Global Environmental Change 23 (2013) 691–700

Contents lists available at SciVerse ScienceDirect

Global Environmental Change

journal homepage: www.elsevier.com/locate/gloenvcha

Could working less reduce pressures on the environment? A cross-national panel analysis of OECD countries, 1970–2007

Kyle W. Knight [a,*], Eugene A. Rosa [b], Juliet B. Schor [c]

[a] Department of Sociology, University of Alabama in Huntsville, 344 Morton Hall, 301 Sparkman Drive, Huntsville, AL 35899, USA
[b] Department of Sociology, Washington State University, PO Box 644020, Pullman, WA 99164, USA
[c] Department of Sociology, Boston College, 531 McGuinn Hall, 140 Commonwealth Avenue, Chestnut Hill, MA 02467, USA

ARTICLE INFO

Article history:
Received 14 March 2012
Received in revised form 11 February 2013
Accepted 27 February 2013

Keywords:
Working hours
Degrowth
Ecological footprint
Carbon dioxide emissions
STIRPAT

ABSTRACT

Many scholars and activists are now advocating a program of economic degrowth for developed countries in order to mitigate demands on the global environment. An increasingly prominent idea is that developed countries could achieve slower or zero economic growth in a socially sustainable way by reducing working hours. Research suggests that reduced working hours could contribute to sustainability by decreasing the scale of economic output and the environmental intensity of consumption patterns. Here, we investigate the effect of working hours on three environmental indicators: ecological footprint, carbon footprint, and carbon dioxide emissions. Using data for 1970–2007, our panel analysis of 29 high-income OECD countries indicates that working hours are significantly associated with greater environmental pressures and thus may be an attractive target for policies promoting environmental sustainability.

1. Introduction

The cumulative weight of available scientific evidence unequivocally shows that the current scale and rate of human (anthropogenic) impacts on the global environment is unprecedented in the 200,000 years humans have lived on earth (Rosa et al., 2010). For instance, the global ecological footprint (EF), a widely used measure of environmental pressure, now stands at 18 billion hectares of bio-productive land and water areas, double what it was in 1966. To maintain this level of consumption would require one and a half Earths (GFN, 2010). As humanity's overshoot of environmental limits become increasingly manifest and its consequences become clearer, more attention is being paid to the idea of supplanting the pervasive growth paradigm of contemporary societies.

Interest in economic degrowth is bolstered by the apparent inability of key structural factors—economic growth, eco-efficiency, or the rise of the service sector—to move societies toward sustainability, as we argue in the next section. We therefore propose the consideration of a new structural variable: reductions in working hours. In doing so, we aim to add to an existing literature in the social sciences on working hours. Economists have mainly addressed the question of whether working hours reductions reduce or expand employment and unemployment, with a variety of conclusions, depending on assumptions about wage responses, length of time considered, and other factors (Kapteyn et al., 2004; Booth and Sciantarelli, 1987; Skuterud, 2007; Boeri et al., 2008). Recently, interest in short-time working has increased, given its use as a response to the 2008 global downturn (OECD, 2010; Boeri and Bruecker, 2011). Working hours have also been linked to income inequality (Bowles and Park, 2005) and the balance of power between the wealthy and workers (Oh et al., 2012). There are also studies of worktime preferences and their relation to actual working hours (Schor, 1992; Galinsky et al., 2005; Jacobs and Gerson, 2004; Reynolds, 2004; Otterbach, 2010). Finally, scholars have been exploring the relation between working hours and well-being. Studies of European countries find that longer working hours are associated with lower happiness (Alesina et al., 2005; Pouwels et al., 2008). In the U.S., research has shown that, even controlling for income, well-being is positively related to "time affluence" and working hours are negatively related to happiness (Kasser and Brown, 2003; Kasser and Sheldon, 2009). Furthermore, the extra happiness accruing from free time may not be positional, in contrast to income, so its benefits are durable (Frank, 1985; Solnick and Hemenway, 1998).

In this paper we consider the relationship between working hours and environmental pressures. Many scholars and activists are currently advocating a program of socially sustainable economic degrowth for high-income countries. A key element of this program is the systematic reduction of worktime. Here, we test the hypothesis that shorter working hours are significantly

* Corresponding author. Tel.: +1 256 824 2294; fax: +1 256 824 2387.
E-mail addresses: kyle.knight@uah.edu, kylewknight@gmail.com (K.W. Knight), rosa@wsu.edu (E.A. Rosa), juliet.schor@bc.edu (J.B. Schor).

0959-3780/$ – see front matter
http://dx.doi.org/10.1016/j.gloenvcha.2013.02.017

associated with lower environmental pressures. We hypothesize two pathways through which hours of work might be associated with less environmental demand. The first is that, all else equal, shorter hours of work reduce the scale of the economy compared to what it would be with higher hours (the scale effect). The second concerns the impact of work hours on the resource intensity of consumption patterns (the compositional effect). Using first-difference panel regression for 27 high-income OECD countries over the years 1970–2007, we test for these effects and find strong empirical support for the former and moderate support for the latter. Although the literature has not explicitly considered it, our model also tests the reverse possibility: that shorter hours are associated with higher consumption impact and/or higher energy or resource use in production, as firms respond to lower hours per worker. These effects, if they are present, are outweighed by the resource-reducing impacts of shorter hours of work.

2. Economic growth and eco-efficiency: the conventional structural factors

In what is now a considerable literature on the anthropogenic drivers of environmental impacts, the challenge of mitigation has been mainly addressed by three structural factors: economic growth, the efficiency of resource use (or eco-efficiency), and the rise of the service sector. However, as we shall argue on the basis of empirical evidence, these factors alone are not able to shoulder the current burden of needed reductions in environmental impacts. However, our findings do suggest that shorter working hours are associated with a smaller impact on the environment.

2.1. Accelerating growth

Early research indicated the existence of an Environmental Kuznets Curve (EKC) according to which environmental degradation increases with economic development up to a point, reaches a peak, and then declines with further economic growth (Grossman and Krueger, 1995). This gave some researchers hope that sustainability could be achieved via an accelerated "business as usual" process involving the encouragement of further growth in both developed and developing countries. However, recent studies using a comprehensive consumption-based indicator of environmental threats, the ecological footprint, found no EKC relationship (e.g., Jorgenson and Burns, 2007; York et al., 2003a). Likewise, tests of total carbon dioxide emissions have failed to show an EKC (Wagner, 2008; York et al., 2003b). On balance the preponderance of evidence casts serious doubt on the EKC claim that a country can grow its way out of global or large-scale environmental problems.

2.2. Eco-efficiency

It is often argued that sustainability may be achieved through increased "eco-efficiency" in the use of natural resources brought about by changing social practices and technologies (e.g., Hawken et al., 1999). Technological solutions, always a privileged view in industrial societies, are frequently seen as the key to achieving sustainability. However, technological approaches raise a host of challenging problems. Every new technology is accompanied by risks, often with unanticipated or unwanted consequences to the environment. Furthermore, when technological innovation leads to improved efficiency the net effect may be an increase, rather than a decrease in environmental demands and impacts. Technological efficiency can backfire, or lead to "rebound effects" (Brookes, 1978; Khazzoom, 1980). First identified by William Stanley Jevons a century and a half ago, The Jevons Paradox, a common rebound effect, refers to his finding that cheaper extraction of coal led to higher coal consumption (York, 2006). This idea has been expanded to caution more generally against the 'technological fix' approach to solving environmental problems. While there is still debate about the size of rebound effects (depending on the type of energy use and whether the analysis is done at the micro or the macro level) it cannot be ignored (Hertwich, 2005; Holm and Englund, 2009; Sorrell, 2007). Detailed studies of trends in energy use in the U.S. and Europe, likewise, demonstrate that increases in efficiency (whether measured in terms of fuel economy, lumens per watt, cubic feet per minute, or unit per dollar) are accompanied by increases in total consumption. For example residential energy consumption, despite the considerable improvement in the efficiency of appliances, increased by 214% between 1950 and 2006, while commercial consumption increased by 338% during the same period (Calwell, 2010).

