Sustainability Science (2018) 13:1167–1174
https://doi.org/10.1007/s11625-017-0517-2

TECHNICAL REPORT

Inequality, poverty, and the carbon intensity of human well-being in the United States: a sex-specific analysis

Andrew K. Jorgenson[1] · **Thomas Dietz**[2] · **Orla Kelly**[1]

Received: 21 July 2017 / Accepted: 28 November 2017 / Published online: 14 December 2017

Abstract

Sustainability requires reducing the carbon intensity of human well-being (CIWB): the level of anthropogenic carbon emissions per unit of human well-being. Here, we examine how multiple forms of inequality affect sex-specific measures of CIWB using data for the 50 US states, while taking into account the effects of other socio-economic and political factors. Results from longitudinal models indicate that state-level female CIWB and male CIWB are both positively associated with (1) income concentration, measured as the income share of the top 10%, and (2) the percent of the population at or below the poverty line. Overall inequality, as measured by the Gini coefficient, has no net effect on male CIWB or female CIWB. These findings suggest that reducing forms of inequality, especially poverty and the concentration of income among the most affluent, are potential pathways to sustainability.

Introduction

The UN sustainable development goals (SDGs) represent an impressive consensus on what sustainability means to the global community (http://www.un.org/sustainabledevelopment/sustainable-development-goals/). They demonstrate an evolution from the widely accepted definition of sustainability in the Bruntland report where sustainable development is development that "meets the needs of current generations without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development 1987). The SDGs focus on human well-being (goals 1–5, 8–11, 16), the environment (goals 13–15), and their intersection (goals 6, 7, 12). Scholars have noted that the set of goals with 169 targets derived from them calls for a priority structure and serious analysis of the interrelationships among the goals (Nilsson et al. 2016; Pongiglione 2015; Reddy and Kvangraven 2015). However, the driving logic of the goals is consistent with the conceptualization of striving to increase human well-being while reducing the stress human actions place on the biophysical environment (Dietz 2015).

Part of this conceptualization is a move beyond the traditional measures of affluence, such as economic activity per capita, towards more direct measures of both objective and subjective well-being. In response to this new conceptualization of sustainability, a body of cross-national research has emerged that examines the "Ecological intensity of well-being (EIWB)" (Dietz et al. 2009, 2012; Dietz and Jorgenson 2014; Jorgenson and Dietz 2015; Knight and Rosa 2011; Lamb et al. 2014; Mazur 2011; Steinberger and Roberts 2010; Steinberger et al. 2012). EIWB contrasts with the traditional economic measures of efficiency that are defined as economic output (contribution to GDP) per unit labor input. Rather, EIWB asks how much stress is placed on the environment compared to the amount of human well-being a nation produces. The substantial variation in EIWB across geopolitical units in turn allows for developing and testing theories of why some forms of social, economic, and political organization are more sustainable, that is, produces less environmental damage per unit well-being, than others.

Earlier versions of this paper were presented at the 2017 Sociology of Development Conference (hosted by Wayne State University) and at the Environmental Sociology Workshop in the Department of Sociology at Boston College. The authors thank the attendees at both events as well as the peer reviewers at *Sustainability Science* for their helpful feedback and comments.

Handled by Suneetha Subramanian, United Nations University Center Administration, India.

✉ Andrew K. Jorgenson
jorgenan@bc.edu

[1] Boston College, 140 Commonwealth Avenue, Chestnut Hill, MA 02467, USA

[2] Michigan State University, 220 Trowbridge Road, East Lansing, MI 48824, USA

In this preliminary study, we analyze the carbon intensity of human well-being (CIWB), the most commonly used instantiation of the broader EIWB concept (Feng and Yen 2016; Givens 2016; Givens, forthcoming; Jorgenson 2014, 2015; Jorgenson et al. 2014; Jorgenson and Givens 2015; Knight 2014; Lamb and Steinberger 2017; Sweiden 2017; Sweiden and Alwakad 2016). Initially developed by Jorgenson (2014), CIWB is a ratio between anthropogenic carbon emissions per capita and an objective measure of human well-being. The primary focus of most research on CIWB has been to assess the extent to which nations' CIWB is associated with overall levels of economic development, with findings suggesting that CIWB and development are positively associated for nations in most macro-regional and temporal contexts.

