Is Labor Green?

A Cross-National Panel Analysis of Unionization and CO_2 Emissions

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ABSTRACT

We assess whether unionization of national workforces influences growth in national CO_2 emissions per capita. Political-economic theories in environmental sociology propose labor unions are an institution affecting environmental conditions. Yet, few studies have quantitatively assessed the influence of unionization on environmental outcomes using cross-national data. We estimate multilevel regression models using data on OECD-member nations from 1970-2014. Results indicate that unionization, measured as the percentage of workers who are union members, is negatively associated with CO_2 emissions per capita, even when controlling for labor conditions. This finding suggests that unionization may promote environmental protection at the national level.

Keywords: unions, treadmill of production, political-economy, CO_2 emissions

In light of the severe consequences anthropogenic climate change is likely to have on societies and ecosystems, and the fact that carbon dioxide (CO_2) emissions are the largest contributor to climate change, research on the social forces that influence CO_2 emissions, most of which stem from fossil fuel combustion, is essential. Previous cross-national research on structural drivers has demonstrated links between CO_2 emissions and demographic and political-economic factors such as the scale of economic activity as measured by gross domestic product (GDP), population, industrialization, urbanization, and world-system position (see for instance Rosa et al., 2015; York, Rosa, & Dietz, 2003a, 2003b; York, 2008; Jorgenson, Clark, & Kentor, 2010; Ergas & York, 2012; Jorgenson & Clark 2012; Greiner and McGee 2018). However, a gap in this research is a quantitative assessment of how the structure of labor relations – an important aspect of industrial and agricultural production processes – is connected with CO_2 emissions.

Treadmill of production (ToP) theory (Schnaiberg 1980; Gould, Pellow and Schnaiberg 2008), one of the predominant theories aiming to explain the forces behind environmental problems, argues capital, state, and labor work together towards economic growth, which serves to expand resource consumption and waste production, thereby exacerbating environmental problems. The treadmill metaphor refers to the processes set in motion by corporate efforts to expand profits via technological development and increased production and consumption. These processes lead to unemployment, due to mechanization, and environmental degradation stemming from growth in industrial activities. The loss of jobs and pollution necessitate further expansion of production to provide new jobs and fund environmental cleanup and protection efforts. Thus, societies are on a "treadmill" where they have to keep running to stay in place - i.e., the economy must continually grow to maintain jobs for workers and address the problems, social and environmental, created by growth in the first place.

Some scholars have developed a nuanced approach to understanding the ToP which suggests that although organized labor sometimes serves to accelerate the treadmill, it also can decelerate the treadmill as unions work to improve the health and quality of life of workers (Obach, 2002, 2004a, 2004b). Yet to our knowledge, there exists only one study (Roberts, Grimes, & Manale, 2003) that has assessed the influence of labor unions, along with other structural variables, on CO_2 emissions at the cross-national level. Roberts et al. (2003) found unionization rates to be negatively correlated with CO_2 emission intensity in nations, but they rely on cross-sectional data. Other research has examined unions and environmentalism through interviews and historical documents, but these studies do not systematically assess large-scale patterns in the environmental consequences of unions (see Dewey, 1998; Dreiling, 1998; Obach, 2002, 2004b; Mayer, 2009; Kojola, 2017). Therefore, it is worthwhile to assess whether unionization has measurable consequences on CO_2 emissions.

Unions can influence anthropogenic CO_2 emissions in various ways. We will explain further below that unions are a place for political advocacy. Unions can also play an important role in economic and management decisions through collective bargaining, thereby redistributing capital and resources to limit capital accumulation and promote generalized social benefits, including environmental protection (Obach, 2002, 2004a, 2004b). However, more research is needed to assess whether unions have broad structural effects on environmental outcomes. This article fills this gap by theorizing how labor may affect environmentally important actions and by providing an empirical assessment of whether unionization rates are connected with environmental problems. Specifically we use multilevel analysis of 34 OECD countries between 1970-2014 to assess whether the percentage of workers who belong to unions in nations is associated with CO_2 emissions per capita. Our results show that unionization is negatively

associated with CO_2 emissions per capita, even when controlling for labor conditions. This finding suggests that unionization may promote environmental protection at the national level.