York et al. (2009) have documented the Jevons Paradox by illustrating that in four major economies (United States, China, Japan, and Indonesia) increasing eco-efficiency (reduced ecological footprint/GDP) was associated with increases in total levels of consumption over four decades, rather than declines. Indeed, the feasibility of achieving the dematerialization of economies through the decoupling of natural resource use from economic growth is not well supported. The most comprehensive study to date does demonstrate that nations have experienced a "relative" decoupling of resource use from economic growth. However, because the scale of global material extraction continues to increase exponentially absolute, or actual, decoupling remains elusive (UNEP, 2011).

Another structural candidate is growth in the service sector. The importance of an industrial core that led the evolution of modern societies is now declining in many societies, being replaced by a growing service sector. Education, finance, health care, electrical utilities, wholesale and retail trade, and especially transportation and communication are coming to play an ever larger role in the economies of modern societies. To what extent has growth in the service sectors of societies, a structural shift, reduced human impacts on the environment? Dietz and Rosa (1994) addressed this issue in several analyses (York et al., 2003a,b, 2005; Dietz et al., 2007). None of the studies found a relationship between the relative size of a society's service economy and reductions in environmental impacts.

The failure to date of economic, technological, and sectorial approaches to stem ecological degradation led us to ask whether another structural factor, a reduction in working hours, could further contribute to environmental relief. In particular, do average working hours affect pressures on the environment in general, and on the dominant greenhouse gas, carbon dioxide (CO_2), in particular? The role of worktime is also being raised by an expanding literature on the feasibility of economic growth itself.

3. The critique of growth

Those who are questioning the wisdom of continuous economic growth are motivated by the fact that the planet has limited resources. This recognition has led researchers back to the "limits to growth" conversation of the 1970s (Meadows et al., 1974). In recent years this perspective has been echoed in a growing volume of writings and research (IPCC, 2007; MEA, 2005; Rosa et al., 2010; Speth, 2008; Vitousek et al., 1997). A particularly influential summary of the global ecosystem in *Nature* identifies "safe planetary boundaries" (Rockström et al., 2009). Consistent with the planetary footprint approach noted above, the planetary boundaries analysis argues that human impacts are excessive in scale, thereby "overshooting" the planet's regenerative capacities. As a growing number of scholars adopt this perspective, they are concluding that achieving sustainability will require that rich nations reduce their footprints by lowering absolute levels of materials consumption and perhaps reducing aggregate GDP growth to zero (Daly, 1996; Gorz, 1994; Jackson, 2009; Princen, 2005; Reisch and Røpke, 2004; Sachs et al., 1998; Schor, 1992, 2010). Even mainstream figures such as Nicholas Stern and Anthony Giddens have begun to question wealthy countries' long term commitment to growth, given the arithmetic of climate change (Watts, 2009; Giddens, 2009). This conversation is about growth in the global north, as is our analysis that follows, because income, wealth and ecological impact are so unequally distributed across the globe, because the global north is responsible for the lion's share of impacts, and because northern countries are wealthy enough to absorb slow or zero growth without excessive welfare loss (Jorgenson and Clark, 2009, 2011; Jorgenson et al., 2010a; Sachs and Santarius, 2007).

This challenge to the conventional growth paradigm has expanded across various fields and geographic regions. Scholars have been developing a body of literature that calls for reduced economic growth in rich countries to be achieved through a mix of policies and social structural changes. This approach goes by a number of names, such as sufficiency, new economics, and *de-croissance* or degrowth (Douthwaite, 1999; Jackson, 2009; Kallis, 2011; Martinez-Alier, 2009; Princen, 2005; Schor, 2010; Seyfang, 2009; Speth, 2008; Victor, 2008). What unites these approaches is the proposition that the EKC logic of accelerated, unrestrained growth is inverted. Social commitment to unrestrained growth is at the core of unsustainability and climate change, rather than its solution. They also reject the view that technological change or resource efficiencies will be sufficient to achieve sustainability or safe greenhouse gas levels within the time frame of feasible action.

The literatures on degrowth and new economics have emerged more or less independently but simultaneously in a number of countries. In France, where interest is strongest, the most influential proponent has been Serge Latouche (2009), who has drawn from ecological economists such as Gorgescu-Roegen (1971) and Andre Gorz (1994) and the 1960s political economy critique of productivism. In the Anglophone world, a similar literature has developed, although with less terminological coherence. The *new economics* paradigm includes a variety of researchers, think tanks and advocacy groups, such as Britain's New Economics Foundation (http://www.neweconomics.org/), the New Economics Institute in the U.S. (http://neweconomicsinstitute.org), and the UK's now closed Commission for Sustainable Development (http://www.sd-commission.org.uk/; see also Jackson, 2009). All work for a shift away from the growth-centric society.

In the US, the work of Herman Daly (1996) who long has advocated a "steady state economics," has been most influential, resulting in contributions such as Peter Victor's (2008) zero growth macro-model of the Canadian economy and the Center for the Advancement of the Steady State Economy (http://steadystate.org/). A second strand of work, inspired by E.F. Schumacher's (1973) *Small is Beautiful*, and the re-localization movement, includes the writings of the International Forum on Globalization (Cavanagh and Mander, 2004), Thomas Princen's (2005) "sufficiency," and Juliet Schor's "plenitude" (2010), among others.

A related body of work looks at individuals and households who are reducing their ecological and carbon footprints by adopting simple lifestyles or low-impact consumption practices as well as downshifting in hours of work (Connolly and Prothero, 2008; Evans and Abrahamse, 2009; Hamilton, 2010; Kasser and Brown, 2003; Kasser and Sheldon, 2009; Schor, 1998). High levels of downshifting are thought to result in lower rates of economic growth, ceteris paribus, a similar point to that of Inglehart (1989), who finds that postmaterialist societies have lower economic growth rates than more materialist societies.

This degrowth perspective argues that growth is failing on multiple fronts: it has led to ecological (overshoot), excessive inequality, political disaffection, and the human loss of direction (Baykan, 2007). Degrowth involves a socially sustainable (Martinez-Alier, 2009) process of strategic downshifting in material throughput (in contrast to involuntary downshifts such as recessions) which relies on policies such as egalitarian income distribution and tax shifting, low hours of work, and high political involvement.

Worktime reduction is at the core of the degrowth agenda (Jackson, 2009; Schor, 2010). In Peter Victor's (2008) macroeconomic model of a degrowth scenario, a reduction in working hours is introduced in order to avoid increased unemployment caused by declining rates of growth. Reducing hours and distributing them more equally is a type of economic degrowth that attempts to make the pursuit of environmental sustainability socially sustainable as well. York (2008) argued, based on empirical analysis of former Soviet republics, that declines in GDP per capita are associated with lower carbon dioxide emissions; however, the economic degrowth experienced by these societies was unplanned and led to numerous social problems. For it to occur without drastic social disruption, would likely require that degrowth be implemented in a planned, systematic way.

Given the central role of worktime in various degrowth scenarios it will be instructive to briefly examine historical trends in work hours.

4. Trends in working hours

Since the mid-19th century work hours have declined markedly in industrialized countries (Lee et al., 2007). Today, average hours of work vary considerably among the relatively affluent OECD nations. According to the most recent data on the countries analyzed here, annual work hours in 2012 ranged from 1388 in The Netherlands to 2193 in South Korea (TCB, 2013). Van Ark (2002) identifies work hours as a key contributor to per capita income differences between countries, along with labor productivity and the employment to population ratio. The product of these three variables is equivalent to per capita economic output, or per capita GDP. Using 2001 data for the OECD countries, he estimated that while labor productivity was 13% higher in the US than EU-14 countries, per capita income was 33% higher; 12% points of this 20% point difference between the income gap and the productivity gap is attributable to lower working hours in the EU than in the US.