We contribute to this growing body of sustainability research by (1) shifting focus from nation states to states within the US, (2) by considering sex-specific measures of human well-being, and by (3) examining inequality as a driver of CIWB. In particular, we estimate models of female CIWB and male CIWB for all 50 US states for the 2000–2010 period, paying particular attention to the effects of multiple measures of income inequality and poverty, while also taking into account the effects of other socio-economic and political factors, including levels of economic development, state environmentalism, education, manufacturing, and fossil-fuel production.

The scaling down to US states as the unit of analysis allows us to make use of what has been called a "Jeffersonian laboratory", in which states all fall under the same overarching set of institutions and have more cultural consistency than when we look across nations, the focus of all prior research on CIWB. However, US states still vary tremendously in their political economy, institutional forms, and culture. Therefore, this meso-level, sub-national analysis may reveal relationships and patterns harder to detect in cross-national analyses (e.g., Jorgenson et al. 2017; Rudel 2009).

Gender equality is UN sustainable development goal 5. It is well known that there are substantial gender inequalities in many aspects of well-being, and that in many ways men and women face different structural constraints, opportunities, and stresses that impinge on their lived experiences and circumstances. Given widespread gender inequality in many forms, it is important to examine well-being separately for women and for men when that is possible. Here, we offer an exploration of those differences using sex-specific average life expectancies as measures of objective well-being in calculating CIWB measures for each state. A growing literature examines sex-specific variation in life expectancy and mortality across US states (Montez et al. 2016; Tencza et al. 2014; Wilmoth et al. 2011). For example, Montez et al. (2016) find that, controlling for individual-level characteristics (e.g., age, race/ethnicity and education), state-level conditions (e.g. affluence, inequality, and poverty) explain over 60% of the variance in women's mortality, more than twice the variance explained by individual characteristics.

A main focus of this preliminary study is inequality. Conventional development theory might suggest that economic growth will both improve human well-being and reduce stress on the environment, while more critical perspectives argue that development requires large amounts of resources and generates increasing amounts of pollution. However, the standard measures of affluence and development used in both conventional and more critical approaches, such as state-level GDP per capita, do not capture substantial economic inequality within states. High levels of inequality may indicate that the benefits of average affluence are not reaching many within that state. It also may indicate that considerable wealth and power is concentrated in the hands of a small segment of the population, who may shape policies and practices to favor their interests without regard for the overall impacts. In addition, inequality in itself may degrade well-being for all, not just for the poor (Pickett and Wilkinson 2015).

There is also a growing body of research that indicates that income inequality increases damage to the environment, including increased carbon emissions (Jorgenson et al. 2017; Boyce 1994; Mikkelson et al. 2007; Torras and Boyce 1998). There are at least two pathways by which these effects might occur. One we might term structural in which the uneven distribution of affluence generates inefficiencies in the production of well-being and increases environmental stress. We test for this overall effect of inequality using the Gini coefficient. It is also possible that the effects of inequality are largely political; a result of the concentration of income and presumably power among the most affluent. We capture this potential effect with the share of overall state income captured by the top 10%. Finally, to examine the effects of poverty, we include the percent of the population at or below 100% of the Federal poverty line.

Materials and methods

The data set

The data set contains annual observations for 2000, 2005, and 2010 for all 50 US states, which yields an overall sample of 150 observations. These are the years in which comparable data are currently available for the two employed life expectancy variables as well as for some of the independent variables. The analyzed data set is available from the lead author on request.

Model estimation technique

Given the limited number of observations per case, the inclusion of both time-variant and time-invariant predictors, and our interest in analyzing both within-state and between-state variation, we use the suite of "xtreg" commands in Stata (version 14) to estimate generalized least-squares random-effects regression models (Cameron and Trivedi 2009). We estimate robust standard errors, clustered by state, and to control for potential unobserved heterogeneity that is cross-sectionally invariant within periods, we include dummy variables for our annual observations with the year 2000 serving as the reference category (Allison 2009). Consistent with all past research on CIWB, we logged (ln) all non-binary variables, so estimated coefficients can be interpreted as elasticities.

