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INCOME INEQUALITY AND CARBON EMISSIONS IN POST-SOVIET NATIONS, 1992–2009[1]

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Abstract. *We assess the relationship between national-level income inequality and carbon dioxide emissions for a sample of eleven post-Soviet nations during the 1992 to 2009 period. Our findings suggest that both total and per capita emissions are positively associated with income inequality, measured as a Gini coefficient. These results are consistent with analytical perspectives that highlight how income inequality could lead to increases in carbon emissions as well as recent sociological research on income inequality and emissions for samples of nations in other structural and geographical contexts.*

Keywords: *income inequality, climate change, carbon emissions, ecological economics, environmental sociology, post-Soviet nations, sustainability.*

Introduction

Environmental sociologists and ecological economists have paid considerable attention to international and global inequalities in responsibility, vulnerability and governance concerning the human dimensions of climate change (Dunlap and Brulle 2015). Economically developed nations are disproportionately responsible for the accumulation of greenhouse gas emissions in the atmosphere (Jorgenson and Clark 2012; Knight and Schor 2014; Rosa and Dietz 2012), while poorer nations are most vulnerable to the harmful consequences of climate change (IPCC 2014; Roberts and Parks 2007). Vast power differences, embedded in structural inequalities among nations, have created nontrivial problems for international climate policy agreements and actions (Ciplet, Roberts and Khan 2015).

An emerging area of research attempts to increase our collective understanding of the complexities of inequality and climate change by focusing on how levels of income inequality *within* nations might be associated with levels of anthropogenic carbon emis-

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sions (e.g., Jorgenson et al. 2016; Knight, Schor and Jorgenson 2017). If it is found that income inequality is associated with higher levels of emissions, carefully planned strategies and initiatives to reduce income inequality could result in climate change mitigation, in addition to other associated social and environmental benefits (Wilkinson and Pickett 2011).

A limitation of the research on income inequality and emissions is that it has neglected to assess such socioenvironmental relationships for the post-Soviet nations that are located in Central and Eastern Europe and Eurasia. This limitation is surprising, given that a notable amount of research in recent years has focused on other human drivers of carbon emissions for these nations (Jorgenson, Clark and Giedraitis 2012; Jorgenson, Longhofer, Grant, Sie and Giedraitis 2017; York 2008) as well as various political-economic and demographic factors that influence their rising levels of income inequality (Mahutga and Bandelj 2008; Mahutga and Jorgenson 2016).

Right after the collapse of the Soviet Union, these nations experienced decreased levels of economic development and lower levels of human well-being (Myant and Drahokoupil 2010) as well as reduced energy use and carbon emissions (Jorgenson et al. 2014; York 2008). Then they all – to some extent – began transitioning away from centrally planned economies with few connections to the global economy and started building private markets (Stark and Bruszt 1998). For many of these nations, this involved focusing on different forms of export-oriented development (Bandelj and Mahutga 2010), which are oftentimes carbon-intensive processes (Rosa and Dietz 2012).

With such changes, in the recent years, the majority of the post-Soviet nations have experienced significant increases in electricity use per person, which is also carbon-intensive if the electricity is generated by fossil-fueled power plants (Jorgenson et al. 2017). According to the World Bank,[2] the average electric power consumption in the post-Soviet nations had increased from 3169 kilowatt hours per capita in the year 2003 to 3648 kilowatt hours per capita in the year 2013 (the most recent year for which these data are currently available for all post-Soviet nations), which is higher than the global averages of 2491 kilowatt hours per capita (in 2003) and 3104 kilowatt hours per capita (in 2013). An important note is that most post-Soviet nations have experienced an upswing in domestic income inequality as well (Mahutga and Jorgenson 2016).

The purpose of this study is to conduct a preliminary longitudinal analysis of the relationship between national carbon emissions and income inequality for a sample of post-Soviet nations. Prior to the analysis, we provide a short summary of analytical perspectives and recent research on income inequality and emissions.

[2] http://databank.worldbank.org/data/home.aspx (accessed August 4, 2017)

Brief Literature Review

We summarize two analytical perspectives that highlight how income inequality could lead to increases in carbon emissions. The first is a political economy approach, largely developed by economist James Boyce (1994; 2008), who argues that inequality is likely to be associated with higher levels of fossil fuel consumption and thus carbon emissions as well as other forms of environmental degradation. Boyce posits that for multiple reasons, the wealthy prefer more pollution. They are more likely to be owners of polluting firms, and they tend to consume more goods and services, which are, by themselves, energy intensive and thus carbon polluting. Also, the wealthy are better equipped to protect themselves from environmental harms while shifting such harms onto the poor, and the wealthy are likely to use their economic resources to gain political power, which they use to dominate the policy environment. Environmental sociologists have similarly argued that reducing environmental harms may first require a shift toward greater political and economic equality (Ciplet et al. 2015; Dietz et al. 2015; Downey 2015).