Bell and Freeman (2001) find that annual work hours are greater in the US compared to many other nations in the OECD or in Europe because of longer hours worked by full-time employees and less vacation and holiday time in the US. Furthermore, work hours tend to be longer in countries with greater income inequality (Bowles and Park, 2005). Alesina et al. (2005) find that substantial decreases in work hours since 1960 have occurred in European countries with strong labor unions, generous welfare states, high taxation, social democratic governments, all of which contribute to lower income inequality. In addition, they argue that the majority of the difference in work hours between the US and Europe can be explained by European labor market regulations that resulted in reduced hours or extended vacation time. A similar political economic analysis is found in Burgoon and Baxandall (2004), who surprisingly find that countries with conservative European governments have seen more worktime reduction in recent years. Recent research by Oh et al. (2012) finds that over the 20th century the increases in the political representation of workers is associated with lower hours of work. There is little evidence that these differences are due to values embedded in national cultures or to marginal tax rates (Alesina et al., 2005; Golden, 2009). These findings reinforce our view that worktime is a malleable structural factor that could be adjusted by willing governments or steady-state industries to reduce environmental degradation.

Especially relevant to the feasibility of worktime reduction is the evidence of mismatch between actual and preferred working hours in many countries. For instance, Reynolds (2003, 2004) found that workers in many countries desire to work fewer hours: United States (37%), Japan (46%), the former West Germany (38%) and Sweden (61%). In addition, Otterbach (2010) finds that richer nations have a higher percentage of workers who wish to work fewer hours and earn less money. However, these data do not reflect the fact that in some countries the aftermath of the 2008 financial crisis has led to increases in underemployment.

5. Working hours and environmental pressures

5.1. Scale effect

As noted above, hours of work is a key variable in the degrowth theories of the new economics paradigm (Coote et al., 2010; Gorz, 1994; Hayden, 1999; Jackson, 2009; Latouche, 2009; Sanne, 2005; Schor, 1991, 2005, 2010; Speth, 2008; Victor, 2008). There are a number of ways in which worktime can affect emissions and other environmental impacts. At the macro-structural level, high or rising work hours create what we call a scale (i.e., size of the economy) effect—more work generates greater economic output, income, and consumption. Ceteris paribus, if more work generates more output and uses more resources, then a reduction in work hours could lead to substantial environmental gains. Furthermore, if the goal is to achieve slow or zero economic growth, then progressive reductions in hours are necessary to avoid unemployment, unless the population is also shrinking. This is because productivity generally grows in a market economy, which reduces the labor requirements for any level of GDP. Ordinarily, GDP growth absorbs some fraction of that displaced labor. Alternatively, gains in productivity can be translated into more free time, instead of expanded production and consumption, either by reducing annual or lifetime hours, as for example by delaying labor force entry or by lowering the retirement age (Schor, 2010; Victor, 2008). Worktime reductions may be especially important to contain environmental pressures when eco-efficiency, or natural resource productivity, is rising, because they dampen the possibility of rebound effects by transforming gains in productivity into more leisure instead of more output. It should be noted that if work hours reductions are combined with a dramatic increase in the number of workers (e.g., through workshare programs) then the overall reduction in the scale effect on environmental impacts may be somewhat attenuated.

This process also entails dynamics on the consumer side because the additional production is converted into income and consumption. Schor (1992) has described this scale effect of converting productivity growth into more output as a ''work and spend'' cycle where individuals become locked into a trajectory of fixed or increasing hours which in turn generate additional income to fund rising consumption. In this way, labor market outcomes such as working time are a key factor in the dynamics of spending, and the functioning of a consumer culture. When ''work and spend'' prevails, advertising and marketing are more effective and competitive consumption is more pronounced. This path leads to greater environmental pressures, because productivity growth is converted into environmentally degrading production and consumption. Looked at from either side of the production-consumption cycle the dynamics of worktime are central.

5.2. Compositional effect

There are also links between working hours and the composition of resource consumption (Nassen et al., 2009). Households have income and time budgets and take both into account when making decisions about working and spending (Becker, 1965). Worktime is a macro-level structural constraint that influences the household allocation of time and resources and shapes consumption patterns. Households with less time and more money will choose timesaving activities and products, such as faster transportation, which are often more environmentally intensive. It seems to be the case that low impact activities are typically more time consuming, although there is relatively little research on this question (Jalas, 2002, 2005). However, transport is a clear case in which speed is associated with compressed time and higher energy costs. Food preparation is likely another (Jalas, 2002). Indeed, in a study of French households, Devetter and Rousseau (2011) found that net of income, longer work hours are associated with greater consumption of environmentally intensive goods. This *compositional effect* of work hours leads to unsustainable consumption patterns by creating time scarcity that encourages the consumption of relatively more environmentally harmful goods and services. This term describes the effect of work hours on environmental pressures beyond its contribution to overall economic output (i.e., net of work hours' contribution to GDP).

5.3. Could shorter work hours raise environmental pressures?

There is, of course, the possibility that reduced working hours could lead to greater environmental pressure. We consider different scenarios for both our scale and compositional effects. On the former, one possibility is a variant of Alcott (2008), who hypothesizes that ''first world frugality'' (lower consumption in the global north) results in lower consumer prices through the reduction of demand, which in turn spurs an increase in demand in poor countries of the global south. This effect could conceivably also be present if shorter work hours reduce aggregate consumer demand in the north. Because our sample is confined to high income countries, we cannot explore this possibility in our estimates. However, there may be analogous effects within national economies. Shorter hours may lead to higher labor productivity and subsequently higher wages, which in turn would increase consumption demand. This is the scale effect operating in the other direction—shorter hours create a rebound effect in which the scale of the economy is larger.

A second possibility is that the compositional effect works in the direction opposite to that which we hypothesized above. Households with more free time might take more vacations by auto or air, they may travel outside the home more, or have greater involvement in extra-mural community activities, leisure or shopping, as well as other energy consuming activities. In addition, if worktime reduction results in an increase in the number of people working then overall commuting traffic may increase. By contrast, if the additional time off work is used to engage in more self-sufficient activities (e.g., gardening) or time-intensive, low-impact activities such as walking and biking to work instead of driving, it could result in decreased resource demands. Clearly, the net impact of the compositional effect is a matter for empirical investigation. The response of income to shorter hours is of course important: If shorter hours are achieved by trading off income for time, the income intensity of time is likely to decline. However, as noted above, if the second round effects of shorter hours are to increase productivity and wages, the impact of worktime reductions on consumption and emissions could be positive. In the models we test below, we can only identify the net impacts of the levels of working hours and environmental indicators. Future research should provide a more elaborated general model with all the potential pathways among hours, income, productivity, and emissions.

6. Previous research on working hours and environmental demands

Despite considerable interest in working hours among scholars in a range of disciplines, the empirical literature on the relationship between worktime and environmental demands and impacts is meager. At the micro level, this is likely due to the absence of data sets that combine time use, expenditure and environmental impact. Nevertheless, an emergent cross-national literature supports a connection between work hours and environmental impacts.

The initial attempt at the macro-structural level to empirically assess the relationship between work hours and environmental degradation was Schor's (2005) bivariate linear regression analysis of the relationship between annual work hours per employee and the ecological footprint. Using data for 18 OECD countries Schor found a positive and significant relationship. This study, motivated by the widely used IPAT formulation (Impacts to the Environment = Population × Affluence × Technology) set the stage for adopting its more sophisticated descendent, STIRPAT, to be described below.

Rosnick and Weisbrot (2006) examined the relationship between work hours and energy consumption among 23–25 advanced societies. For various combinations of countries, they found elasticities (i.e., the percentage increase in energy consumption per 1% increase in working hours of 1.3%, 1.9% and 2.8%). Furthermore, they estimated that if constant energy per hour of work is assumed and if workers in the European Union worked the same number of hours as in the US, energy consumption would be 18% higher in the EU. In a multivariate regression analysis using data for 48 countries, they found that annual hours per worker has a positive significant effect on energy consumption per capita even when controlling for labor productivity, employment to population ratio, climate, and population. However, as noted above, the multiplicative product of work hours, the employment to population ratio, and labor productivity is equal to GDP per capita. Hence, this finding only documents the effect of hours on energy in terms of its contribution to GDP, not net of GDP. Thus, this analysis provides evidence that longer work hours contribute to greater total demands on the environment because of the associated increase in the scale of economic production and consumption. It does not assess the potential effect of work hours, net of GDP, on the environmental impact of patterns of consumption.

