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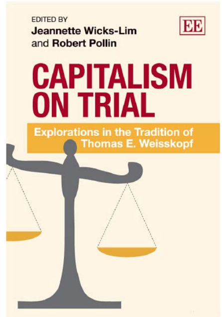

Reducing growth to achieve environmental sustainability: the role of work hours

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12.1 INTRODUCTION: RADICAL ECONOMICS AND THE QUESTION OF GROWTH

In the 1960s and early 1970s, radical economists were thorough-going critics of capitalism, not only because it was failing on its own terms, but also on the grounds that its objectives were flawed. They were part of a larger counter-cultural movement that stressed non-material values, such as the importance of work satisfaction and economic democracy. They deprecated consumer culture and were generally sympathetic to environmentalists who argued that the basic dynamics of capitalism were incompatible with ecological sustainability. However, by the mid 1970s, capitalism was in economic crisis. The downturns in productivity, profitability, and growth, as well as rising unemployment in OECD countries, led many radical economists, including Thomas Weisskopf, to shift their attention to a different set of questions. They used the analytic tools of Marxism and heterodox economics to analyse what was causing the crisis, how previous crises had been resolved, and what the possibilities for more humane and egalitarian alternatives might be. The turn that Weisskopf, his co-authors, and many of his contemporaries took at that point led to a long and productive research trajectory, the fruits of which are explored in other chapters in this volume. But in the process, the more fundamental critiques of capitalism were left behind.

Economic growth, in particular, became a relatively unquestioned *desideratum*. Radical economists moved closer to social democrats and liberals, for whom growth was rarely a problem, but usually a solution—the means for redistribution, rising standards of living, and in some accounts, more democratic and peaceful societies. As mainstream economists took pleasure in "disproving" the supporters of the *Limits to Growth* school during the falling oil prices of the 1980s, radicals mainly failed to engage on the question of bio-physical limits to growth. However, through the 1980s and 1990s, Herman Daly and his school of ecological economics argued that ecological limits were being exceeded, and that the central problem of economics should be to manage the economy within them. This view has steadily gained adherents, and in the last 5 years the conversation about growth has re-emerged as a topic of scholarly and political interest.

In this chapter, we attempt to bring the de-growth conversation back into radical economics. We do so by focusing on working hours and, to a lesser extent, productivity, which have been central concerns of Weisskopf and his co-authors. Working hours are a key variable of interest for reducing environmental impact, as we show below. They are also central to managed trajectories of de-growth or the steady-state because with growth in productivity (or the labor force), falling average hours of work are necessary to avoid increases in unemployment. Our research, using a cross-national panel of OECD countries over the years 1970–2007, shows that declines in hours of work reduce ecological footprints and carbon emissions. In the sections that follow we discuss the extent of the ecological challenge and previous research on the drivers of ecological impact, the emergence of the growth critique, the role of working hours in eco-impact, and our results.

12.2 ECOLOGICAL DEGRADATION AND THE CRITIQUE OF GROWTH

The global ecological footprint[1] (EF) of humanity now stands at 18 billion hectares of bio-productive land and water area, double what it was in 1966. Current consumption exceeds the sustainable capacity of the Earth by at least 50 percent and is resulting in unprecedented environmental degradation, including climate destabilization and rapid loss of biodiversity and ecosystem functioning (Global Footprint Network, 2010a). York et al. (2003a) found that approximately 95 percent of the cross-national variation in total ecological footprint can be explained by population size and level of economic development (or affluence), variables which have been identified in many other studies of ecological impact (Shi, 2003; York et al., 2003b).

In what is now a considerable literature on the anthropogenic drivers of environmental impacts, much of the focus has been on the promise of economic growth and technological efficiency. Early research indicated the existence of an Environmental Kuznets Curve (EKC) whereby environmental degradation increases with economic development up to a point and then declines with further economic growth (Grossman and Krueger, 1995). This gave some researchers hope that achieving sustainability would be a painless process involving the encouragement of further growth in both developed and developing countries. However, recent studies of carbon dioxide and the EF find no evidence of an EKC relationship (for example, York et al., 2003a; 2003b; Jorgenson and Burns, 2007; Jorgenson and Clark, 2010). Instead, these studies find that environmental impacts increase with economic growth. Furthermore, Stern (2004) argues that the original EKC studies on local air and water pollutants were statistically flawed and concludes that there is no EKC.