Dependent variables

In this study, state-level CIWB is measured as per capita dioxide emissions divided by average life expectancy at birth, delineated by sex (female CIWB, male CIWB). Thus, we employ two dependent variables. While average life expectancy is the most commonly used well-being measure in the calculation of CIWB, studies of CIWB could certainly employ other objective measures of human well-being as the denominator, such as morbitity rates, or subjective measures, such as perceptions of well-being (Ambrey and Daniels 2017; Knight and Rosa 2011).

The numerator for the two ratios is state-level per capita carbon emissions from fossil-fuel combustion, measured in millions of metric tons. These include emissions from the commercial, industrial, residential, transportation, and electric power sectors. We obtained these emissions data from the United States Environmental Protection Agency's (EPA) online database (https://www3.epa.gov/statelocalclimate/resources/state_energyco2inv.html, Accessed 2 July 2 2015). Data for the two denominators, state-level average life expectancy at birth for females and for males, were obtained from the Institute for Health Metrics and Evaluation's online database (http://www.healthdata.org, Accessed 2 September 2016). For in-depth details on the calculation of the two life expectancy measures, see Wang et al. (2013). To be clear, unlike the two life expectancy measures, the carbon emissions data are not delineated by sex, since to the best of our knowledge, such state-level emissions data are unavailable. We also note that none of the employed independent variables are delineated by sex either, a point that we return to in our "Discussion and conclusion" section.

Employing a ratio as a dependent variable creates a complication that must be resolved prior to the analysis. Since the variability of the numerator and the dominator can differ substantially, a ratio can be dominated by one or the other. In the overall data set for the current analysis, the coefficient of variation (standard deviation/mean) for the carbon emissions data is substantially larger than for both female average life expectancy and male average life expectancy. Thus, the relative variation in carbon emissions per capita—the numerator—is notably larger than the variation in both female and male life expectancy—the two dominators. Under such conditions, the variation in the carbon emissions data could drive variation in the two ratios.

To resolve this potential complication, we take the same approach initially used by Dietz et al. (2012), which is commonly employed in cross-national studies of CIWB (e.g., Feng and Yen 2016; Givens 2016; Jorgenson 2014; Sweiden 2017; Sweiden and Alwakad 2016). We constrain the coefficient of variation of the numerator and denominator to be equal by adding a constant to the numerator (per capita emissions), which shifts the mean without changing the variance. For the currently analyzed data, the coefficients of variation for the two variables can be made equal by adding 1057.485 to the per capita emissions data when paired with female life expectancy and 724.439 when paired with male life expectancy. The two state-level measures of the carbon intensity of well-being are as follows:

$$\text{Female CIWB} = \left[\left(\text{CO}_2\text{PC} + 1057.485\right)/\text{Female LE}\right] \times 100.$$
$$\text{Male CIWB} = \left[\left(\text{CO}_2\text{PC} + 724.439\right)/\text{Male LE}\right] \times 100.$$

Here, CIWB is the carbon intensity of well-being, CO_2PC is carbon dioxide emissions per capita, and LE is average life expectancy. Consistent with past CIWB research, we multiple by 100 to scale the two ratios (Dietz et al. 2012; Givens 2015; Jorgenson 2014).

Independent variables

We include two measures of income inequality: the Gini coefficient and the income share of the top 10%. We obtained the Gini coefficient data from the "US state-level income inequality" database, hosted by Mark Frank, Professor of Economics at Sam Houston State University (http://www.shsu.edu/~eco_mwf/inequality.html, Accessed 1 August 2015). The values of estimated Gini coefficients can range from zero (perfect equality) to 100 (perfect inequality).

We gathered the income share of the top 10% data from the World Wealth and Income Database (WWID), which were developed by Mark Frank and colleagues (http://www.wid.world/#Database, Accessed 6 August 2015). These data, which are employed in other recent research (Jorgenson et al. 2017), are measured in percentages. Both income inequality measures are constructed from individual tax filing data available from the Internal Revenue Service. For in-depth information on the calculation of these two measures, see Frank et al. (2015).