The most extensive analysis thus far examined the ecological footprint and hours of work in a cross-section of 45 countries (Hayden and Shandra, 2009). Their multivariate analysis revealed that annual hours per worker has a positive significant relationship with the ecological footprint, controlling for the employment to population ratio, labor productivity, and other relevant control variables as well as net of GDP per capita. In our terms, these findings provide evidence for both scale and compositional effects of work hours on the ecological footprint. Their analysis also indicates that the effect of work hours is larger than that of the employment to population ratio and labor productivity.

7. Hypotheses

Building on these studies, we test two main hypotheses (summarized below). The first hypothesis addresses scale effect of work hours, which we test by estimating the effect of work hours on three measures of environmental impact via its contribution to GDP. We do this by disaggregating GDP into three components: annual work hours, labor productivity, and employment to population ratio (Hayden and Shandra, 2009; Van Ark, 2002). We hypothesize that the contribution of work hours to GDP is positively related to three environmental impacts: total ecological footprint, total carbon footprint, and total carbon dioxide emissions. If the estimated effect of work hours is positive and significant in these models, then there is support for the hypothesis that environmental demands and impacts could be reduced by decreasing the scale of economic production and consumption through a reduction in work hours. Our second hypothesis addresses the compositional effect of work hours, which we test by estimating the effect of work hours, net of GDP, on the same three dependent variables. We hypothesize that work hours is positively related to all three measures. If the estimated effect of work hours net of GDP is positive and significant, it provides evidence that lower work hours might reduce environmental impacts and demands by reducing the resource intensity of consumption patterns, even when the scale of economic output remains constant.

Hypothesis 1. Work hours is positively associated with total ecological footprint, total carbon footprint, and total carbon dioxide emissions, net of labor productivity and employment to population ratio.

Hypothesis 2. Work hours is positively associated with total ecological footprint, total carbon footprint, and total carbon dioxide emissions, net of GDP.

8. Data and methods

We extend the incipient literature on the worktime-environment nexus by testing the above hypotheses with a cross-national panel analysis. In particular, we test the effects of work hours on the total ecological footprint, the total carbon footprint, and total carbon emissions with panel analyses of data on 29 OECD nations from 1970 to 2007; we limit our data to years after 1970 because of the paucity of data on important control variables prior to that year. We gathered data on OECD member nations classified as high-income by the World Bank in 2007 (World Bank, 2009). The complete list of countries included in our study is provided in Table A1 in the appendix. Our sample choice was based upon substantive and methodological considerations. The degrowth and worktime reduction propositions examined here are only considered for high-income countries which tend to disproportionately consume global resources and have the economic and social resources to undergo such changes. These are the only countries for whom degrowth is advocated; there is near-consensus that poor countries should grow. Furthermore, there is a considerable amount of missing data on work hours for the less developed countries and where available, its quality is suspect because it either covers a small number of workers, or is reported as benchmark numbers that do not change over time (e.g., 40 h). Despite its classification as high-income, Israel is not included in the analysis due to missing data on one or more variables. Our dataset has an unbalanced panel structure with country-years as the unit of analysis. To maximize the use of available data we allow the number of observations to vary across models with sample sizes ranging from 605 to 646. The first-difference transformation of the variables (described below) entails the loss of the first year of data for each country.

We utilize the STIRPAT model, developed by Dietz and Rosa (1994) and further elaborated by York et al. (2002, 2003a), by Rosa et al. (2004), and by Dietz et al. (2007) as our analytical framework. STIRPAT is a stochastic version of the well-known

IPAT mathematical identity developed by Ehrlich and Holdren (1971). Our use of STIRPAT, as noted above, builds on the connection of IPAT to worktime raised by Schor (2005). This model is used to test hypotheses regarding the effects of population (P), affluence (A), and technology (T) on environmental impacts (I). It takes the form of an elasticity model in which environmental impacts are conceptualized as a multiplicative function of population, affluence, and technology.

The specification of the basic STIRPAT model is:

$$I_i = aP_i^b A_i^c T_i^d e_i \quad (1)$$

The constant "a" scales the model, "b," "c," and "d" are the exponents of P, A, and T and "e" is the error term (the IPAT model assumes $a = b = c = d = e = 1$). The subscript "i" indicates that these quantities (I, P, A, and T) vary across observational units. To test this type of regression model requires all factors be converted to logarithms. "T" is typically included in the error term, rather than being estimated separately, since there is no clear consensus on valid technology indicators. Here, we disaggregate this term to include other relevant social structural factors not included in the original formulation, such as urbanization and the shares of the economy composed of manufacturing and services. These modifications yield the following log specification of the model:

$$Ln(I) = a + b\,Ln(P) + c\,Ln(A) + e \quad (2)$$

The coefficients produced are interpreted as elasticities that indicate the percentage change in the dependent variable associated with a one-percentage point increase in the independent variable, holding the effects of the other independent variables constant.

We adopted STIRPAT as our framework because it explicitly links socioeconomic variables with ecological ones, embeds an indirect effect of work hours on consumption, and is an operationalized procedure for analyzing empirical data. We modify previous STIRPAT research, where population and affluence were the key variables, by making working hours the primary driver of interest with population, affluence, and other factors serving as control variables. We estimate our STIRPAT models using first-difference panel regression.

With panel analysis it is possible to address heterogeneity bias arising from the effect of unmeasured time-invariant variables (i.e., unit effects) that can seriously affect OLS coefficient estimates, making OLS less than optimal (Alderson and Nielsen, 1999). Fixed effects regression calculates country-specific intercepts as a way to deal with heterogeneity bias, while random effects regression treats the country-specific intercepts as a random component of the error term. However, fixed effects regression does not adequately address the problem of non-stationarity (i.e., variables with non-constant means, variances, or covariances) that, if present, can produce spurious results (Wooldridge, 2005). An advantage of first difference estimation is that it differences away the time-invariant unit effects and can transform non-stationary data into stationary data while also mitigating cross-sectional dependence (Liddle, 2012). Many recent studies argue that the first difference estimation technique is preferred over fixed effects estimation since it addresses these statistical concerns (Liddle, 2012; Poumanyvong and Kaneko, 2010).

In analyses unreported here, we also estimated two-way fixed effects models with correction for first-order autocorrelation and found similar results to those reported below for the key variables. Importantly, however, the compositional effect of work hours on the carbon footprint was found to be significant and positive. The coefficient for manufacturing percent of GDP was also positive and significant in all models and the services percent of GDP was significant and positive in the carbon footprint models. When there are differences between fixed effects and first difference estimates, the latter are preferred as it indicates that the former are spurious (Jorgenson and Clark, 2012). Furthermore, the fixed effects estimates were found to be sensitive to sample composition, producing diverging results when, in our outlier analysis, certain countries were excluded from the sample. For these reasons, we have more confidence in and prefer the first-difference estimates reported here.

We estimate first-difference regression models with cluster-robust standard errors and include dummy variables for each year of data in all models to control for period-specific effects that potentially affect all countries within each year (e.g., Cole and Neumayer, 2004). Since the variables are logged before differencing the coefficient estimates can be interpreted as the percentage increase in the dependent variable for a 1% increase in the independent variable, all else constant. Based on the results of Wooldridge tests for autocorrelation in panel data for each model, we find that autocorrelation is not present in the first differenced data. In addition, all variance inflation factors (VIFs) are well below conventional thresholds (i.e., all are less than 5.0) suggesting that multicolinearity is not a serious problem in the reported models. As noted below, several overly influential cases (Estonia in 1989–1990 and 1991–1992 and Norway in 1990–1991 and 1992–1993) were identified and excluded from certain models.