Literature Review

The treadmill of production (ToP) is one of the most influential theoretical frameworks in environmental sociology and focuses on the role of political-economic dynamics in connection with environmental problems. Allan Schnaiberg (1980) introduced the ToP theory as a structural analysis of environmental problems where he incorporates political-economic theories including neo-Marxian monopoly capital to explain the rise of environmental degradation (Foster & York, 2004). A number of colleagues including Ken Gould, Adam Weinberg, and David N. Pellow worked with Schnaiberg to revisit the ToP over the years (Gould, Pellow, and Schnaiberg 2004, 2008; Pellow, Schnaiberg, and Weinberg 2000; Schnaiberg and Gould 1994; Schnaiberg, Pellow, and Weinberg 2002). The ToP is based on the recognition that economic growth requires large amounts of natural resources and produces large quantities of waste and thus causes environmental problems. The nature of the capitalist system is centered on production expansion and profits are used for capital growth. So as to maximize profits, capital endeavors to suppress worker's rights, environmental protection, and social service programs. Schnaiberg contextualizes the rise of environmental problems after World War II, noting that economic changes in most industrial nations encourage vast accumulation of capital while extracting natural resources and destroying the environment. These capitalist processes are being applied at accelerated rates with technologies needing more natural resources and energy consumption. As the name suggests, the treadmill illustrates how these economic processes continue on a seemingly endless pursuit.

The ToP has developed over time reflecting political-economic changes of the processes behind environmental degradation. Most notably, the initial ToP from 1980 did not carefully consider globalization or the distinctive dynamics specific to particular localities (Buttle 2004). Although the original focus of the ToP was on the United States after World War II, the logic of the treadmill can be applied to the dynamics of global corporate capitalism. Since Schnaiberg published in 1980, scholars have applied the theory to address issues of globalization by incorporating national and international divisions of labor, as well as the divide among countries in which production takes place and where consumption occurs. For instance, more recent work on the ToP examines how government officials promote neo-liberal policies of "free trade" that push environmental degradation from rich nations to poor nations (Gould et al. 2008). Jorgenson and Clark (2009) argue the ToP in conjunction with the ecologically unequal exchange theory help to explain how the structure of international trade works to benefit wealthy nations and destroy the environments of poorer nations. There is still room for theoretical expansions of the ToP to incorporate global capitalist dynamics of foreign investments and transnational trade (Jorgenson and Clark 2012).

There are various components to the ToP, but the piece most relevant here is the theorization of the alliance among the three key institutional actors driving the treadmill: the state, capital, and big labor. The alliance is also referred to as the growth coalition where the state, capital, and labor are working to accelerate the treadmill, since economic growth has benefits to each of them, but these three actors do not have the same power, motivations or general interests. Schnaiberg (1980) identifies the state, capital, and labor as institutional actors that have cooperative and competitive relationships towards production expansion. Capital plays the central role in production expansion and environmental harm. Despite the fact that capital

relies on the state and labor to maintain the ToP, it undermines the credibility of the state and labor when the treadmill system leads to unemployment and pollution. For instance, the state has a cooperative relationship with capital by supporting treadmill expansion through policies that encourage economic growth such as business-friendly tax legislation and deregulation (Schnaiberg & Gould, 1994). However, the state is left in a difficult position when government officials are held responsible due to public dissatisfaction about the undesirable results of the treadmill. Schnaiberg and Gould (1994) argued the state typically will not go against capital because the state functions more as a force for the elite class. Environmental sociologists argue that legislation aimed at protecting the environment has had only very modest effects on reducing environmental impacts in the production process in part because the state typically does not take actions that challenge corporate power (Foster, Clark, & York, 2010). Recycling is an example of the inadequacy of state supported environmental protections in the treadmill system. The expansion of recycling in the United States and other nations did little to conserve energy and resources and did not provide high paying jobs (Pellow et al. 2000).