We also include measures of the percent of the population at or below 100% of the poverty line. These data are obtained from the Minnesota Population Center's Integrated Public Use Microdata Series: Version 6.0 (Ruggles et al. 2015).

We include gross domestic product (GDP) per capita by state (reported in chained 2007 dollars), which we gathered from the United States Department of Commerce Bureau of Economic Analysis database (http://www.bea.gov/itable/, accessed 10 July 2015). These annual data are reported in "chained" 2007 dollars, which is a method of adjusting real dollar amounts for inflation over time, allowing for direct comparisons of values from different years.

We also include Dietz et al.'s (2015) measure of state environmentalism, which quantifies pro-environmental voting by states' Congressional delegations. Dietz et al. (2015) create an average of House and Senate scores that are based on the League of Conservation Voters' rating (ranging from 0 to 100) for each member of Congress based on her or his votes on environmental issues as identified by the League for the 1990–2005 period.

We include measures of the percent of the adult population with a 4-year college degree or higher, which we obtained from the Minnesota Population Center's Integrated Public Use Microdata Series: Version 6.0 (Ruggles et al. 2015).

We also include measures for manufacturing as a percent of state GDP and total fossil-fuel production (coal, natural gas, and crude oil) in billions of British thermal units (Btu). The manufacturing data are gathered from the United States Department of Commerce "Bureau of Economic Analysis" database (http://www.bea.gov/index.htm, accessed 21 September 2015). The fossil-fuel production data are obtained from the United States Energy Information Administration (EIA) "State Energy Data System" database (http://www.eia.gov/state/seds/seds-data-complete.cfm?sid=US#Production, accessed 5 February 2016).

To account for potential regional variation, we include dummy variables for Census Region, which consist of Midwest Census Region, South Census Region, West Census Region, and Northeast Census Region. In the reported models, Northeast Census Region is the reference category.

Univariate descriptive statistics for all substantive variables included in the reported regression analysis are provided in Table 1, and their bivariate correlations are reported in Table 2.

Results

The findings for the analysis are provided in Table 3. We estimate the same two models for both Female CIWB and Male CIWB. As a reminder, all non-binary variables are logged, so estimated coefficients can be interpreted as elasticities. The first model includes all predictors, while the second model is reduced to only the substantive predictors with statistically significant effects in the first model. The regional and temporal intercepts are included in all estimated models. The elasticity coefficients are flagged for statistical significance, and their clustered robust standard errors are provided in parentheses.

The results suggest that both state-level CIWB outcomes are positively associated with income inequality, measured as the income share of the top 10%. The estimated effects are similar for female CIWB and male CIWB, with a 1% increase in the income share of the top 10% leading to between a 0.028 and 0.029% increase in female CIWB, and between a 0.025 and 0.026% increase in male CIWB. However, the estimated effect of the Gini coefficient, the other income inequality measure, is nonsignificant for both outcomes. The income inequality effects, overall, are consistent with recent research on US state-level carbon emissions

Table 1 Descriptive statistics

	Mean	Standard deviation	Minimum	Maximum
Female CIWB	2.607	0.028	2.551	2.706
Male CIWB	2.303	0.039	2.239	2.435
Gini coefficient	4.084	0.057	3.963	4.225
Income share of top 10%	3.780	0.115	3.513	4.086
Percent at or below poverty line	2.673	0.236	2.040	3.219
GDP per capita	10.699	0.179	10.284	11.152
State environmentalism	3.823	0.571	1.871	4.500
Percent college degree or higher	2.860	0.200	2.363	3.339
Manufacturing as % GDP	2.565	0.481	1.069	3.428
Fossil-fuel production	8.612	6.303	0.000	16.175

All variables in table are in logarithmic form (ln); three observations per case (2000, 2005, 2010); $N = 150$