Overall, this estimation approach is robust against omitted variables, heterogeneity bias, serial correlation, and non-stationarity, and is methodologically consistent with the cross-national social science literature on environmental impacts (e.g., Cole and Neumayer, 2004; Jorgenson et al., 2010b).

8.1. Dependent variables

Our first dependent variable is the total ecological footprint. It measures consumption-based pressure (in global hectares) on the environment by aggregating five basic forms of human consumption: food, housing, transportation, consumer goods, and services. The five types of consumption are converted into a common metric, the amount of productive land and water areas in hectares at average world productivity required to meet that consumption. These data are from the Global Footprint Network (2010). The footprint is defined by Rees as "the area of land and water ecosystems required on a continuous basis to produce the resources that the population consumes, and to assimilate (some of) the wastes that the population produces, wherever on Earth the relevant land/water may be located" (2006, p. 145). Since it is consumption-based, the ecological footprint attributes exports and imports to the importing nation by estimating the materials and energy embodied in the traded commodities, such that consumption is the sum of production and imports minus exports (i.e., it includes resources embodied in trade). A major advantage of the ecological footprint is that it is the most comprehensive indicator of resource demands available and it is a widely used indicator in the environmental social sciences (e.g., Hayden and Shandra, 2009; Jorgenson, 2003; Jorgenson and Burns, 2007; York et al., 2003a).

Our second dependent variable is a subcomponent of the ecological footprint: the carbon footprint. This indicator measures the area of biologically productive land required to sequester a country's carbon emissions resulting from consumption. A key difference between this indicator and measures of carbon emissions is that the carbon footprint is based on total consumption, excluding exports and including imports, while carbon emissions data are territorially based and therefore do not accurately reflect consumption because emissions from export production are included, but emissions from the production of imports are not. Hence, the carbon footprint takes into account the carbon embodied in imports and exports thereby more accurately reflecting the carbon emissions associated with a country's consumption. A substantial limitation of this indicator is that it includes nuclear energy by counting each unit of energy produced by nuclear power as requiring the same amount of land area to sequester CO_2 as a unit of fossil energy.

It is important to note that carbon emissions measured by the territorial versus the footprint method can lead to significantly different estimates. In particular, Witting and Vringer (2009) found that consumption-based greenhouse gas emissions were higher than territorial emissions in most developed countries. In detailed analyses of OECD countries as a whole, Ahmad and Wyckoff (2003) determined that carbon dioxide emissions from domestic consumption exceed that of domestic production. Emissions embodied in imports and exports are typically greater than 10% of emissions from domestic production and in some cases greater than 30%. Conservative estimates for 1995 indicate that among OECD nations consumption-based carbon emissions were 5% higher than territorial emissions in 1995 (Ahmad and Wyckoff, 2003). Peters and Hertwich (2008) showed that 21.5% of global CO_2 emissions in 2001 were embodied in international trade and that developed countries are typically net importers of emissions while developing countries are net exporters. Given the significance of embodied carbon emissions, analyses of the common territorial indicators of carbon emissions and alternative consumption-based indicators may produce divergent results.

Our third dependent variable is total carbon emissions measured in thousand metric tons of carbon dioxide (World Resources Institute, 2010). This is the standard territorial indicator of carbon dioxide emissions that accounts for the mass of carbon dioxide produced by the combustion of solid, liquid, and gaseous fuels, as well as from gas flaring and the manufacture of cement. These data do not include emissions from land use change or emissions from bunker fuels used in international transportation. Data for this variable are not available after 2005.

8.2. Independent variables

Following Hayden and Shandra (2009) we disaggregate GDP per capita into three components to test the effect of work hours on our dependent variables. First, our key independent variable is annual hours of work per employee. These data are intended to reflect the actual number of hours worked including overtime and excluding paid hours not worked such as holidays, vacations, and sick days. These data were compiled by The Conference Board (TCB, 2011) from numerous sources including national labor force surveys, the OECD Growth Project, and the OECD Employment Outlook. Second, labor productivity is measured as GDP per hour of work in 1990 US$ adjusted for purchasing power parity. Third, the employment to population ratio measured as the percentage of employed persons in the population. Data for these three variables are from The Conference Board. Further information on the sources and methodologies for these data are available from The Conference Board (TCB, 2011).

Table 1
Descriptive statistics.

Variable	*N*	Mean	Std. dev.
EF total	648	.009	.104
Carbon EF	648	.022	.169
CO_2 total	607	.011	.053
Population	648	.005	.006
GDP p.c. ($US)	648	.026	.024
Urbanization	648	.003	.006
Manuf. % GDP	648	−.011	.040
Service % GDP	648	.006	.018
Annual hours	648	−.004	.012
Emp. % pop	648	.005	.019
GDP per hour	648	.025	.023

Note: All variables are logged and first-differenced.

GDP per capita measured in 2000 US$ is included to control for the level of economic development (World Bank, 2010). We also control for total population size, the percentage of population living in urban areas, manufacturing as a percentage of GDP, and services as a percentage of GDP (World Bank, 2010).

Descriptive statistics and pairwise correlations for all dependent and independent variables are presented in Tables 1 and 2, respectively.

9. Results and discussion

Six regression models are presented in Table 3. For each of our three dependent variables we estimate two models each; Models 1, 3, 5 decompose GDP into three variables (work hours, labor productivity, and the employment to population ratio) in order to assess the scale effect on our dependent variables of work hours' contribution to GDP relative to that of labor productivity and the employment to population ratio. These models may also reflect the compositional effect, if it exists, and thus provide estimates of the "total effect" of work hours. However, the existence of the compositional effect cannot be assessed without controlling for GDP in separate models. Models 2, 4, and 6 assess the compositional effect by estimating the effect of work hours net of GDP.

Models 1, 3, and 5 test our first hypothesis, which is supported in all three cases: work hours are significant and positive, as are the other two components of GDP (GDP per hour and Employees % of population), for all three dependent variables. In Models 2, 4, and 6 we test for the existence of a compositional effect: does work hours have a significant effect on our environmental indicators net of GDP per capita and other control variables? In one of these three models we find support for the compositional effect hypothesis.

Table 2
Correlation matrix.

		1	2	3	4	5	6	7	8	9	10
EF total	1										
Carbon EF	2	.735									
CO_2 total	3	.163	.242								
Population	4	.058	.068	.284							
GDP p.c.	5	.245	.185	.323	−.017						
Urbanization	6	.074	.079	.283	.360	.245					
Manuf. % GDP	7	.080	.094	.115	−.003	.286	.110				
Service % GDP	8	−.139	−.046	−.057	−.090	−.269	−.042	−.428			
Work hours	9	.099	.079	.043	.036	.146	.075	.119	−.044		
Emp. % pop	10	.168	.106	.230	.134	.524	.159	.097	−.151	−.050	
GDP per hour	11	.082	.072	.150	−.112	.545	.139	.179	−.163	−.335	−.244

Note: All variables are logged and first-differenced.

