negative and significant, while the Midwest regional dummy

Figure 2. Scatterplot of the association between the percent change in total emissions from 2007 to 2013 and the percent change in average working hours from 2007 to 2013. Each dot represents a different state.



variable is also significant, once again highlighting regional variability in carbon emissions. In both models, the effects of manufacturing as a percentage of GDP, average household size, and working-age population are non-significant.

Following the suggestions of two anonymous reviewers, as a robustness check for our reported findings we also estimated "hybrid" models, which combine the features of both fixed effects models and random effects models (Allison 2009; Firebaugh, Warner, and Massoglia 2013; Schunck 2013). The results, which are provided in the appendix, are consistent with the findings reported in table 4. In addition to the hybrid models, we also conducted sensitivity analyses to test for the presence of overly influential cases in the fixed effects and random effects models. These sensitivity analyses, which involved estimating each model excluding one state at a time, are consistent with the reported findings, suggesting that there are no overly influential cases in the sample. While we do control for energy production, we also ran models simultaneously excluding Nebraska, South Dakota, and North Dakota, which have experienced a "fracking boom" in recent years that could influence the results. The findings again remained substantively similar. Finally, we estimated additional models that also control for the percentage of the population with a bachelor's degree. The results of these models are substantively the same as the reported findings, while the estimated effect of the education measure on state-level carbon emissions is nonsignificant.

Discussion & Conclusion

A growing number of researchers have questioned whether continued economic growth, with its attendant carbon emissions, is sustainable. They argue that we need planned economic contraction, or degrowth, in order to reach emissions targets and avoid the most disastrous effects of climate change. A key part of the degrowth

Table 4. Longitudinal Regression Models of the Effect of Average Hours Worked per Week on CO_2 Emissions in All 50 US States, 2007–2013

	Model 1		Model 2		Model 3		Model 4	
	Scale (FE)		Comp. (FE)		Scale (RE)		Comp. (RE)	
Working hours	0.668***	(0.179)	0.675***	(0.202)	0.654**	(0.243)	0.552*	(0.235)
Employed pop. %	0.519***	(0.120)			0.209	(0.218)		
GDP per hour	0.06	(0.094)			0.129	(0.089)		
GDP per capita			0.108	(0.067)			0.134	(0.090)
Total population	0.918***	(0.167)	0.806***	(0.174)	0.747***	(0.033)	0.758***	(0.038)
Manufacturing (% of GDP)	−0.024	(0.042)	−0.028	(0.041)	−0.054	(0.034)	−0.046	(0.033)
Energy production	0.070*	(0.029)	0.068*	(0.027)	0.139***	(0.017)	0.121***	(0.018)
Average household size	−0.288	(0.225)	−0.262	(0.240)	−0.312	(0.244)	−0.336	(0.234)
Working-age population	1.034	(0.700)	1.008	(0.745)	0.73	(0.707)	0.912	(0.687)
State environmentalism					−0.311***	(0.064)	−0.338***	(0.076)
Midwest					0.443***	(0.088)	0.461***	(0.104)
South					0.256**	(0.097)	0.267*	(0.115)
West					−0.029	(0.096)	−0.013	(0.115)
Constant	−18.743***	(3.813)	−15.853***	(3.963)	−14.027***	(3.156)	−14.365***	(3.058)
N	350		350		350		350	
R-Squared	0.998		0.998		0.923		0.919	

Note: All continuous variables are logged (ln). All models are calculated with AR(1) correction. All models contain unreported year-specific intercepts. Models 1 and 2 also contain unreported unit-specific intercepts. Standard errors in parentheses. *$p < 0.05$ **$p < 0.01$ ***$p < 0.001$

paradigm is a reduction of working hours. Previous cross-national research has shown that longer work hours are associated with increased environmental pressures, including fossil-fuel energy consumption and carbon emissions (Fitzgerald, Jorgenson, and Clark 2015; Hayden and Shandra 2009; Knight, Rosa, and Schor 2013a, 2013b; Rosnick and Weisbrot 2007; Schor 2005).