Table 2 Bivariate correlations

		1	2	3	4	5	6	7	8	9
Female CIWB	1									
Male CIWB	2	0.988								
GDP per capita	3	−0.290	−0.310							
Gini coefficient	4	−0.061	−0.057	0.176						
Income share of top 10%	5	−0.218	−0.234	0.364	0.622					
State environmentalism	6	−0.587	−0.561	0.190	−0.102	0.293				
Percent college degree or higher	7	−0.710	−0.725	0.643	0.124	0.313	0.454			
Percent at or below poverty line	8	0.290	0.323	−0.540	0.184	−0.050	−0.218	−0.482		
Manufacturing as % GDP	9	0.114	0.089	−0.356	−0.215	−0.095	0.156	−0.271	0.201	
Fossil-fuel production	10	0.516	0.511	−0.179	0.149	−0.060	−0.457	−0.379	0.343	−0.052

All variables in table are in logarithmic form (ln); three observations per case (2000, 2005, 2010); $N = 150$

Table 3 Elasticity coefficients for the regression of female CIWB and male CIWB

Random-effects model estimates for all 50 US states, 2000–2010				
	Female CIWB	Female CIWB	Male CIWB	Male CIWB
Gini coefficient	−0.004		−0.008	
	(0.007)		(0.009)	
Income share of top 10%	0.028***	0.029***	0.025**	0.026**
	(0.008)	(0.008)	(0.010)	(0.010)
Percent at or below poverty line	0.008*	0.007*	0.012*	0.011*
	(0.004)	(0.004)	(0.007)	(0.006)
GDP per capita	0.016*	0.016*	0.030**	0.030**
	(0.009)	(0.009)	(0.011)	(0.011)
State environmentalism	−0.027***	−0.028***	−0.033***	−0.036***
	(0.007)	(0.007)	(0.009)	(0.009)
Percent college degree or higher	−0.023#	−0.021#	−0.041*	−0.039*
	(0.016)	(0.016)	(0.019)	(0.019)
Manufacturing as % GDP	−0.001		−0.001	
	(0.003)		(0.003)	
Fossil-fuel production	0.001		0.001	
	(0.001)		(0.001)	
West region	−0.010#	−0.008	−0.015*	−0.012#
	(0.007)	(0.006)	(0.008)	(0.008)
South region	0.016*	0.018**	0.022*	0.026**
	(0.008)	(0.008)	(0.010)	(0.010)
Midwest region	0.008	0.010#	0.010	0.013#
	(0.006)	(0.006)	(0.009)	(0.008)
2005	−0.006***	−0.006***	−0.007***	−0.007***
	(0.001)	(0.001)	(0.002)	(0.002)
2010	−0.019***	−0.019***	−0.025***	−0.025***
	(0.002)	(0.003)	(0.003)	(0.003)
Constant	2.494***	2.479***	2.132***	2.105***
	(0.082)	(0.080)	(0.105)	(0.107)
R-sq within	0.906	0.907	0.929	0.931
R-sq between	0.648	0.612	0.662	0.626
R-sq overall	0.672	0.640	0.686	0.653

$^{\#}p < .10$, $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$ (one-tailed), robust standard errors clustered by state in parentheses; all non-binary variables are in logarithmic form (ln); three observations per case (2000, 2005, 2010); $N = 150$

(Jorgenson et al. 2017), which also yields significant positive effects of the income concentration at the top of the distribution and null findings concerning the Gini coefficient, the latter of which does not specify where within an income distribution inequality exists. The results here also suggest that a 1% increase in the percent of the population at or below the poverty line leads to between 0.007 and 0.008% increase in female CIWB, and between a 0.011 and 0.012% increase in male CIWB.

Consistent with cross-national research, we also find that the state-level measures of CIWB delineated by sex are positively associated with state-level GDP per capita. For both estimated models of Female CIWB, the elasticity coefficient for state-level GDP per capita is 0.016, indicating that a 1% increase in GDP per capita is associated with a 0.016 percent increase in female CIWB. With an elasticity coefficient of 0.030 in both estimated models of male CIWB, the effect of state-level GDP per capita is moderately larger for male CIWB than for female CIWB.