Technological innovation has also been viewed as the key to achieving sustainability, but this approach also has problems. One is that efficiency-oriented technological change often backfires, or leads to what are called "rebound effects." One such rebound effect is known as the Jevons Paradox. First identified by William Stanley Jevons in the mid nineteenth century, this paradox is based on his finding that increased efficiency in the use of coal led to increased demand and greater overall consumption of coal (Clark and Foster, 2001). This idea has been expanded to argue more generally against the "technological fix" approach to solving environmental problems (Hertwich, 2005; Sorrell, 2007). There is now a considerable literature showing that some portion of the gains in energy efficiency is canceled out by increases in demand on account of the lower effective price. There is still debate about the size of rebound effects, which depend on the type of energy use and whether the analysis is done at the micro or the macro level. However, at the high end of the estimates, macro-level arguments suggest that technological improvements can actually result in increased levels of energy and materials use in production and consumption. For example, York et al. (2009) have documented the Jevons paradox by illustrating that in four major economies increasing ecological efficiency (reduced EF/GDP) led not to reduced total levels of consumption over 4 decades, but rather to increased levels.

The failures of market and technological approaches to stem ecological degradation have led researchers back to a conversation that began in the 1970s with the claim that there are "limits to growth" (Meadows et al., 1974), a perspective which is echoed in an influential 2009 *Nature* paper identifying "safe planetary boundaries." This perspective 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 planetary footprint through lower levels of materials consumption and perhaps even zero growth in aggregate GDP (Daly, 1977; 1996; Gorz, 1994; Princen, 2005; Jackson, 2009). The conversation has focused on the global North because income, wealth, and ecological impact are so unequally distributed across the globe (Schor, 1991; 2005; Jorgenson and Burns, 2007; Sachs and Santarius, 2007).

In recent years, this work 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 (for example, Manno, 1999; Speth, 2008; Victor, 2008; Jackson, 2009; Latouche, 2009; Martinez-Alier, 2009; Seyfang, 2009; Schor, 2010; Kallis, 2011). These approaches go by a number of names, such as sufficiency, new economics, *decroissance*, or de-growth. In line with traditional Marxian analyses, this approach argues that the logic of growth is at the core of unsustainability and climate change, and rejects the view that technological change will be sufficient to solve those problems within a feasible time frame. At the same time, it tends to reject the pessimism of some versions of Marxism, and offers a set of economic and political pathways that have the potential to reduce ecological impact in advance of a system breakdown. In addition, the new economics/de-growth position is both a scholarly literature and a political program.

The literature on de-growth and new economics has emerged more or less simultaneously in a number of countries. In France, where it is strongest, the most influential proponent has been Serge Latouche (2009), who has drawn from ecological economists such as Georgescu-Roegen (1971) and Andre Gorz (1994) and the 1960s/1970s political economy critique of productivism. Décroissance (de-growth) advocates argue that growth is failing on multiple fronts: the ecological (overshoot), the social (excessive inequality), the political (disaffection), and the human (loss of direction) (Baykan, 2007). De-growth involves a socially sustainable (Martinez-Alier, 2009) process of downshifting 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. In both its versions—radical (advocating a new sector of cooperatives, green enterprises, and localization) and reformist (relying mainly on policy transformation), reduced working hours is at the core of the de-growth agenda.