The second approach argues that higher income inequality facilitates consumption competition (Schor 1998), which leads to growth in carbon emissions. There are two potential pathways for this positive association between income inequality and emissions. The first, which is known as the Veblen Effect, is that inequality induces status consumption as households increase their spending to keep up with the visible lifestyles of higher-income households (Veblen 1934; Schor 1998). Second, income inequality has been shown to have a positive association with the level of working hours (Bowles and Park 2005), and recent studies have shown that increased working hours are drivers of energy consumption and CO_2 emissions via both their impacts on economic development and on the consumption choices of households (Fitzgerald et al. 2015; Knight, Rosa, and Schor 2013).

Drawing from the two analytical perspectives summarized in the preceding paragraphs, a recent strand of longitudinal research investigates the potential relationship between income inequality and carbon emissions. Jorgenson et al. (2016) find that among a sample of high-income nations, income inequality has a positive effect on national-level emissions, while for a sample of low income nations, the association between income inequality and emissions is nonsignificant. Results from a study by Knight, Schor and Jorgenson (2017) similarly show that among a sample of high income nations, wealth inequality is positively associated with national-level emissions. And sub-nationally, Jorgenson, Schor and Huang (2017) find that income inequality is positively associated with US state-level carbon emissions.

In a related area of recent research, Jorgenson (2015) finds that income inequality is positively associated with the carbon intensity of human well-being (i.e., the amount of carbon emitted per unit of human well-being) for a sample of OECD nations and for a sample of Non-OECD nations, and the positive association increases in magnitude through time for both groups of nations. Of particular relevance for the present study, Jorgenson, Alekseyko, and Giedraitis (2014) have found that for a sample of post-Soviet nations, income inequality is positively associated with the energy intensity of human well-being (i.e., the amount of fossil-fuel energy consumed per unit of human well-being), while controlling for various other factors.

We now turn to the analysis of income inequality and carbon emissions for a sample of post-Soviet nations.

Methods

The Sample

The analyzed sample consists of eighteen annual observations from 1992 to 2009 for eleven Post-Soviet nations, including Armenia, Azerbaijan, Belarus, Estonia, Georgia, Kazakhstan, the Kyrgyz Republic, Latvia, Lithuania, the Russian Federation and Ukraine. Overall, this results in a sample of 198 total observations. The limited availability of the independent variable of interest (i.e., income inequality measured as the Gini coefficient) restricts the sample to this time frame for these eleven nations. Ideally, we would prefer to include all post-Soviet nations in the analysis and for a wider time frame, but, like other research on the same category of nations (e.g., Jorgenson et al. 2012; 2015; Mahutga and Bandelj 2008; Mahutga and Jorgenson 2016; York 2008), data availability precludes us from doing so.

The Dependent Variables

We analyze two measures of anthropogenic carbon dioxide emissions: total emissions (in metric tons) and per capita emissions (metric tons per capita). Total emissions are the most important measure when considering climate change, given that it is the overall accumulation of emissions in the atmosphere that contributes to global warming. Per capita emissions are commonly treated as a type of inequality measure of carbon pollution. The atmosphere is viewed as global commons, where carbon pollution accumulates over time, and from this perspective, every person in the world has equal rights to the atmosphere, and the amount of allowable pollution should be determined on a per capita basis. Both measures account for carbon dioxide emissions stemming from the burning of fossil fuels and the manufacture of cement. These data were obtained from the World Bank's online Word Development Indicators DataBank.[3]

[3] http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators (accessed April 3, 2017).

The Independent Variables

Our key independent variable of interest is income inequality, measured as the Gini coefficient, which quantifies the degree of dispersion over a population and varies from 0 (perfect equality) to 1 (perfect inequality). Consistent with other recent studies of post-Soviet nations (e.g., Jorgenson et al. 2014; Mahutga and Bandelj 2008; Mahutga and Jorgenson 2016), we use the Gini coefficients for earnings based on employer surveys that are supplemented with Gini coefficients for income based on household surveys, which we obtained from TransMonEE (2012). Like all national-level data, these income inequality measures have their limitations in how they are measured and the extent to which they are valid for comparisons between nations and within nations through time. Nonetheless, they are currently the most comprehensive longitudinal data available on income inequality for the post-Soviet nations, and, as we discuss below, we employ 2-way fixed effects modeling techniques that allow for relatively rigorous hypothesis testing.