The effect of state environmentalism on both outcomes is negative and statistically significant. More specifically, a 1% increase in state environmentalism leads to between a 0.027 and 0.028% decrease in female CIWB, and between a 0.033 and 0.036 decrease in male CIWB. These findings are consistent with, while simultaneously expanding Dietz et al. (2015), who find a robust negative association between carbon emissions and state environmentalism. Similarly, both male CIWB and female CIWB are negatively associated with the percent college degree or higher, where a 1% increase in this level of education leads to between a 0.039 and 0.041% decrease in male CIWB, and between a 0.021 and 0.023% decrease in female CIWB. The effects of both manufacturing as percent GDP and fossil-fuel production on female CIWB and male CIWB are nonsignificant. The null findings for the manufacturing and fuel production measures, we suspect, are at least partly due to the employed numerator for both CIWB outcomes consisting of carbon emissions from the commercial, industrial, residential, transportation, and electric power sectors combined (see also Jorgenson et al. 2017).

To check the sensitivity of the results to the specific approach which we used to measure female CIWB and male CIWB, we repeated the analysis using different measures: the residuals from regressing each life expectancy measure on per capita carbon emissions rather than the ratio of the two variables. We used the residuals from these regressions as alternative dependent variables to the CIWB ratio measures. Positive residuals indicate higher well-being relative to levels of emissions, while negative residuals indicate lower well-being relative to levels of emissions. While there are some methodological concerns with residualization (York 2012), the approach has been used in other studies on similar topics (Knight and Rosa 2011), and treated as a sensitivity analysis in cross-national research on CIWB (Jorgenson 2014; Jorgenson and Givens 2015). The residuals, as expected, are close to perfectly negatively correlated with the CIWB ratio measures, and the results of the sensitivity analysis are substantively identical to the reported findings for the analysis of the ratios for female CIWB and male CIWB.

Discussion and conclusion

Our results indicate that inequality influences sustainability. In the analysis, it was not overall inequality as measured by the Gini coefficient that mattered. Instead, the concentration of income among the most affluent and the percent of the population below the poverty line both increase US states' carbon intensity of well-being. The former may reflect disproportionate power and thus the ability to shape public and private policy. The affluent possesses the resources to shield themselves from many health risks to which the rest of the population is subject. They may also favor neo-liberal institutions and neo-conservative politics which minimize collective investment in health infrastructure and in environmental protection. All of these could lead to higher greenhouse gas emissions and lower life expectancy for the overall population even as the affluent avoids the consequences of these dynamics.

The effects of poverty are consistent with the well-known adverse health impacts of such conditions. They are also consistent with the argument that poverty may increase environmental stress. The poor are often trapped in using inefficient technologies and have consumer choices that are more limited than the affluent. As a result, even though the overall level of consumption of the poor is substantially less than that of the affluent, they are often locked into forms of consumption, such as energy inefficient housing, that generate substantial environmental impacts. Furthermore, a substantial body of environmental justice research indicates that poorer neighborhoods and communities are often disproportionately exposed to, and potentially harmed by, a variety of industrial-based pollutants (e.g., Mohai et al. 2009). We suggest that it is likely that our findings concerning the positive association between poverty levels and both state-level CIWB measures are also partly representative of these sorts of socio-environmental inequities.

Our independent variables generally had about the same effect on female CIWB and male CIWB. One notable exception seems to be the effect of state-level GDP per capita, where the elasticity coefficient for male CIWB is about twice that for female CIWB. This may be a result of men being more involved with the traditional economy captured by GDP measures, whereas women's well-being may be more influenced by factors not captured in the traditional economic accounts.

We find that state environmentalism mitigates against the factors that tend to increase state-level CIWB. The effects are about equal for both outcomes. This is not surprising, since we use the same measure of greenhouse gas emissions for male CIWB and female CIWB. Thus, both CIWB measures would be influenced equally through efforts of environmentalists to reduce emissions. We also find that the percent of the population with a college degree tends to reduce male CIWB and the effect is the largest elasticity in our model, about 25% greater than the effects of state environmentalism, state-level GDP per capita, or income share of the top 10%. However, the effects of education on female CIWB are about half the effects on male CIWB and are only marginally statistically significant. Again, since we use the same numerator in both the male and female measures, this difference likely arises because higher education has a more salubrious effect on life expectancy for men than for women.