Big labor is theorized to play an important role in the treadmill. Schnaiberg (1980) saw more potential for labor unions compared to the state when it comes to defying capital. Capital has a direct relationship with labor to produce commodities through labor power and technologies. Furthermore, capital seeks to maximize profits and worker productivity by lowering wages and increasing technological use. In contrast, labor seeks to increase workers' wages and employment. These labor demands put limits on capital, opening up the potential for labor to counter the exploitative tendencies of corporations. Although a goal of unions is to increase laborers' income, potentially making them supporters of the treadmill, labor unions also advocate for better working conditions, such as less exposure to environmental hazards, which

require employers to address the inherent social cost of maximizing profits. The rise of global capitalism pushes governments and global organizations to support a structure of international trade where capital displaces union jobs in rich nations to non-union jobs in poor nations. Indeed, unions have been on the decline since the 1970s due to globalized labor markets, international trade, and anti-union laws (Blanchflower 2007). In general, the state assists capital's interests in these actions by dismantling regulations and protections for worker interests (Oliver 2005). The treadmill system develops new technologies to expand production and reduce the power of labor by de-skilling jobs and replacing workers with machines. Thus, the ability of unions to advocate for higher wages and better working conditions has declined drastically over time, shifting their role within the ToP (Schnaiberg at al. 2002; Buttel 2004; Gould et al. 2008).

Despite their decline in power, labor unions remain involved in workplace decisions, which can lead them to be critical actors on the production process and subsequently on the environment. Labor unions and environmentalists engage in similar economic battles against big, centralized capital interests. In fact, labor unions may serve to challenge the ideological forces that perpetuate the treadmill (Gunderson 2017). In the initial ToP theory, organized labor and capital are identified as having a competitive relationship for the distribution of resources. As Obach (2004a) explains, unions can decelerate the treadmill by voicing concerns about environmental quality through collective bargaining actions and by redirecting resources into social and employee needs such as social programs, wages, public services, or healthcare services, instead of industrial expansion. Without these oversights, capital's elite class is more likely to engage in environmental and social exploitation.

The history of labor unions and environmentalism demonstrates the strategies labor unions can deploy to resist capital's drive for endless growth. Obach (2004a) extends the ToP

theory by showing that there are several mechanisms labor unions sometimes use to slow the treadmill of production. First, labor unions can encourage different types of labor practices. Unions often oppose corporations' push for automation. For instance, during the 1950s and 1960s, the American Federation of Labor and Congress of Industrial Organization (AFL-CIO) voiced concerns over the replacement of workers through technology by passing resolutions against automation (Obach 2004). Furthermore, AFL-CIO pursued efforts to compensate workers who lost their jobs due to technology. Second, labor unions can advocate for redistributing resources to social programs. Unions slow the treadmill by struggling to ensure a share of profits go to workers' benefits, such as health insurance and higher wages (Obach 2004). The treadmill slows down if surplus resources are placed towards social needs instead of profit expansion (Schnaiberg 1980).

Third, labor unions can emphasize other factors instead of solely profit. Unions can slow the treadmill by advocating for resources to be put towards improving working conditions. Organized labor has been influential on health and safety concerns, advocating for members' environmental safety in the workplace (Silverman, 2006). Unions have pushed for environmental reform by raising awareness of pollution in the workplace. For example, in the United States, the United Steelworkers conducted their own safety investigations on the impact of smog on workers (Dewey, 1998), and the United Farm Workers led by Cesar Chavez followed Rachel Carson's work to expose the harms of agricultural pesticides to workers and consumers. Subsequently, growth in public attention around occupational safety was followed by rising concerns on community safety from pollution. Labor unions outside of the United States have advocated for the environment through the workplace and beyond. For example, the Spanish labor union, Comisiones Obreras, is actively involved in occupational health and safety concerns at the

international level (Stevis, 2011). In Italy, labor unions fought against environmental industrial hazards and helped create the Public Health System and Labor Statute in their country (Barca, 2012).