We include other measures that are commonly employed in analyses of national anthropogenic emissions, including GDP per capita, manufacturing as a percentage of GDP, exports as a percentage of GDP and the level of democratization. We also control for total population size in the models of total carbon emissions. With the exception of the democratization measure, these additional independent variables are obtained from the World Bank's online Word Development Indicators DataBank[4]

GDP per capita, which is measured in constant 2010 US dollars, is consistently found to be associated with higher total and per capita emissions in global samples of nations as well as in analyses of post-Soviet nations (e.g., Jorgenson and Clark 2012; Jorgenson, Clark and Giedraitis 2012; York 2008; York and McGee 2017). The relative size of a nation's manufacturing sector could increase energy consumption and thus carbon emissions, and past research on carbon emissions for global samples of nations (Rosa and Dietz 2012) as well as research on the energy intensity of human well-being for post-Soviet nations (Jorgenson et al. 2014) support this assertion.

Exports as a percentage of GDP, are included to account for the extent to which a nation is integrated in the world economy, and past research on samples of developing nations has found positive associations between carbon emissions and exports as a percentage of GDP (e.g., Roberts and Parks 2007). We use the combined "POLITY2" score to control for the level of democratization, which ranges from values of -10 to +10, where a value of -10 represents a strongly autocratic and +10 represents a strongly democratic political order. These data were obtained from the Integrated Network for Societal Conflict Research.[5] It is commonly argued that environmental protection, in-

[4] Ibid.

[5] (http://www.systemicpeace.org/inscr/inscr.htm. (accessed June 5, 2014).

cluding reduced greenhouse gas emissions, is enhanced where both policy capacity and responsiveness are high, and such conditions are more likely in nations with higher levels of democratization (Downey 2015; Ehrhardt-Martinez, Crenshaw and Jenkins 2002). Also, prior longitudinal research on post-Soviet nations finds that the energy intensity of human well-being is, on average, lower in nations with higher levels of democratization than in nations that are less democratic (Jorgenson et al. 2014).

Total population is based on the de facto definition, which counts all residents regardless of legal status or citizenship, except for refugees not permanently settled in the country of asylum, who are generally considered part of the population of their country of origin. As one would expect, population size is consistently shown to be a primary driver of total carbon emissions (e.g., Rosa and Dietz 2012; Rosa, York and Dietz 2004).

Model Estimation Technique

We use a time-series cross-sectional Prais-Winsten regression model with panel-corrected standard errors, allowing for disturbances that are heteroskedastic and contemporaneously correlated across panels (Beck and Katz 1995). We correct for AR(1) disturbances (i.e., first-order autocorrelation), and we estimate models with the AR(1) process common to all panels as well as specific to each panel. We employ dummy variables to control for both year-specific and nation-specific effects, the equivalent of a two-way fixed effects model (Allison 2009). We note that this technique controls out between-nation variation in favor of estimating within-nation effects, a common approach in analyses of the human drivers of carbon emissions (Marquart-Pyatt, Jorgenson, and Hamilton 2015). Given the limited sample size, the relatively large number of estimated coefficients (due to the nation-specific and year specific intercepts) and the hypothesized positive association between both dependent variables and the independent variable of interest, we conduct one-tailed tests of statistical significance, flagged at p-values of .01, .05 and .10.

All non-binary variables are transformed into logarithmic form, an established approach in research on the drivers of anthropogenic emissions (Rosa and Dietz 2012; York, Rosa and Dietz 2003). For such variables, the regression models estimate elasticity coefficients, where the coefficient for the independent variable is the estimated net percent change in the dependent variable associated with a one percent increase in the independent variable. We note that prior to logarithmic transformation, we add a constant of one to the Gini coefficients, since they, in original form, can range in values from zero to one. Table No. 2 (in the APPENDIX) reports the univariate descriptive statistics for the two dependent variables and the six independent variables included in the study (all in logarithmic form).

Results

The findings for the analysis are provided in Table No. 1. Two versions of the same model are estimated and reported for each of the dependent variables. Model A includes the AR(1) correction common to all panels, while Model B includes the panel-specific AR(1) correction. The close to perfect r-squared statistics for each estimated model are largely due to the nation-specific and year-specific intercepts that serve as the two-way fixed effects.

TABLE No. 1. **The elasticity coefficients for the regression of carbon dioxide emissions on income inequality and other independent variables: two-way fixed effects model estimates for 11 post-Soviet nations, 1992–2009.**

	Total Emissions	Total Emissions	Per Capita Emissions	Per Capita Emissions
	Model A	**Model B**	**Model A**	**Model B**
Gini Coefficient	.744*	.919**	.521*	.571**
	(.558)	(.552)	(.334)	(.338)
GDP Per Capita	.352***	.418***	.275***	.316***
	(.111)	(.107)	(.070)	(.064)
Manufacturing as % GDP	.099*	.060	.072**	.058*
	(.069)	(.068)	(.039)	(.038)
Exports as % GDP	-.021	-.012	-.018	-.006
	(.049)	(.047)	(.028)	(.027)
Democratization	.003	-.004	.006	.001
	(.052)	(.051)	(.029)	(.028)
Total Population	.603**	.486*		
	(.357)	(.342)		
Constant	-3.105	-1.716	-.998**	-1.262***
	(5.294)	(5.231)	(.553)	(.509)
R-sq	.993	.994	.969	.978
# of Estimated Coefficients	34	34	33	33