In the Anglophone world, a similar literature has developed, although with less terminological coherence. *New economics* includes a variety of researchers, think tanks, and advocacy groups that are working for a shift away from the growth-centric society, such as Britain's New Economics Foundation (www.neweconomics.org and Sims et al., 2010) and the Commission for Sustainable Development (Jackson, 2009), as well as efforts aimed at the creation of an alternative, local, small-scale economy (Seyfang, 2009). In the US, the work of Herman Daly (1996), who has advocated a "steady state economics," has been most influential, resulting in contributions such as Peter Victor's macro-model of the Canadian economy with zero growth (Victor, 2008), and the Center for the Advancement of the Steady State Economy (www.steadystate.org). A second strand of work, inspired by E.F. Schumacher's (1973) *Small is Beautiful* and the re-localization movement, includes Thomas Princen's "sufficiency" (2005) 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 (Schor, 1998; Kasser and Sheldon, 2009). While not directed explicitly at the macro questions of growth, this literature is highly relevant to it, because macro trends are ultimately the aggregate of micro level changes.

The critique of growth has been spurred on by another burgeoning literature, which is focused on the relation between economic growth and human wellbeing that has been scrutinized by social scientists. This issue was famously raised by Richard Easterlin in the 1970s (Easterlin, 1974; 1995; Diener et al., 2010; Layard, 2005). Research has found that economic growth in industrialized countries since World War II has not resulted in substantial increases in subjective wellbeing (Diener and Oishi, 2000). Furthermore, Helliwell (2003) finds that social factors other than affluence such as low corruption, high levels of mutual trust, and effective social and political institutions are more predictive of national-level life satisfaction. Additionally, Inglehart (2009) finds that as national per capita income increases it contributes less to subjective wellbeing. The new "science of happiness" provides an additional argument against growth-centric economic systems.

We take a critical view of economic growth and technological fixes while focusing our attention on a social structural change that has been identified as a key potential policy for achieving sustainability: worktime reduction in high-income countries. We test the effect of work hours on total EF, total carbon footprint, and total carbon dioxide (CO_2) emissions with panel data on 29 high-income OECD countries.

12.3 WORKING HOURS REDUCTIONS

Much of the literature, and particularly empirical research, has largely ignored reduced working hours. In Marxist theory, the imperative to grow results in increases in labor productivity and stable or increasing working hours rather than an increase in leisure (for a discussion of the relationship between work hours and productivity, see Schor, 1992). Technologically-based approaches focus on the eco-efficiency of production (for example, de-materialization or de-carbonization), with little thought about hours of work. Even in the sociological literature that has begun to take household behavior change and sustainable consumption seriously, work hours are not considered (Spaargaren and van Vliet, 2000). By contrast, in the de-growth paradigm, time use, and specifically hours of work, is a key variable (Gorz, 1994; Schor, 2005; 2010; Hayden, 1999; Sanne, 2005; Victor, 2008; Jackson, 2009; Coote et al., 2010). There are a number of reasons for the centrality of working hours, including the factors having to do with the basic operation of market economies, compositional effects at the household level, the relation between time use and happiness, and the social impacts of time affluent societies.

At the macro-structural level, progressive reductions in hours are necessary in a slow or zero growth economy in order to avoid unemployment. This is because productivity growth is generally occurring in a market economy. When it does, fewer workers are needed at any level of GDP. Ordinarily, GDP growth absorbs some fraction of that displaced labor. Unless population is shrinking, hours of work will need to fall to avoid a mounting problem of unemployment. This can happen by reducing annual hours or reducing lifetime hours (by delaying labor force entry or lowering the retirement age) (Victor, 2008; Schor, 2010). If environmental regulations or investments are simultaneously raising output per unit of natural resources used (that is, the productivity of natural capital), the need for hours reductions may be even greater.

This process can also be described from the consumption side. In a market economy without mechanisms to reduce hours, productivity growth is translated into GDP growth, which in turn is converted into income and consumption. Schor (1992) has described this as a "work and spend" cycle in which employees become locked into a trajectory of fixed hours and rising consumption. In this way, labor market outcomes such as working time are a key factor in the dynamics of spending, and indeed, the operation of a consumer culture. When "work and spend" prevails, advertising and marketing are more effective and competitive consumption is more pronounced. Furthermore, this path leads to higher environmental impact, because productivity growth is converted into environmentally degrading production and consumption. This is what we call the *scale effect*. Looked at from either perspective—growth or de-growth, production or consumption—the dynamics of worktime are central.