In this study, we examined the relationship between state-level working hours and carbon emissions for all 50 US states. Analyzing this relationship at the state level is important for a number of reasons. The federal government in the United States has been slow to enact policies that effectively deal with climate change mitigation, and this has worsened under the Trump administration. As a result, states have taken significant actions to curb their emissions. Furthermore, sub-national entities (e.g., states, cities, and regions) have announced that they will continue their push to meet the goals of the Paris Climate Accord even after the Trump Administration has signaled its intention to pull the United States out of its obligations (Domonoske 2017). Second, states have a recent history of enacting work time legislation (Messenger and Ghosheh 2013; National Conference of State Legislatures 2017), in contrast to the federal government, which has done little to advance shorter working hours since the 1938 Fair Labor Standards Act. Finally, it is useful to study the relationship between working hours and emissions at the state level because we cannot assume it operates similarly within countries as across them.

The results of our analysis suggest that working time is positively associated with higher state-level carbon emissions, and we find evidence for both the scale and composition effects. For the scale effect, our findings indicate that longer hours of work increase emissions through their contribution to GDP, net of labor productivity and the employment to population ratio. The relationship between working hours and carbon emissions holds net of GDP as well. This is likely due to longer hours of work leading to more carbon-intensive lifestyles due to lower levels of time affluence. Our results are generally consistent with previous cross-national research. A notable exception is that we find a significant composition effect of working hours on emissions, in contrast to Knight, Rosa, and Schor (2013a, 2013b).

While our findings suggest that a reduction of working time could be a viable climate change mitigation strategy for US states, they also have implications for the future of work, and particularly the impact of advances in AI and automation on employment (Acemoglu and Restrepo 2017; Brynjolfsson and McAfee 2014). If unaddressed, labor displacement via technological change could lead to higher levels of unemployment. Instead of relying on economic growth to combat future unemployment, working time reduction has the potential for a "triple dividend" (Jackson 2005). First, a reduction in working time potentially spreads employment to more employees, thus reducing unemployment. Second, research suggests that reduced working hours benefit individuals via lower levels of stress, increased leisure time, and increases in quality of life (Alesina, Glaeser, and Sacerdote 2005; Hayden 1999; Kasser and Brown 2003; Pouwels, Siegers, and Vlasblom 2008). Third, working time reduction allows a society to reduce its impact on the environment.

While working time reduction offers a potential triple dividend of socio-environmental benefits, it is not without its challenges. US work time reductions are often involuntary. People may be faced with a decision of working less or losing their jobs. Environmentally, it does not matter if the reductions are voluntary or not, as the benefit for reduced carbon emissions occurs regardless. On the social side, however, these involuntary reductions can be difficult to deal with. Therefore, to make work time reduction socially, economically, politically, and environmentally feasible, voluntary programs to trade income for time are to be preferred. To increase the desirability to such policies, planned working time reduction in the United States should be accompanied by other structural changes.

In the United States, the combination of a weak welfare state, high income and wealth inequality, and an abundance of low wage employment tends to result in long working hours. While "work share" programs have been implemented in many states, they are not likely to make working time reductions feasible on their own, as their benefits are limited. Because the United States does not have a strong welfare state to provide for the basic needs of its population, people must work longer hours in order to afford basic necessities (Alesina, Glaeser, and Sacerdote 2005; Schor 2010). Healthcare is an important example of this effect. Many employees must work long hours in order to be eligible for employer-sponsored health insurance, and there is currently no legal requirement for employers to provide benefits to part-time workers. This creates a disincentive for employees to choose part-time work and an incentive for firms to require working longer hours to reduce the costs of health insurance premiums (Schor 1992). In many other affluent democratic nations, these structural barriers to shorter working hours are limited or absent because healthcare is provided via the state. Another structural change that should accompany a working time reduction is a reduction in income and wealth inequality. Previous research finds that higher income inequality results in longer working hours (Bowles and Park 2005). Lower inequality could also lead to reduced carbon emissions (Jorgenson, Schor, and Huang 2017) and improved human well-being (Hill and Jorgenson 2018). An additional, and important, issue is creating more meaningful work, especially with increases in automation on the horizon. This is beyond the scope of the present study, but recently highlighted by Foster (2017) in his discussion of work and sustainability.