Notes: * p<.10, ** p<.05, *** p<.01 (one-tailed), panel-corrected standard errors in parentheses;
all non-binary variables are in logarithmic form (ln);
models include country-specific and year-specific intercepts;
Model A includes AR(1) correction common to all panels;
Model B includes panel-specific AR(1) correction;
N = 198, 18 annual observations for 11 nations.

Overall, the results suggest that income inequality, measured as the Gini coefficient, is positively associated with both total carbon emissions and per capita emissions. For total emissions, a one percent increase in income inequality is associated with a .744 percent increase in emissions in Model A and a .919 percent increase in emissions in Model B. For per capita emissions, a one percent increase in income inequality is associated with a .521 percent increase in emissions in Model A and a .571 percent increase in emissions in Model B.

Turning to the additional independent variables, GDP per capita is found to have a positive and statistically significant effect on both measures of emissions. Manufacturing as a percentage of GDP, exhibits a positive effect that is statistically significant in both models of per capita emissions as well as Model A for total emissions, while total population has a positive and statistically significant effect on total emissions in both Model A and Model B. The estimated effects of exports as a percentage of GDP and the level of democratization are nonsignificant in all models.

In a series of unreported sensitivity analyses, we estimated each model for both outcomes while systematically excluding one of the eleven nations. The results were all substantively consistent with the reported findings for the full sample. We also estimated models that include the quadratic for GDP per capita as well as models that include measures of urban population as a percentage of total population. The estimated effects of urban population and the quadratic for GDP per capita were nonsignificant, and their inclusion did not suppress the estimated effect of income inequality on either outcome.

Conclusion

The purpose of this preliminary study was to investigate the relationship between income inequality and anthropogenic carbon emissions for post-Soviet nations. Our results indicate that income inequality, measured as the Gini coefficient, is positively associated with both total and per capita emissions for the sample of 11 post-Soviet nations, at least for the 1992 to 2009 period. These findings are consistent with the political economy and status competition analytical perspectives concerning how income inequality could lead to increases in carbon emissions as well as the recent sociological research on income inequality and emissions for samples of nations in other structural and geographical contexts. Besides supporting the two analytical perspectives and helping to advance the growing body of research on inequality and emissions, this study also contributes to the scholarship on the socioenvironmental relationships for post-Soviet nations, further enhancing our collective understanding of the human dimensions of environmental change.

Like all research, this study has limitations. For example, due to data availability for the employed inequality measure, multiple post-Soviet nations are excluded from the analysis, and the Gini coefficient for the included nations is not currently available for years more recent than 2009. And while the Gini coefficient is the most widely employed measure of income inequality in research across the social sciences, it doesn't specify with precision where the actual inequality is within an income distribution. Ideally, like research on income inequality and carbon emissions for other nations (Knight, Schor and Jorgenson 2017) and subnational units (Jorgenson, Schor and Huang 2017), we would prefer to employ a variety of additional income inequality measures that focus on these sorts of characteristics, such as the income share of the top five percent and top ten percent, but these measures are currently unavailable for the post-Soviet nations.

We conclude by suggesting three potential future steps in this line of inquiry. First, given the findings for the present study, it would be important to conduct additional analyses that more closely identify the specific pathways through which income inequality affects carbon emissions in the post-Soviet nations in Central and Eastern Europe as well as Eurasia. Second, if appropriate data become available for the Gini coefficient and perhaps other income inequality measures, future research on inequality and national emissions for these nations would do well to expand the temporal scope of the analysis to years more recent than 2009. Finally, future research on other environmental outcomes in post-Soviet nations, such as industrial water pollution, ground-level air pollutants and land cover change should investigate the effects of income inequality as well.

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APPENDIX

TABLE No. 2. **Descriptive statistics.**

	Mean	Standard Deviation	Minimum	Maximum
Total Carbon Dioxide Emissions	10.393	1.883	7.741	14.547
Carbon Dioxide Emissions Per Capita	1.711	.679	.396	2.857
Gini Coefficient	.342	.044	.223	.419
GDP Per Capita	7.211	.860	5.432	8.864
Manufacturing as % GDP	2.822	.429	1.407	3.774
Exports as % GDP	3.751	.386	2.589	4.457
Democratization	2.368	.665	1.098	2.996
Total Population	15.873	1.316	14.104	18.817

Notes: all variables are in logarithmic form (ln); N = 198, 18 annual observations for 11 nations.