Table 3
First-difference panel regression results for high-income OECD countries.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
DV:	EF total	EF total	Carbon EF	Carbon EF	CO_2 total	CO_2 total
GDP p.c.		0.90 (.198)***		0.96 (.264)***		0.59 (.136)***
Population	0.89 (.407)**	1.19 (.480)**	1.73 (.742)**	2.12 (.839)**	2.15 (.598)***	2.25 (.592)***
Urbanization	−0.47 (.299)	−0.32 (.286)	0.26 (.563)	0.34 (.597)	1.00 (.394)**	1.09 (.372)***
Manuf. %GDP	−0.02 (.098)	−0.02 (.097)	0.31 (.197)	0.30 (.200)	0.06 (.054)	0.06 (.056)
Service %GDP	−0.29 (.194)	−0.33 (.200)	0.44 (.318)	0.41 (.347)	0.14 (.174)	0.12 (.187)
Work hours	1.37 (.243)***	0.55 (.181)***	1.30 (.392)***	0.50 (.358)	0.50 (.135)***	−0.05 (.127)
Emp.% pop	1.18 (.218)***		1.26 (.356)***		0.63 (.190)***	
GDP per hour	0.77 (.182)***		0.73 (.279)**		0.55 (.136)***	
Intercept	−0.01 (.018)	−0.01 (.019)	−0.03 (.013)*	−0.03 (.013)**	−0.04 (.011)***	−0.04 (.011)***
N	646	646	646	646	605	605
Countries	28	28	28	28	29	29
Years	1970–2007	1970–2007	1970–2007	1970–2007	1970–2005	1970–2005
R^2	.1812	.1725	.1926	.1891	.3393	.3388

Notes: Cluster-robust standard errors are reported in parentheses. All models include period dummy variables. Iceland is not included in Models 1–4 due to unavailable data.
* $p \leq .10$.
** $p \leq .05$.
*** $p \leq .01$.

The coefficient for work hours is significant and positive for ecological footprint per capita but not for the carbon footprint and total carbon dioxide emissions.

Turning to the control variables, we find that GDP per capita has a significant positive effect on total ecological footprint, total carbon footprint, and total carbon emissions. This reaffirms previous research that suggests that affluence or economic development is a key driver of environmental impacts (see York et al., 2003a,b). The coefficient for total population is positive and significant in all estimated models, a finding consistent with structural human ecology theory. Interestingly, the coefficient estimate for population (indicating the associated percentage increase in the dependent variable for each 1% increase in population) differed substantially among our three different outcomes, ranging from 0.89 for total ecological footprint to 2.25 for total carbon emissions. Urbanization is significant only in the models predicting total carbon emissions (for which it is positive). The relationship between urbanization and resource consumption is not very well established in the cross-national literature due to numerous inconsistent findings that vary across samples and environmental indicators (Jorgenson and Burns, 2007; Liddle and Lung, 2010; York et al., 2003a,b). Manufacturing and services as percentages of GDP were found to be non-significant in all of the estimated models. In Models 1, 2, 3, and 4 two overly influential cases were identified with Cook's *D* statistics (Norway 1990–1991 and 1992–1993 and excluded from the reported models). When included, these cases reduced the significance of the population coefficients and had a minor influence on the coefficient estimates for other variables. In Models 5 and 6 predicting carbon emissions, two overly influential cases (Estonia 1989–1990 and 1991–1992) were identified and excluded. When included, the coefficient for manufacturing was positive and significant. We also estimated models (not reported here) excluding manufacturing, services, and urbanization and found the estimates for all other variables to be substantively similar to those presented here. Consistent with Hayden and Shandra (2009) and Rosnick and Weisbrot (2006), labor productivity (GDP per hour per worker) and the employment to population ratio (employed as a percentage of population) both had positive and significant effects on the outcome variables in all models in which they were included.

The major discrepancy among our models is the fact that for carbon dioxide emissions and carbon footprint we find evidence of a scale effect of work hours but not a compositional effect. However, we find evidence of both effects for total ecological footprint. The ecological footprint is a more comprehensive measure of environmental demands and impact in that it includes material resources in addition to energy consumption and associated carbon emissions. This suggests that the compositional effect of work hours on consumption patterns may be more consequential for non-energy resources. As noted previously, Rosnick and Weisbrot (2006) assessed the scale effect of work hours on energy consumption, but not the compositional effect. Therefore, this is an issue that could benefit from further study.

As is true of all non-experimental research methods, our analysis does not provide definitive evidence of causality. Future research using more sophisticated techniques such as instrumental variables may be able to provide a better assessment of the causal nature of the relationships we observe in the present study. Furthermore, as Liddle (2012) notes, first-differencing of annual data produces short-run models; future research may benefit from employing advanced techniques such as panel Fully-Modified OLS (FMOLS) to estimate long-run elasticities (e.g., Liddle, 2012). Further research on the relationship between work hours and environmental impacts and demands may also be enriched by examining additional environmental indicators beyond those assessed here. In addition, comparative analyses of the environmental consequences of specific worktime reduction policies enacted in different countries, such as France and Denmark, could be especially helpful in gaining a deeper understanding of this relationship by identifying the types of labor-market interventions that are more effective in reducing environmental impacts and their associated causal pathways.

10. Conclusion

In this article we have investigated the effect of work hours on environmental pressures, including the ecological footprint, the carbon footprint, and carbon dioxide emissions. Consistent with previous research, our panel analysis of high-income OECD countries demonstrates that working time is significantly associated with environmental pressures and thus may be an attractive target for policies promoting environmental sustainability. At a time when further economic growth and higher incomes in developed countries appear to have a diminishing contribution to greater well-being, increased free time could be a socially and environmentally beneficial goal (Layard, 2005). However, there are considerable obstacles to such a path. Businesses have long resisted reductions in hours of work (Schor, 1992). Furthermore, since the financial crisis of 2008, austerity economics, which calls for more, not less work, has dominated the conversation. If the shorter worktime agenda is to advance, it will require a new economic and social conversation.

Appendix A. [{(Appendix)}]

Table A1
List of countries.

Australia
Austria
Belgium
Canada
Czech
Republic
Denmark
Estonia
Finland
France
Germany
Greece
Hungary
Iceland
Ireland
Italy
Japan
Luxembourg
Netherlands
New Zealand
Norway
Portugal
Slovak Republic
Slovenia
South Korea
Spain
Sweden
Switzerland
United Kingdom
United States

Note: OECD countries excluded include Israel due to missing data on one or more of the variables and Turkey, Poland, Chile, and Mexico due to not being classified as high-income countries.

References

Ahmad, N., Wyckoff, A., 2003. Carbon dioxide emissions embodied in international trade of goods. OECD Science, Technology and Industry Working Papers, 2003/15, OECD Publishing.

Alcott, B., 2008. The sufficiency strategy: Would rich-world frugality lower environmental impact? Ecological Economics 64, 770–786.

Alderson, A., Nielsen, F., 1999. Income inequality, development, and dependence: a reconsideration. American Sociological Review 64 (4), 606–631.

Alesina, A., Glaeser, E., Sacerdote, B., 2005. Work and Leisure in the US and Europe: Why so Different? NBER Macroeconomic Annual, .

Baykan, B.G., 2007. From limits to growth to degrowth within French green politics. Environmental Politics 16 (3), 513–517.

Becker, G., 1965. A theory of the allocation of time. Economic Journal 75, 493–517.

Bell, L., Freeman, R.B., 2001. Working hard. In: Wong, G., Picot, G. (Eds.), Working Time in Comparative Perspective. W.E. Upjohn Institute for Employment Research, Kalamazoo, MI, pp. 71–105.

Boeri, T., Burda, M.C., Kramarz, F. (Eds.), 2008. Working Hours and Job Sharing in the EU and USA: Are Europeans Lazy? Or Americans Crazy?. Oxford University Press, New York.

Booth, A., Sciantarelli, F., 1987. The employment effects of a shorter working week. Economica 54, 237–248.

Boeri, T., Bruecker, H., 2011. Short-time work benefits revisited: some lessons from the Great Recession. Economic Policy 26 (68), 697–765.

Bowles, S., Park, Y., 2005. Emulation, inequality, and work hours: was Thorsten Veblen right? The Economic Journal 115, 397–412.

Brookes, L.G., 1978. Energy policy, the energy price fallacy and the role of nuclear energy in the UK. Energy Policy 6 (2), 94–106.

Burgoon, B., Baxandall, P., 2004. Three worlds of working time: the partisan and welfare politics of work hours in industrialized countries. Politics and Society 32 (4), 439–473.

Calwell, C., 2010. Is Efficient Sufficient? The Case for Shifting our Emphasis in Energy Specifications to Progressive Efficiency and Sufficiency. European Council for and Energy Efficient Economy, Stockholm.