While our findings are robust across different modeling techniques and various sensitivity analyses, our study is not without limitations. Due to data availability, the study covers a limited number of years: 2007–2013. Analyzing a broader time period would allow for additional questions to be asked, such as how the effect of working hours on carbon emissions changes through time. Also, while analyzing state-level data is useful for substantive and methodological reasons, the composition effect occurs at the household level. Therefore, future research could be improved by including such micro-level data to better understand the mechanisms behind the composition effect. Future research should also examine the working hours-emissions relationship in other sub-national contexts. The United States is a relatively unique case, as many affluent countries have experienced working hours reductions in recent decades, while hours have increased in the United States. Finally, future research would benefit from a more direct assessment of how the rise of AI and automation influence the relationship between working time and various environmental outcomes, including carbon emissions.

Appendix

Table A1. Hybrid Method Regression Models of the Effect of Average Hours Worked per Week on CO_2 Emissions in all 50 US States, 2007–2013

	Model 5		Model 6	
	Scale (Hybrid)		Comp. (Hybrid)	
Working hours (d)	0.633**	(0.221)	0.635**	(0.227)
Employed population % (d)	0.582**	(0.214)		
GDP per hour (d)	0.048	(0.091)		
GDP per capita (d)			0.133	(0.095)
Total population (d)	0.984**	(0.322)	0.862**	(0.321)
Manufacturing (% of GDP) (d)	−0.031	(0.036)	−0.035	(0.036)
Energy production (d)	0.055*	(0.024)	0.050*	(0.024)
Average household size (d)	−0.294	(0.238)	−0.267	(0.238)
Working-age population (d)	1.281	(0.696)	1.292	(0.699)
State environmentalism	−0.124	(0.088)	−0.174	(0.100)
Midwest	0.474***	(0.113)	0.388**	(0.127)
South	0.123	(0.140)	0.171	(0.159)
West	−0.124	(0.129)	−0.112	(0.147)
Working hours (m)	2.648	(2.115)	3.381	(2.386)
Employed population % (m)	−1.705**	(0.649)		
GDP per hour (m)	0.902***	(0.271)		
GDP per capita (m)			0.511	(0.301)
Total population (m)	0.644***	(0.055)	0.697***	(0.060)
Manufacturing (% of GDP) (m)	−0.099	(0.079)	−0.114	(0.089)
Energy production (m)	0.204***	(0.031)	0.192***	(0.035)
Average household size (m)	−0.958	(0.920)	−0.403	(1.038)
Working-age population (m)	−2.339	(2.242)	−3.053	(2.565)
Constant	−3.208	(11.099)	−12.120	(12.407)
N	350		350	
R-squared	0.949		0.936	

Note: Hybrid models include the unit-specific mean (labeled with an "m") as well as the deviations from that mean (labeled with a "d") for each time-variant explanatory variable. All continuous variables are logged (ln). All models are calculated with AR(1) correction. All models contain unreported year-specific intercepts. Standard errors in parentheses. $*p < 0.05$ $**p < 0.01$ $***p < 0.001$

About the Authors

Jared B. Fitzgerald is a PhD student in sociology at Boston College. His research examines the political economy of environmental change and sustainability. Recent research has examined the relationship between working hours and energy consumption, the political economy of the water footprint, and the environmental implications of income and wealth inequality.

Juliet B. Schor is Professor of Sociology at Boston College. Her research is on issues of time use, consumption, and sustainability. She is the author *of The Overworked American: The Unexpected Decline of Leisure* and *Plenitude: The Economics of True Wealth*.