Like all research, this study has limitations. The temporal scope of the analysis is limited by the availability of data, and as with any non-experimental design, there may be key variables that we have not included. Ideally, we would like to follow the approach of mortality researchers who are able to link individual-level mortality data to state-level data to model both individual and contextual effects. However, to the best of our knowledge, the necessary data to do such analyses looking at both human well-being and environmental stress do not exist.

Overall, our findings suggest that inequality, and in particular concentration of income on the one hand and poverty on the other are problematic for sustainability. While we acknowledge their preliminary nature, these results suggest that policies aimed at reducing income inequality and poverty within US states are pathways to simultaneously enhancing both human well-being and climate change mitigation efforts. We also find that economic growth of the conventional sort increases US states' carbon intensity of well-being, while education and state environmentalism reduce it. This suggests the necessity of more equitable and sustainable forms of economic development as well as the social and environmental benefits of higher education and the potential for effective institutional and regulatory conditions and practices.

While most of the independent variables had similar effects on both female CIWB and male CIWB, there are interesting differences in the effects of affluence, measured at state-level GDP per capita, and of education. These clearly warrant further theoretical development and empirical investigation in both sub-national and cross-national contexts. In addition, if and when such sex-specific data become available, future research would do well to employ sex-specific measures of predictors of state-level female CIWB and male CIWB, and ideally sex-specific measures of state-level carbon emissions in the construction of the two CIWB ratios. Doing so would provide a more nuanced understanding of these socio-environmental relationships, at least in the US sub-national context, and the extent to which they differ between females and males.

References

Allison P (2009) Fixed effects regression models. Sage Publications, Thousand Oaks

Ambrey C, Daniels P (2017) Happiness and footprints: assessing the relationship between individual well-being and carbon footprints. Environ Dev Sustain 19:895–920

Boyce J (1994) Inequality as a Cause of Environmental Degradation. Ecol Econ 11:169–178

Cameron C, Trivedi P (2009) Microeconometrics using stata. Stata Press, College Station

Dietz T (2015) Prolegomenon to a structural human ecology of human well-being. Sociol Dev 1:123–148

Dietz T, Jorgenson A (2014) Towards a new view of sustainable development: human well-being and environmental stress. Environ Res Lett 9:031001

Dietz T, Rosa E, York R (2009) Efficient well-being: rethinking sustainability as the relationship between human well-being and environmental impacts. Hum Ecol Rev 16:113–122

Dietz T, Rosa E, York R (2012) Environmentally efficient well-being: is there a Kuznets curve? J Appl Geogr 32:21–28

Dietz T, Frank K, Whitley C, Kelly J, Kelly R (2015) Political influences on greenhouse gas emissions from US States. Proc Natl Acad Sci 112:8254–8259

Feng J, Yuan J (2016) Effect of technology innovation and spillovers on the carbon intensity of human well-being. Springer Plus 5:346

Frank M, Sommeiller E, Price M, Saez E (2015) Frank–Sommeiller–Price series for top income shares by US States since 1917. Methodological notes, The World Top Incomes Database. http://www.wid.world/. Accessed 6 Aug 2015

Givens J (2016) Urbanization, slums, and the carbon intensity of well-being: implications for sustainable development. Hum Ecol Rev 22:107–128

Givens J (forthcoming) World society, world polity, and the carbon intensity of well-being, 1990–2011. Sociol Dev

Jorgenson A (2014) Economic development and the carbon intensity of human well-being. Nat Clim Change 4:186–189

Jorgenson A (2015) Inequality and the carbon intensity of human well-being. J Environ Stud Sci 5:277–282

Jorgenson A, Dietz T (2015) Economic growth does not reduce the ecological intensity of human well-being. Sustain Sci 10:149–156

Jorgenson A, Givens J (2015b) The changing effect of economic development on the consumption-based carbon intensity of well-being. PLoS One 10(5):e0123920