Cavanagh, J., Mander, J., 2004. Alternatives to Economic Globalization: A Better World is Possible. Berrett-Koehler, San Francisco, CA.

Cole, M., Neumayer, E., 2004. Examining the impact of demographic factors on air pollution. Population and Environment 26 (1), 5–21.

Connolly, J., Prothero, A., 2008. Green consumption: life-politics, risk and contradictions. Journal of Consumer Culture 8 (1), 117–145.

Coote, A., Simms, A., Franklin, J., 2010. 21 h: Why a Shorter Working Week Can Help Us All to Flourish in the 21st Century. New Economics Foundation, London.

Daly, H.E., 1996. Beyond Growth: The Economics of Sustainable Development. Beacon Press, Boston.

Devetter, F., Rousseau, S., 2011. Working hours and sustainable development. Review of Social Economy 69 (3), 333–355.

Dietz, T., Rosa, E.A., 1994. Rethinking the environmental impacts of population, affluence, and technology. Human Ecology Review 1, 277–300.

Dietz, T., Rosa, E.A., York, R., 2007. Driving the human ecological footprint. Frontiers in Ecology and the Environment 5 (1), 13–18.

Douthwaite, R., 1999. The Growth Illusion. Green Books, Devon, UK.

Evans, D., Abrahamse, W., 2009. Beyond rhetoric: the possibilities of and for 'sustainable lifestyles'. Environmental Politics 18 (4), 486–502.

Ehrlich, P., Holdren, J., 1971. The impact of population growth. Science 171, 1212–1217.

Frank, R., 1985. Choosing the Right Pond. Oxford University Press, New York.

Galinsky, E., Bond, J.T., Kim, S.S., Backon, L., Brownfield, E., Sakai, K., 2005. Overwork in America: When the way we work Becomes too much. Families and Work Institute, New York.

Giddens, A., 2009. The Politics of Climate Change. Polity Press, London.

Global Footprint Network (GFN), 2010. Ecological Footprint Atlas 2010. Global Footprint Network, Oakland, CA.

Golden, L., 2009. A brief history of long work time and the contemporary sources of overwork. Journal of Business Ethics 84, 217–227.

Gorgescu-Roegen, N., 1971. The Entropy Law and the Economic Process. Harvard University Press, Cambridge, MA.

Gorz, A., 1994. Capitalism, Socialism, Ecology. Verso, London.

Grossman, G.M., Krueger, A.B., 1995. Economic growth and the environment. Quarterly Journal of Economics 112, 353–378.

Hamilton, C., 2010. Consumerism, self-creation and prospects for a new ecological consciousness. Journal of Clean Production 18 (6), 571–575.

Hawken, P., Lovins, A.B., Lovins, L.H., 1999. Natural Capitalism: The Next Industrial Revolution. London, Earthscan.

Hayden, A., 1999. Sharing the Work, Sparing the Planet: Work Time, Consumption and Ecology. Zed Books Ltd., New York.

Hayden, A., Shandra, J.M., 2009. Hours of work and the ecological footprint: an exploratory analysis. Local Environment 14 (6), 574–600.

Hertwich, E.G., 2005. Consumption and the rebound effect. Journal of Industrial Ecology 9 (1–2), 85–98.

Holm, S., Englund, G., 2009. Increased ecoefficiency and gross rebound effect: evidence from USA and six European countries 1960–2002. Ecological Economics 68, 879–887.

Inglehart, R., 1989. Culture Shift in Advanced Industrial Society. Princeton University Press, Princeton, NJ.

IPCC, 2007. Climate change 2007: synthesis report. In: Core Writing Team,Pachauri, R.K., Reisinger, A. (Eds.), Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. IPCC, Geneva, Switzerland.

Jackson, T., 2009. Prosperity Without Growth: Economics for a Finite Planet. Earthscan, London.

Jacobs, J.A., Gerson, K., 2004. The Time Divide: Work, Family, and Gender Inequality. Harvard University Press, Cambridge, MA.

Jalas, M., 2002. A time use perspective on the materials intensity of consumption. Ecological Economics 41, 109–123.

Jalas, M., 2005. The everyday life context of increasing energy demands: Time use survey data in a decomposition analysis. Journal of Industrial Ecology 9 (1–2), 129–145.

Jorgenson, A.K., 2003. Consumption and environmental degradation: a cross-national analysis of the ecological footprint. Social Problems 50, 374–394.

Jorgenson, A.K., Burns, T.J., 2007. The political-economic causes of change in the ecological footprints of nations, 1991–2001: a quantitative investigation. Social Science Research 36, 834–853.

Jorgenson, A.K., Clark, B., 2009. The Economy, military, and ecologically unequal relationships in comparative perspective: a panel study of the ecological footprints of nations, 1975–2000. Social Problems 56, 621–646.

Jorgenson, A., Clark, B., 2012. Are the economy and the environment decoupling?. A comparative international study, 1960-2005. American Journal of Sociology 118 (1), 1–44.

Jorgenson, A.K., Clark, B., 2011. Societies consuming nature: a panel study of the ecological footprints of nations, 1960–2003. Social Science Research 40 (1), 226–244.

Jorgenson, A.K., Clark, B., Kentor, J., 2010a. Militarization and the environment: a panel study of carbon dioxide emissions and the ecological footprints of nations, 1970–2000. Global Environmental Politics 10, 7–29.

Jorgenson, A., Rice, J., Clark, B., 2010b. Cities, slums, and energy consumption in less developed countries, 1990 to 2005. Organization and Environment 23 (2), 189–204.

Kallis, G., 2011. In defence of degrowth. Ecological Economics 70, 873–880.

Kasser, T., Brown, K.W., 2003. On time, happiness, and ecological footprints. In: De Graff, J. (Ed.), Take Back Your Time. Berrett-Koehler Publishers, San Francisco, CA, pp. 107–112.