Andrew K. Jorgenson is Professor of Sociology and Professor of Environmental Studies at Boston College. Broadly speaking, the primary area of his research is the human dimensions of global and regional environmental change. His work appears in such venues as *American Journal of Sociology*, *Social Forces*, *Social Problems*, *Sociological Science*, *Nature Climate Change*, *Climatic Change*, *Sustainability Science*, and *Environmental Research Letters*. He is founding coeditor of the journal *Sociology of Development*.

References

Acemoglu, Daron, and Pascual Restrepo. 2017. "Robots and Jobs: Evidence from US Labor Markets." Working Paper 23285. National Bureau of Economic Research. http://www.nber.org/papers/w23285.

Alcott, Blake. 2008. "The Sufficiency Strategy: Would Rich-World Frugality Lower Environmental Impact?" *Ecological Economics* 64:770–86.

Alesina, Alberto, Edward Glaeser, and Bruce Sacerdote. 2005. "Work and Leisure in the United States and Europe: Why So Different?" *NBER Macroeconomics Annual* 20:1–64.

Alexander, Samuel. 2012. "Planned Economic Contraction: The Emerging Case for Degrowth." *Environmental Politics* 21:349–68.

Allison, Paul. 2009. *Fixed Effects Regression Models*. Los Angeles, CA: SAGE Publications.

Autor, David. 2015. "Why Are There Still So Many Jobs? The History and Future of Workplace Automation." *Journal of Economic Perspectives* 29:3–30.

Beck, Nathaniel, and Jonathan Katz. 1995. "What To Do (and Not To Do) with Time-Series Cross-Section Data." *American Political Science Review* 89:634–47.

Becker, Gary A. 1965. "A Theory of the Allocation of Time." *Economic Journal* 75:493–517.

Bell, Linda A, and Richard B Freeman. 2001. "The Incentive for Working Hard: Explaining Hours Worked Differences in the US and Germany." *Labour Economics* 8 (2): 181–202.

Bowles, Samuel, and Yongjin Park. 2005. "Emulation, Inequality, and Work Hours: Was Thorsten Veblen Right?" *Economic Journal* 115:F397–412.

Brady, David, Yunus Kaya, and Jason Beckfield. 2007. "Reassessing the Effect of Economic Growth on Well-Being in Less-Developed Countries, 1980–2003." *Studies in Comparative International Development* 42:1–35.

Brynjolfsson, Erik, and Andrew McAfee. 2014. *The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies*. New York: W. W. Norton & Company.

California Environmental Protection Agency. 2015. "Overview of ARB Emissions Trading Program." https://www.arb.ca.gov/cc/factsheets/emissions_trading_program.pdf (May 22, 2017, date last accessed).

Conference Board. 2017. "Total Economy Database Data." https://www.conference-board.org/data/economydatabase/index.cfm?id=27762.

Daly, Herman. 1996. *Beyond Growth: The Economics of Sustainable Development*. Boston: Beacon Press.

———. 1999. "Steady-State Economics: Avoiding Uneconomic Growth." In *Handbook of Environmental and Resource Economics*, edited by Jeroen C. J. M. Van den Bergh, 635–42. Cheltenham, UK: Edward Elgar Publishing.

Dietz, Thomas. 2015. "Prolegomenon to a Structural Human Ecology of Human Well-Being." *Sociology of Development* 1:123–48.

Dietz, Thomas, Ken Frank, Cameron Whitley, Jennifer Kelly, and Rachel Kelly. 2015. "Political Influences on Greenhouse Gas Emissions from US States." *Proceedings of the National Academy of Sciences* 112:8254–59.

Domonoske, Camila. 2017. "Mayors, Companies Vow to Act on Climate, Even as U.S. Leaves Paris Accord." NPR.org. http://www.npr.org/sections/thetwo-way/2017/06/05/531603731/mayors-companies-vow-to-act-on-climate-even-as-u-s-leaves-paris-accord.