There are also links between working hours and environmental impact at the household level. Households have both income and time budgets (Becker, 1965; Lancaster, 1966) and they take both into account when making decisions. Households with less time and more money will choose time-saving activities and products, such as faster transportation. This is what we call the *compositional effect*. 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). However, transport is a clear case in which speed is associated with higher energy costs. Food preparation is likely another (ibid.).

In most de-growth scenarios, shorter worktime functions as a compensation for slower growth in consumption, which adds another potential linkage between hours and environmental impact (Coote et al., 2010; Jackson, 2009; Schor, 2005; 2010). This connection between time use and happiness is supported by a growing literature. Studies of European countries find that longer working hours are associated with lower happiness (Alesina et al., 2005; Pouwels et al., 2008). In the US, Tim Kasser and his co-authors have found that, even after controlling for income, wellbeing is positively related to "time affluence" and working hours are negatively related to happiness (Kasser and Brown, 2003; Kasser and Sheldon, 2009). Furthermore, gains in happiness associated with increased free time are not affected by relative comparisons to others' free time. This is not the case with income, for which the associated happiness depends on income relative to others. Thus, the wellbeing benefits of worktime reduction are more durable than those associated with rising income (Schor, 2010; Solnick and Hemenway, 1998; Frank, 1985). This suggests a second potential household level effect in which time affluence reduces consumption desire and environmental impact. If people who have more time are happier, this may reduce their spending, along the lines discussed by Kasser and Brown (2003).

12.4 CROSS-NATIONAL VARIATION IN WORKING HOURS

Hours worked varies considerably among OECD nations. According to the most recent data on the countries analysed here, annual hours ranged from 1372 (26.4 hours per week on average) in The Netherlands to 2242 (43.1 hours per week on average) in South Korea (The Conference Board, 2011). Van Ark (2002) identifies work hours as a key contributor to per capita income differences between countries, along with labor productivity and the labor participation rate. Using 2001 data, he estimates that while labor productivity was 13 percent higher in the US than the European Union, per capita income was 33 percent higher; 12 percentage points of the 20 percentage-point difference between the income gap and the productivity gap were attributable to lower working hours in the EU than in the US.

Bell and Freeman (2001) find that most of the difference in annual work hours between North Americans and Europeans is due to the greater hours worked by full-time employees in North America and a substantial portion of the difference between the US and other OECD countries is due to less vacation and holiday time in the US. Bell and Freeman (ibid.) also find that income inequality has a significant, positive effect on work hours. 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, and social democratic governments, all of which contribute to lower income inequality. In addition, they find that the majority of the difference in work hours between the US and Europe can be explained by European labor market regulations that reduced hours and/or extended vacation time. There is little evidence that these differences are due to national cultures or marginal tax rates (Alesina et al., 2005; Golden, 2009). Overall, these studies suggest that worktime is a malleable structural factor that could be adjusted by willing governments in order to reduce the scale of natural resource consumption.

Also of interest here are the preferences of workers in high-income nations. Using ISSP survey data for 21 countries at various levels of development, Otterbach (2010) finds that countries with higher GDP per capita have a higher percentage of workers who wish to work fewer hours and earn less money. The same is true for workers who wish to work the same number of hours and earn the same amount of money. In addition, the percentage of workers who prefer to work longer hours and earn more money is higher in countries with lower GDP per capita. Furthermore, evidence has been found for a negative association between work hours and life satisfaction. Results using both cross-sectional and panel data suggest that EU countries with lower work hours tend to have higher average life satisfaction (Alesina et al., 2005). These studies suggest that public opinion might be in favor of reducing work hours.

12.5 PREVIOUS RESEARCH

Despite considerable interest in working hours from environmental sociologists and others, the empirical literature on this question is very limited. At the micro level, this is likely due to the absence of datasets that combine time use, expenditure, and environmental impact. One recent attempt (Nassen et al., 2009), using a variety of data sources, looks at Swedish households and concludes that every 1 percent decline in working hours results in a decline in energy consumption and GHG emissions of 0.8 percent. De-composition of what we have called the scale and composition effects finds that the former is much larger, and that the latter, while very small, is positive (that is, more time leads to more energy-intensive activities and impacts). In contrast, a French study finds that households with longer hours of work have higher impact through bigger homes, more transport expenditures and higher expenditures for eating out (Devetter and Rousseau, 2011).