Kasser, T., Sheldon, K.M., 2009. Time affluence as a path toward personal happiness and ethical business practice: empirical evidence from four studies. Journal of Business Ethics 84, 243–255.
Kapteyn, A., Kalwij, A., Zaidi, A., 2004. The myth of worksharing. Labour Economics 11 (3), 293–313.
Khazzoom, J.D., 1980. Economic implications of mandated efficiency in standards for household appliances. Energy Journal 1 (4), 21–40.
Latouche, S., 2009. Farewell to Growth. Polity, Cambridge, UK.
Layard, R., 2005. Happiness: Lessons from a New Science. Penguin Press, New York.
Lee, S., McCann, D., Messenger, J.C., 2007. Working Time Around the World: Trends in Working Hours, Laws, and Policies in a Global Comparative Perspective. Routledge, London.
Liddle, B., 2012. What are the carbon emissions elasticities for income and population? A robustness exercise employing the STIRPAT framework. USAEE Working Paper No. 12-135. Available at SSRN: http://ssrn.com/abstract=2162222.
Liddle, B., Lung, S., 2010. Age-structure, urbanization, and climate change in developed countries: revisiting STIRPAT for disaggregated population and consumption-related environmental impacts. Population and Environment 31, 317–343.
Martinez-Alier, J., 2009. Socially sustainable economic de-growth. Development and Change 40 (6), 1099–1119.
Meadows, D.H., Meadows, D.L., Randers, J., Behrens III, W.W., 1974. The Limits to Growth. New American Library, New York.
MEA (Millennium Ecosystem Assessment), 2005. Ecosystems and Human Well-Being: General Synthesis. Island Press, Washington, DC.
Nassen, J., Larsson, J., Holmberg, J., 2009. The effect of working hours on energy use: a micro analysis of time and income effects. In: ECEEE Summer Study.
OECD, 2010. Moving Beyond the Jobs Crisis, OECD Employment Outlook. OECD, Paris.
Oh, S.Y., Park, Y., Bowles, S., 2012. Veblen effects, political representation, and the reduction in working time over the 20th century. Journal of Economic Behavior & Organization 83 (2), 218–242.
Otterbach, S., 2010. Mismatches between actual and preferred work time: empirical evidence of hours constraints in 21 countries. Journal of Consumer Policy 33, 143–161.
Peters, G.P., Hertwich, E.G., 2008. CO_2 embodied in international trade with implications for global climate change. Environmental Science and Technology 42 (5), 1401–1407.
Poumanyvong, P., Kaneko, S., 2010. Does urbanization lead to less energy use and lower CO_2 emissions? A cross-country analysis. Ecological Economics 70, 434–444.
Pouwels, B., Siegers, J., Vlasblom, J.D., 2008. Income, working hours, and happiness. Economics Letters 99 (1), 72–74.
Princen, T., 2005. The Logic of Sufficiency. MIT Press, Cambridge, MA.
Rees, W.E., 2006. Ecological footprints and bio-capacity: essential elements in sustainability assessment. In: Dewulf, J., Van Langenhove, H. (Eds.), Renewables-Based Technology: Sustainability Assessment. John Wiley and Sons, Chichester, UK, pp. 143–158.
Reisch, L.A., Røpke, I., 2004. The Ecological Economics of Consumption. Cheltenham, UK, Edward Elgar.
Reynolds, J., 2003. You can't always get the hours you want: mismatches between actual and preferred work hours in the U.S. Social Forces 81 (4), 1171–1199.
Reynolds, J., 2004. When too much is not enough: actual and preferred work hours in the United States and abroad. Sociological Forum 19 (1), 89–120.
Rockström, J., Steffen, W., Noone, K., Persson, A., Chapin, F.S., Lambin, E.F., Lenton, T.M., Scheffer, M., Folke, C., Schellnhuber, H.J., Nykvist, B., de Wit, C.A., Hughes, T., van der Leeuw, S., Rodhe, H., Sörlin, S., Snyder, P.K., Costanza, R., Svedin, U., Falkenmark, M., Karlberg, L., Corell, R.W., Fabry, V.J., Hansen, J., Walker, B., Liverman, D., Richardson, K., Crutzen, P., Foley, J.A., 2009. A safe operation space for humanity. Nature 461, 472–475.
Rosa, E.A., York, R., Dietz, T., 2004. Tracking the anthropogenic drivers of ecological impacts. Ambio 33 (8), 509–512.
Rosa, E.A., Diekmann, A., Dietz, T., Jaeger, C.C., 2010. Human Footprints on the Global Environment: Threats to Sustainability. MIT Press, Cambridge, MA.
Rosnick, D., Weisbrot, M., 2006. Are Shorter Hours Good for the Environment? A Comparison of US and European Energy Consumption. Center for Economic and Policy Research, Cambridge, MA.
Sachs, W., Loske, R., Linz, M., 1998. Greening the North: A Post-Industrial Blueprint for Ecology and Equity. Zed Books, London.
Sachs, W., Santarius, T., 2007. Fair Future: Resource Conflicts, Security and Global Justice. Zed Books, London.
Sanne, C., 2005. The consumption of our discontent. Business Strategy and the Environment 14, 315–323.
Schor, J.B., 1991. Global inequality and environmental crisis: an argument for reducing working hours in the north. World Development 19 (1), 73–84.
Schor, J.B., 1992. The Overworked American: The Unexpected Decline of Leisure. Basic Books, New York.
Schor, J.B., 1998. The Overspent American: Why We Want What We Don't Need. Basic Books, New York.
Schor, J.B., 2005. Sustainable consumption and worktime reduction. Journal of Industrial Ecology 9 (1–2), 37–50.
Schor, J.B., 2010. Plenitude: The New Economics of True Wealth. The Penguin Press, New York.
Schumacher, E.F., 1973. Small is Beautiful: Economics as if People Mattered. Harper and Row, London.
Seyfang, G., 2009. The New Economics of Sustainable Consumption: Seeds of Change. Palgrave Macmillan, New York.
Skuterud, M., 2007. Identifying the potential of work-sharing as a job-creation strategy. Journal of Labor Economics 25 (2), 265–287.
Solnick, S.J., Hemenway, D., 1998. Is more always better? A survey on positional concerns. Journal of Economic Behavior and Organization 37, 373–383.
Sorrell, S., 2007. The Rebound Effect: An Assessment of the Evidence for Economy-wide Energy Savings from Improved Energy Efficiency. UK Energy Research Centre, London.
Speth, J.G., 2008. The Bridge at the Edge of the World: Capitalism, the Environment, and Crossing from Crisis to Sustainability. Yale University Press, New Haven, CT.
The Conference Board (TCB), 2011. The Conference Board Total Economy Database., In: http://www.conference-board.org/data/economydatabase/.
The Conference Board (TCB), 2013. The Conference Board Total Economy Database., In: http://www.conference-board.org/data/economydatabase/.
UNEP, 2011. Decoupling natural resource use and environmental impacts from economic growth. In: Fischer-Kowalski, M., Swilling, M., van Weizäcker, E.U., Ren, Y., Moriguchi, Y., Crane, W., Krausman, F., Eisenmenger, N., Giljum, S., Hennicke, P., Romero-Lankao, P., Siriban Manalang, A. (Eds.), A Report of the Working Group on Decoupling to the International Resource Panel. United Nations Environment Programme, Nairobi, Kenya.
Van Ark, B., 2002. Understanding productivity and income differentials among OECD countries: a survey. In: Banting, K., Sharpe, A., St-Hilaire, F. (Eds.), The Review of Economic Performance and Social Progress: Towards a Social Understanding of Productivity. Institute for Research and Public Policy, Montreal, Canada.
Victor, P.A., 2008. Managing Without Growth: Slower by Design, Not Disaster. Edward Elgar, Cheltenham, UK.
Vitousek, P.M., Mooney, H.A., Lubchenco, J., Melillo, J.M., 1997. Human domination of earth's ecosystems. Science 277, 494–499.
Wagner, M., 2008. The carbon Kuznets curve: a cloudy picture emitted by bad econometrics? Resource and Energy Economics 30, 388–408.
Watts, J., 2009. Stern: Rich nations will have to forget about growth to stop climate change. The Guardian p. 35.
Witting, H.C., Vringer, K., 2009. Carbon and land use accounting from a producer's and consumer's perspective – an empirical examination covering the world. Economic Systems Research 21 (3), 291–310.
Wooldridge, J., 2005. Introductory Econometrics: A Modern Approach, 3rd ed. Thomson, Mason, OH.
World Bank, 2009. Historical Income Classifications. World Bank, Washington, DC. Available at: In: www.worldbank.org (retrieved August).
World Bank, 2010. World Data Bank. http://databank.worldbank.org/ddp/home.do?Step=12&id=4&CNO=2 (retrieved March 2010).
World Resources Institute, 2010. Earth Trends Environmental Information., In: http://earthtrends.wri.org (retrieved March 2010).
York, R., 2006. Ecological paradoxes: William Stanley Jevons and the paperless office. Human Ecology Review 13 (2), 143–147.
York, R., Rosa, E.A., Dietz, T., 2002. Bridging environmental science with environmental policy: Plasticity of population, affluence, and technology. Social Science Quarterly 83 (1), 18–34.
York, R., Rosa, E.A., Dietz, T., 2003a. Footprints on the Earth: the environmental consequences of modernity. American Sociological Review 68, 279–300.
York, R., Rosa, E.A., Dietz, T., 2003b. A rift in modernity? Assessing the anthropogenic sources of global climate change. The International Journal of Sociology and Social Policy 23 (10), 31–51.
York, R., Rosa, E.A., Dietz, T., 2005. The ecological footprint intensity of national economies. Journal of Industrial Ecology 8, 139–154.
York, R., 2008. De-carbonization in former Soviet republics, 1992-2000: The ecological consequences of de-modernization. Social Problems 55 (3), 370–390.
York, R., Rosa, E.A., Dietz, T., 2009. A tale of contrasting trends: three measures of the ecological footprint in China, India, Japan, and the United States, 1961–2003. Journal of World-Systems Research 15 (2), 134–146.