Dunlap, Riley, and Robert Brulle, eds. 2015. *Climate Change and Society: Sociological Perspectives*. New York: Oxford University Press.

Easterlin, Richard. 1995. "Will Raising the Incomes of All Increase the Happiness of All?" *Journal of Economic Behavior & Organization* 27:35–47.

Economic Policy Institute. 2017. "SWA-Wages I Table 4.1 I Average Wages and Work Hours, 1967–2010 (2011 Dollars) I State of Working America." http://www.stateofworkingamerica.org/chart/swa-wages-table-4-1-average-wages-work-hours/.

Firebaugh, Glenn, Cody Warner, and Michael Massoglia. 2013. "Fixed Effects, Random Effects, and Hybrid Models for Causal Analysis." In *Handbook of Causal Analysis for Social Research*, edited by Stephen L. Morgan, 113–32. Dordrecht, Netherlands: Springer.

Fitzgerald, Jared, Andrew Jorgenson, and Brett Clark. 2015. "Energy Consumption and Working Hours: A Longitudinal Study of Developed and Developing Nations, 1990–2008." *Environmental Sociology* 1:213–23.

Foster, John Bellamy. 2011. "Capitalism and Degrowth: An Impossibility Theorem." *Monthly Review* 62(8):26–33. https://monthlyreview.org/2011/01/01/capitalism-and-degrowth-an-impossibility-theorem/.

———. 2017. "The Meaning of Work in a Sustainable Society." *Monthly Review* 69(4):1–14.

Foster, John Bellamy, Brett, Clark, and Richard, York. 2010. "Capitalism and the Curse of Energy Efficiency The Return of the Jevons Paradox." *Monthly Review* 62(6): 1–12.

Frey, Carl Benedikt, and Michael A. Osborne. 2017. "The Future of Employment: How Susceptible Are Jobs to Computerisation?" *Technological Forecasting and Social Change* 114:254–80.

Gordon, Robert. 2016. *The Rise and Fall of American Growth: The U.S. Standard of Living since the Civil War*. Princeton, NJ: Princeton University Press.

Grant, Don, Andrew Jorgenson, and Wesley Longhofer. 2016. "How Organizational and Global Factors Condition the Effects of Energy Efficiency on CO_2 Emission Rebounds among the World's Power Plants." *Energy Policy* 94:89–93.

Greenfieldboyce, Nell. 2016. "Trump Says He Has 'Open Mind' on Climate, But Staff Pick Raises Questions." NPR.org, November 23. http://www.npr.org/sections/thetwo-way/2016/11/23/503156456/trump-says-he-has-open-mind-on-climate-but-staff-pick-raises-questions.

Hayden, Anders. 1999. *Sharing the Work, Sparing the Planet: Work Time, Consumption & Ecology*. New York: Zed Books.

———. 2014. *When Green Growth Is Not Enough: Climate Change, Ecological Modernization, and Sufficiency*. Montreal, Quebec: MQUP.

Hayden, Anders, and John Shandra. 2009. "Hours of Work and the Ecological Footprint of Nations: An Exploratory Analysis." *Local Environment* 14:575–600.

Hill, Terrance, and Andrew Jorgenson. 2018. "Bring Out Your Dead! A Study of Income Inequality and Life Expectancy in the United States, 2000–2010." *Health & Place* 49:1–6.

Huber, Joseph. 2009. "Ecological Modernization: Beyond Scarcity and Bureaucracy." In *The Ecological Modernisation Reader*, edited by Arthur Mol, David Sonnenfeld, and Gert Spaargaren, 42–55. New York: Routledge.

Intergovernmental Panel on Climate Change. 2014. "Climate Change 2014: Synthesis Report."

Jackson, Tim. 2005. "Live Better by Consuming Less? Is There a 'Double Dividend' in Sustainable Consumption?" *Journal of Industrial Ecology* 9:19–36.