At the macro level, the first attempt 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 EF using data for 18 OECD countries in which the relationship was found to be positive and significant. Shortly thereafter, Rosnick and Weisbrot (2006) examined the relationship with energy consumption. 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 percent 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, labor participation rate, climate, and population. However, this only documents the effect of work hours on energy consumption in terms of its contribution to GDP, not net of GDP. That is, this analysis demonstrates that countries with longer work hours consume more energy because they have greater economic output, but it does not demonstrate how work hours affects energy consumption over and above the contribution to economic output by encouraging unsustainable consumption patterns. Thus, this analysis provides evidence of a scale effect of work hours, but not a compositional effect. The most extensive analysis thus far is that of Hayden and Shandra (2009), whose multivariate analysis of 45 countries revealed that annual work hours per worker has a positive significant effect on the EF, both controlling for labor participation rate and labor productivity among other relevant control variables as well as net of GDP per capita. Their analysis also indicates that the effect of work hours is larger than that of the labor participation rate and labor productivity.

With this study we examine the effect of work hours on three different environmental indicators: total EF, total carbon footprint, and total CO_2 emissions. We test the effect of work hours net of GDP per capita (and additional control variables) to determine if longer work hours result in less sustainable consumption patterns. To assess the environmental consequences of work hours' contribution to overall economic production we disaggregate GDP into three components (annual work hours, labor productivity, and the labor participation rate) and assess the effect of work hours controlling for labor productivity and the labor participation rate (Hayden and Shandra, 2009). In all cases, we expect work hours to have a significant, positive effect on the dependent variable.

12.6 DATA AND METHODS

We use data spanning the years 1970 to 2007[2] on 29 OECD member nations classified as high-income by the World Bank in 2007 (World Bank, 2009).[3] Israel is not included in the analysis due to missing data on one or more variables. Our dataset has an unbalanced panel structure and we allow the number of observations to vary across models with sample sizes ranging from 636 to 676.

We utilize the STIRPAT model, developed by Dietz and Rosa (1994) and further elaborated by York et al. (2003a), as our analytical framework. This elasticity model conceptualizes environmental impact (I) as a multiplicative function of population (P), affluence (A), and technology (T) and is used to test hypotheses regarding the effects of these three factors on environmental impacts. STIRPAT models are estimated by converting the dependent and independent variables into logarithmic form and using linear regression techniques to estimate the coefficients which are interpreted as indicating the percentage change in the dependent variable associated with a 1 percentage point increase in the independent variable. Our models are estimated using fixed effects panel regression. We include unreported dummy variables for each year of data in all models to control for period-specific effects that potentially affect all countries within each year. This reduces the likelihood of spurious results arising from similar time trends among the dependent and independent variables (Jorgenson and Clark, 2010). All models also include a correction for first-order autocorrelation (Knight et al., 2012, unpublished).

12.6.1 Dependent Variables

Total EF (in global hectares) measures consumption-based pressure on the environment and is constructed from five basic forms of human consumption: food, housing, transportation, consumer goods, and services. These data are from the Global Footprint Network (2010b). 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). The EF attributes exports and imports to the importing nation by estimating the materials and energy embodied in the traded commodities (that is, consumption = production + imports – exports). A major advantage of the EF is that it is the most comprehensive indicator of resource demands available. The footprint is a widely used indicator in the environmental social sciences (for example, Hayden and Shandra, 2009; Jorgenson and Burns, 2007; Jorgenson and Clark, 2010; York et al., 2003a).

Our second dependent variable is a subcomponent of the EF: the carbon footprint. This indicator measures the area of biologically productive space required to sequester a country's carbon emissions resulting from consumption. One drawback of this measure, though, is that it includes nuclear energy by counting each unit of energy produced by nuclear power as equal in footprint to a unit of fossil fuel energy.