Jorgenson A, Alekseyko A, Giedraitis V (2014) Energy consumption, human well-being and economic development in central and eastern European nations: a cautionary tale of sustainability. Energy Policy 66:419–427

Jorgenson A, Schor J, Huang X (2017) Income inequality and carbon emissions in the United States: a state-level analysis, 1997–2012. Ecol Econ 134:40–48

Knight K (2014) Temporal variation in the relationship between environmental demands and well-being: a panel analysis of developed and less-developed countries. Popul Environ 36:32–47

Knight K, Rosa E (2011) The environmental efficiency of well-being: a cross-national analysis. Soc Sci Res 40:931–949
Lamb W, Steinberger J (2017) Human well-being and climate change mitigation. Wiley Interdiscip Rev Clim Change. https://doi.org/10.1002/wcc.485
Lamb W, Steinberger J, Bows-Larkin A, Peters G, Roberts T, Wood FR (2014) Transitions in pathways of human development and carbon emissions. Environ Res Lett 9:014011
Mazur A (2011) Does increasing energy or electricity consumption improve quality of life in industrial nations?” Energy Policy 39:2568–2572
Mikkelson G, Gonzalez A, Garry D, Peterson (2007) Economic inequality predicts biodiverstiy loss. PLoS One 2(5):e444
Mohai P, Pellow D, Roberts T (2009) Environmental justice. Annu Rev Environ Resour 34:404–430
Montez J, Karas A, Zajacova, Hayward M (2016) Explaining inequalities in women’s mortality between US states. SSM Popul Health 2:561–571
Nilsson M, Griggs D, Visbeck M (2016) Map the interactions between sustainable development goals. Nature 534:320–322
Pickett K, Wilkinson R (2015) Income inequality and health: a causal review. Soc Sci Med 128:316–326
Pongiglione F (2015) The need for a priority structure for the sustainable development goals. J Glob Eth 11:37–42
Reddy S, Kvangraven IH (2015) Global development goals: if at all, why, when and how?. SSRN: https://ssrn.com/abstract=2666321. Accessed 12 Oct 2017
Rudel T (2009) How do people transform landscapes? A sociological perspective on suburban sprawl and tropical deforestation. Am J Sociol 115:129–154
Ruggles S, Genadek K, Goeken R, Grover J, Sobek M (2015) Integrated public use microdata series: version 6.0 [Machine-readable database]. University of Minnesota, Minneapolis
Steinberger J, Roberts T (2010) From constraint to sufficiency: the decoupling of energy and carbon from human needs, 1975–2005. Ecol Econ 70:425–433
Steinberger J, Roberts T, Peters G, Baiochi G (2012) Pathways of human development and carbon emissions embodied in trade. Nat Clim Change 2:81–85
Sweidan O (2017) Economic performance and carbon intensity of human well-being: empirical evidence from the MENA region. J Environ Plan Manag. https://doi.org/10.1080/09640568.2017.1332986
Sweidan O, Alwaked A (2016) Economic development and the energy intensity of human well-being: evidence from the GCC countries. Renew Sustain Energy Rev 55:1363–1369
Tencza C, Stokes A, Preston S (2014) Factors responsible for mortality variation in the United States: a latent variable analysis. Demogr Res 21:27–70
Torras M, Boyce J (1998) Income, inequality, and pollution: a reassessment of the environmental Kuznets curves. Ecol Econ 25:147–160
Wang H, Schumacher A, Levitz C, Mokdad A, Murray C (2013) Left behind: widening disparities for males and females in US county life expectancy, 1985–2010. Popul Health Metr 11:8. https://doi.org/10.1186/1478-7954-11-8****
Wilmoth JR, Boe C, Barbieri M (2011) Geographic differences in life expectancy at age 50 in the United States compared with other high-income countries. In: Crimmins E, Preston S, Cohen B (eds) International differences in mortality at older ages. The National Academies Press, Washington, DC, pp 333–368
World Commission on Environment and Development (1987) Our common future. Oxford University Press, Oxford
York R (2012) Residualization is not the answer: rethinking how to address multicollinearity. Soc Sci Res 41:1379–1386