———. 2009a. *Prosperity Without Growth: Economics for a Finite Planet*. Sterling, VA: Earthscan.

_______. 2009b. "Beyond the Growth Economy." *Journal of Industrial Ecology* 13:487–90.

Jalas, M. 2002. "A Time Use Perspective on the Materials Intensity of Consumption." *Ecological Economics* 41:109–23.

———. 2005. "The Everyday Life Context of Increasing Energy Demands: Time Use Survey Data in a Decomposition Analysis." *Journal of Industrial Ecology* 9:129–45.

Jalas, Mikko, and Jouni K. Juntunen. 2015. "Energy Intensive Lifestyles: Time Use, the Activity Patterns of Consumers, and Related Energy Demands in Finland." *Ecological Economics* 113:51–59.

Jevons, William Stanley. 1865. *The Coal Question: An Inquiry Concerning the Progress of the Nation and the Probably Exhaustion of our Coal-Mines*. London: Macmillan.

Jorgenson, Andrew. 2006. "Global Warming and the Neglected Greenhouse Gas: A Cross-National Study of the Social Causes of Methane Emissions Intensity, 1995." *Social Forces* 84:1779–98.

———. 2014. "Economic Development and the Carbon Intensity of Human Well-Being." *Nature Climate Change* 4:186–89.

Jorgenson, Andrew, and Ryan Birkholz. 2010. "Assessing the Causes of Anthropogenic Methane Emissions in Comparative Perspective, 1990–2005." *Ecological Economics* 69 (12): 2634–43.

Jorgenson, Andrew, and Brett Clark. 2012. "Are the Economy and the Environment Decoupling? A Comparative International Study, 1960–2005." *American Journal of Sociology* 118:1–44.

Jorgenson, Andrew, Juliet Schor, and Xiaorui Huang. 2017. "Income Inequality and Carbon Emissions in the United States: A State-Level Analysis, 1997–2012." *Ecological Economics* 134:40–48.

Kasser, Tim, and Kirk W. Brown. 2003. "On Time, Happiness, and Ecological Footprints." In *Take Back Your Time: Fighting Overwork and Time Poverty in America*, edited by John de Graaf, 107–112. San Francisco, CA: Berrett-Koehler Publishers, Inc.

Kerschner, Christian. 2010. "Economic De-Growth vs. Steady-State Economy." *Journal of Cleaner Production* 18:544–51.

King, Lewis, and Jeroen C. J. M. van den Bergh. 2017. "Worktime Reduction as a Solution to Climate Change: Five Scenarios Compared for the UK." *Ecological Economics* 132:124–34.

Knight, Kyle, Eugene Rosa, and Juliet Schor. 2013a. "Reducing Growth to Achieve Environmental Sustainability: The Role of Work Hours." In *Capitalism on Trial: Explorations in the Tradition of Thomas E. Weisskopf*, edited by Jeannette Wicks-Lim and Robert Pollin, 187–204. Cheltenham, UK: Edward Elgar Publishing.

———. 2013b. "Could Working Less Reduce Pressures on the Environment? A Cross-National Panel Analysis of OECD Countries, 1970–2007." *Global Environmental Change* 23:691–700.

Knight, Kyle, and Juliet Schor. 2014. "Economic Growth and Climate Change: A Cross-National Analysis of Territorial and Consumption-Based Carbon Emissions in High-Income Countries." *Sustainability* 6: 3722–31.

Lavelle, Marianne. 2016. "2016: President Obama's Climate Legacy Marked by Triumph, but Also Lost Opportunities." *Inside Climate News*. https://insideclimatenews.org/news/23122016/obama-climate-change-legacy-trump-policies.

Longhofer, Wesley, and Andrew Jorgenson. 2017. "Decoupling Reconsidered: Does World Society Integration Influence the Relationship Between the Environment and Economic Development?" *Social Science Research* 65:17–29.