Our third dependent variable is total carbon emissions measured in thousand metric tons of CO_2 (World Resources Institute, 2011). This is the standard, production-based indicator of CO_2 emissions which accounts for the mass of carbon dioxide produced by the combustion of solid, liquid, and gaseous fuels. It also includes emissions which result from certain manufacturing processes, such as from gas flaring and the manufacture of cement. This measure does not include emissions from land use change such as de-forestation (which releases carbon emissions) or emissions from bunker fuels used in international transportation. Data for this variable end in 2005. The key difference between the carbon footprint and carbon emissions is that the carbon footprint adjusts for carbon embodied in imports and exports so that it better reflects the carbon emissions associated with a country's consumption.

The choice of method for measuring carbon emissions has non-trivial consequences. Wilting and Vringer (2009) found that consumption-based greenhouse gas emissions were greater than production-based emissions in most developed countries. Ahmad and Wyckoff (2003) determined that among the OECD as a whole, CO_2 emissions from domestic consumption exceeded that of domestic production. Emissions embodied in imports and exports are typically greater than 10 percent of emissions from domestic production and in some cases greater than 30 percent. Conservative estimates for 1995 indicate that for the OECD consumption-based carbon emissions were 5 percent higher than production-based emissions in 1995 (ibid.). Given the significance of embodied carbon emissions, analyses of the common production-based (that is, territorial) indicators of carbon emissions and alternative consumption-based indicators including embodied carbon may produce divergent results. We have included both in our estimates because both a production-side and a consumption-side measure is of interest.

12.6.2 Independent Variables

As noted above, following Hayden and Shandra (2009), we disaggregate GDP into three components to test the effect of work hours on our dependent variables. First, our key independent variable is the 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 (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 labor participation rate is measured as the percentage of employed persons in the population. The source of data for these three variables is The Conference Board (2011), from whom further information on the detailed sources and methodologies is available.

GDP per capita measured in 2000 US$ is included to control for the level of economic development (World Bank, 2011). 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, 2011).

12.7 RESULTS AND DISCUSSION

In order to test for the scale effect, we estimated the effect of work hours—net of labor productivity, the labor participation rate, and other control variables—on the EF, the carbon footprint, and CO_2 emissions. We found that the effect of work hours is significant and positive for all three of our dependent variables, as are the other two components of GDP (labor productivity and the labor participation rate). Furthermore, population and manufacturing as a percentage of GDP are significant and positive in all models while urbanization is not significant in any, and services as a percentage of GDP is significant (and positive) only when predicting total carbon footprint. The coefficient for our variable of interest, work hours, is 1.21 ($p \leq 0.01$) for the EF, 1.46 ($p \leq 0.01$) for the carbon footprint, and 0.42 ($p \leq 0.05$) for the CO_2 emissions. Table 12.1 presents the results of our analyses in terms of the predicted change in the dependent variables for a 10 percent or 25 percent reduction in work hours while holding all other variables constant. (10 percent and 25 percent are somewhat arbitrary reductions, but are used as examples of the size range that would be feasible over the short to medium term.) As this table illustrates, for a 10 percent reduction in work hours, the predicted declines in EF, carbon footprint, and CO_2 emissions are 12.1 percent, 14.6 percent, and 4.2 percent respectively. Reductions of these magnitudes constitute substantial progress. For example, consider that, as of

Table 12.1 Predicted change in dependent variables for 10 percent and 25 percent reductions in work hours with all other variables held constant

	Scale effect[a]		Compositional effect[b]	
Reduction in work hours:	10%	25%	10%	25%
Ecological footprint	–12.1%	–30.2%	–4.9%	–12.2%
Carbon footprint	–14.6%	–36.6%	–8.6%	–21.5%
Carbon dioxide emissions	–4.2%	–10.5%	ns[c]	ns

Notes:
a "Scale effect" refers to estimates based on models that control for population, urbanization, manufacturing as a percentage of GDP, services as a percentage of GDP, labor productivity, and the labor participation rate.
b "Compositional effect" refers to estimates based on models that control for population, urbanization, manufacturing as a percentage of GDP, services as a percentage of GDP, and GDP per capita.
c "ns" indicates that the estimated effect of work hours on carbon dioxide emissions in this model was not statistically significant at the 0.10 level and is therefore not reported here.