Martinez-Alier, Joan. 2009. "Socially Sustainable Economic De-Growth." *Development and Change* 40: 1099–1119.

———. 2012. "Environmental Justice and Economic Degrowth: An Alliance between Two Movements." *Capitalism Nature Socialism* 23:51–73.

Meadows, Donella, Jorgen Randers, and Dennis Meadows. 2004. *Limits to Growth: The 30-Year Update*. White River Junction, VT: Chelsea Green Publishing.

Messenger, Jon Carleton, and Naj Ghosheh. 2013. *Work Sharing During the Great Recession: New Developments and Beyond*. Cheltenham, UK: Edward Elgar Publishing.

Milanovic, Branko. 2017. "The Illusion of 'Degrowth' in a Poor and Unequal World." Globalinequality. http://glineq.blogspot.co.uk/2017/11/the-illusion-of-degrowth-in-poor-and.html.

Mol, Arthur, and Martin Janicke. 2009. "The Origins and Theoretical Foundations of Ecological Modernisation Theory." In *The Ecological Modernisation Reader*, edited by Arthur Mol, David Sonnenfeld, and Gert Spaargaren, 17–27. New York: Routledge.

Mol, Arthur, Gert Spaargaren, and David Sonnenfeld. 2014. "Ecological Modernization Theory: Taking Stock, Moving Forward." In *Routledge International Handbook of Social and Environmental Change*, edited by Stewart Lockie, David Sonnenfeld, and Dana Fisher, 15–30. New York: Routledge.

National Conference of State Legislatures. 2017. "Work Share Programs." http://www.ncsl.org/research/labor-and-employment/work-share-programs.aspx.

Pollin, Robert. 2015. *Greening the Global Economy*. Cambridge, MA: MIT Press.

Pouwels, Babette, Jacques Siegers, and Jan Dirk Vlasblom. 2008. "Income, Working Hours, and Happiness." *Economics Letters* 99:72–74.

Princen, Thomas. 2005. *The Logic of Sufficiency*. Cambridge, MA: MIT Press.

Regional Greenhouse Gas Initiative. 2017. "Regional Greenhouse Gas Initiative (RGGI) CO_2 Budget Trading Program—Home." https://www.rggi.org/.

Rice, James. 2007. "Ecological Unequal Exchange: International Trade and Uneven Utilization of Environmental Space in the World System." *Social Forces* 85 (3): 1369–92.

Rockström, Johan, Will Steffen, Kevin Noone, Åsa Persson, F. Stuart Chapin III, Eric F. Lambin, Timothy M. Lenton, Marten Scheffer, Carl Folke, Hans Joachim Schellnhuber, et al. 2009. "A Safe Operating Space for Humanity." *Nature* 461:472–75.

Rosa, Eugene, and Thomas Dietz. 2012. "Human Drivers of National Greenhouse-Gas Emissions." *Nature Climate Change* 2:581–86.

Rosa, Eugene, Richard York, and Thomas Dietz. 2004. "Tracking the Anthropogenic Drivers of Ecological Impacts." *AMBIO: A Journal of the Human Environment* 33:509–12.

Rosnick, David, and Mark Weisbrot. 2007. "Are Shorter Work Hours Good for the Environment? A Comparison of U.S. and European Energy Consumption." *International Journal of Health Services* 37: 405–17.

Sachs, Wolfgang. 2008. "Climate Change and Human Rights." *Development* 51:332–37.

Sachs, Wolfgang, Reinhard Loske, and Manfred Linz. 1998. *Greening the North: A Post-Industial Blueprint for Ecology and Equity*. New York: Zed Books.

Schneider, François, Giorgos Kallis, and Joan Martinez-Alier. 2010. "Crisis or Opportunity? Economic Degrowth for Social Equity and Ecological Sustainability. Introduction to This Special Issue." *Journal of Cleaner Production* 18:511–18.

Schor, Juliet. 1991. "Global Equity and Environmental Crisis: An Argument for Reducing Working Hours in the North." *World Development* 19:73–84.