2007, we needed a 50 percent reduction in the EF to get back into line with the planet's global carrying capacity, as noted above in Section 12.2.

In order to test the compositional effect, we estimated the effect of work hours, net of GDP per capita and other control variables, on our three dependent variables. We found that work hours is significant and positive for the EF and the carbon footprint, but not for total CO_2 emissions. GDP per capita, total population, and manufacturing as a percentage of GDP, were found to be positive and significant in all three models while urbanization was not significant in any model, and services as a percentage of GDP was significant (and positive) only when predicting total carbon footprint. The coefficient for work hours is 0.49 ($p \leq 0.05$) for the EF, 0.86 ($p \leq 0.10$) for the carbon footprint, and –0.16 ($p > 0.10$) for the CO_2 emissions. Focusing on statistically significant effects, Table 12.1 shows that, when holding all other variables constant, a 10 percent reduction in work hours is associated with a 4.9 percent reduction in the EF and an 8.6 percent decline in the carbon footprint. Reductions from the compositional effect are more modest than the scale effect but still represent meaningful improvements.

The major discrepancy in our results is that for CO_2 emissions we do not find a significant effect of work hours on carbon emissions net of GDP per capita, but we do for the ecological and carbon footprints.[4] This suggests that the compositional effect of work hours on consumption patterns is not apparent for CO_2 emissions because this variable is production-based whereas the other two are consumption-based. That is, this indicator of CO_2 emissions includes emissions originating from the production of goods that were exported and consumed elsewhere. Footprint measures are consumption-based, meaning that they incorporate embodied energy and materials so that the footprint reflects the consumption of a country, including imported goods but excluding those that are exported. This difference in calculation is the major distinction between these measures, and therefore is likely the source of this discrepancy.

On the whole, the results demonstrate that working time is a significant contributor to environmental problems and thus is an attractive target for policies promoting environmental sustainability. Our findings suggest, though, that decreasing work hours while maintaining current levels of GDP is less effective in reducing anthropogenic pressure on the environment than reducing GDP by lowering work hours. That is, the scale effect of work hours is much larger than the compositional effect. This supports the conceptualization in the de-growth and new economics literatures of the role of work hours and socially sustainable economic de-growth in achieving global environmental sustainability.

12.8 CONCLUSION

Many scholars have argued that continued economic growth in the global North is antithetical to achieving global environmental sustainability. An increasingly prominent idea is that developed countries could achieve slower or zero economic growth in a socially sustainable way by reducing work hours. Research suggests that reduced work hours could contribute to sustainability by decreasing the scale of both production and consumption. We tested this idea using panel data for 29 high-income OECD countries. Overall, we found that countries with shorter work hours tend to have lower ecological footprints, carbon footprints, and carbon dioxide emissions. Our results suggest that working hours should be placed squarely at the center of economic analyses and concerns. While the 1970s' shift to focus on productivity, profits, and growth made sense at the time, we believe that a new conversation about growth in wealthy countries is long overdue, given current conditions. These include the environmental degradation associated with growth, the shift to inequality-enhancing growth, and the declining ability of additional GDP to promote human wellbeing in high-income nations. It is our hope that the findings we have presented can help to rekindle that debate among the radical economists who were at the center of thinking critically about growth 40 years ago and the generations who have followed them.

NOTES

1. The ecological footprint is a comprehensive consumption-based indicator of environmental threats. It is described in more detail in the section on dependent variables (Section 12.6.1).
2. We limit our analysis to 1970 and later because of the paucity of data on important control variables prior to that year. In the case of carbon dioxide emissions, data only extend to 2005.
3. These countries include Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, South Korea, Luxembourg, The Netherlands, New Zealand, Norway, Portugal, the Slovak Republic, Slovenia, Spain, Sweden, Switzerland, the United Kingdom, and the United States. OECD countries excluded because they are not classified as high-income are Turkey, Poland, Chile, and Mexico.
4. Note, however, that while we do not find evidence of a compositional effect of work hours (that is, net of GDP) for carbon emissions, we do find evidence of a scale effect.

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