———. 1992. *The Overworked American: The Unexpected Decline of Leisure*. New York: Basic Books.

_______. 2005. "Sustainable Consumption and Worktime Reduction." *Journal of Industrial Ecology* 9: 37–50.

_______. 2010. *Plenitude: The New Economics of True Wealth*. New York: Penguin Press.

Schunck, Reinhard. 2013. "Within and Between Estimates in Random-Effects Models: Advantages and Drawbacks of Correlated Random Effects and Hybrid Models." *The Stata Journal* 13(1):65–76.

Shandra, John, Bruce London, Owen Whooley, and John Williamson. 2004. "International Nongovernmental Organizations and Carbon Dioxide Emissions in the Developing World: A Quantitative, Cross-National Analysis." *Sociological Inquiry* 74:520–45.

Shao, Qinglong, and Shiran Shen. 2017. "When Reduced Working Time Harms the Environment: A Panel Threshold Analysis for EU-15, 1970–2010." *Journal of Cleaner Production* 147:319–29.

Stevenson, Betsey, and Justin Wolfers. 2008. "Economic Growth and Subjective Well-Being: Reassessing the Easterlin Paradox." Working Paper 14282, National Bureau of Economic Research.

US Census Bureau. 2016. Census.gov. https://www.census.gov/en.html.

———. 2017. "American Community Survey." https://www.census.gov/programs-surveys/acs/data.html.

US Department of Commerce Bureau of Economic Analysis. 2016. "Bureau of Economic Analysis." https://www.bea.gov/itable/index.cfm.

US Department of Labor Bureau of Labor Statistics. 2016. "Employment, Hours, and Earnings from the Current Employment Statistics Survey (National) Home Page." https://www.bls.gov/ces/.

US Energy Information Administration. 2016. "US Energy Information Administration—EIA—Independent Statistics and Analysis." *State Energy Data System*. https://www.eia.gov/state/seds/.

United States Environmental Protection Agency. 2015. "Sources of Greenhouse Gas Emissions." https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions.

US Environmental Protection Agency. 2016. "State Energy CO_2 Emissions Database." https://www3.epa.gov/statelocalclimate/resources/state_energyco2inv.html.

———. 2017. "State Energy CO_2 Emissions." https://19january2017snapshot.epa.gov/statelocalclimate/state-energy-co2-emissions_.html.

US Global Change Research Program. 2017. "2017: Climate Science Special Report: Fourth National Climate Assessment, Volume 1." https://science2017.globalchange.gov/.

van Ark, Bart, and Robert H. McGuckin. 1999. "International Comparisons of Labor Productivity and Per Capita Income." *Monthly Labor Review* 122:33–41.

van den Bergh, Jeroen C. J. M. 2011. "Environment versus Growth—A Criticism of 'Degrowth' and a Plea for 'A-Growth.'" *Ecological Economics* 70:881–90.

van Koppen, Kris, and Arthur Mol. 2009. "Ecological Modernization of Industrial Ecosystems." In *The Ecological Modernization Reader*, edited by Arthur Mol, David Sonnenfeld, and Gert Spaargaren, 295–317. New York: Routledge.

Victor, Peter. 2008. *Managing Without Growth: Slower by Design, Not Disaster*. Cheltenham, UK: Edward Elgar Publishing.

York, Richard. 2008. "De-Carbonization in Former Soviet Republics, 1992–2000: The Ecological Consequences of De-Modernization." *Social Problems* 55:370–90.

———. 2012. "Asymmetric Effects of Economic Growth and Decline of CO_2 Emissions." *Nature Climate Change* 2:762–64.

York, Richard, and Julius McGee. 2016. "Understanding the Jevons Paradox." *Environmental Sociology* 2: 77–87.

York, Richard, Eugene Rosa, and Thomas Dietz. 2003. "Footprints on the Earth: The Environmental Consequences of Modernity." *American Sociological Review* 68:279–300.