Although work for environmental justice and protection for workers, such as occupational and community safety, does not directly reduce CO_2 emissions, a large part of pollution that harms workers derives from the use of fossil fuels. Thus, labor unions collectively working to reduce pollution exposure tend to pressure industries to decrease their use of fossil fuels, which in turn may help to suppress the growth rate of CO_2 emissions. Furthermore, Roberts et al. (2003) argue that (globally) the least efficient producers tend to be the most politically oppressive, and that labor unions are the key to carbon-efficiency.

Finally, labor unions have a history of supporting environmental stewardship. Labor activists and scholars have shown that, despite potential tensions, there are many instances of labor union collaborations with environmentalists, and that unions are a place for environmental advocacy (Mayer, 2009; Dewey, 1998). In the 1970s, the Australian labor union, the Builders Labourers Federation, was one of the key supporters of protecting the environment from unsustainable practices by withholding their labor in the "green bans" (Snell & Fairbrother, 2010). For that reason, the International Confederation of Free Trade Unions decided to include the "environment" within the Occupational Health, Safety, and Environment Working Party (Silverman, 2006). Labor unions from around the world have gathered to discuss the environment and expand worker's rights to include environmental rights (Rathzel & Uzzell, 2011). Based on the ToP and Obach's (2004a) understanding of labor's role in the treadmill, there are good reasons to expect labor unions to play a critical role in environmental politics.

Central traits of labor unions, including the fundamental concern for organizing solidarity for better working conditions, links workers collectively with environmental issues.

Despite the potential for labor-environment coalitions, there are instances around the world where labor unions have worked against environmental protection. Unions, seeking to protect jobs and wages, have often helped spur the treadmill by supporting economic initiatives pushed by corporations. Studies find that since workers are dependent on their employers for jobs, they can be blackmailed – meaning workers are under pressure to prioritize their individual interests over the collective union's interests – into supporting capital interests in industry, which potentially sets up an antagonistic relationship between labor and environmental groups (Kazis & Grossman, 1982). Specific industrial sectors, such as road construction and resource extraction, often take the position that "environmentalism kills jobs" or support weak ecological modernization efforts, which is often in conflict with other union organizations that support environmental protection and blue-green coalition building (Felli 2014; Estabrook, 2007; Rathzel & Uzzell, 2011). This can encourage public leaders and the media to use "jobs versus the environment" rhetoric, even though research shows that environmental protection does not typically contribute significantly to job losses (Freudenburg, Wilson, & O'Leary, 1998; Matthews, 2011; Bell & York, 2010; Kojola, 2017).

An example of the antagonism between workers and environmentalists that sometimes occurs is the battle over protection for the northern spotted owl in U.S. Pacific Northwest. Timber firms worked to subvert and undermine environmental protections so as to allow for continued clear-cutting of ancient forests (the owl's habitat) by claiming economic necessity (Foster, 1993). Here, the timber industry framed the issue as one where environmentalists were trying to push laws that would lead to job losses, thus setting up the idea that the conflict was

between workers and environmentalism (Freudenburg et al. 1998). Thompson and Tracy (1995) demonstrate a similar divide between environmental conservationists and timber workers in Western Australia. Similarly, a number of trade unions in Spain support mountaintop removal in the Laciana Valley arguing it will bring more jobs (Cabrejas, 2012). A more recent example of the battle between workers and environmentalists is the ongoing debate over the Keystone XL pipeline in North America where some unions supported the construction for jobs and economic growth and withdrew their support for the BlueGreen Alliance (Kojola, 2017). Nontheless, recent research found labor union households in the United States had equal strength of environmental concerns as non-union households even in weak economic periods, demonstrating that union members do not necessarily see a tension between supporting workers' interests and supporting environmental protection (Kojola at al 2014).

It is important to recognize that the effects of unions are mediated by their connections with various aspects of working conditions. Some scholars have examined the connection between working hours in the typical week and CO_2 emissions (Knight, Rosa, and Schor 2013) and energy consumption (Fitzgerald, Jorgenson, and Clark 2015) at the cross-national level, and found that more working hours is connected with higher emissions and energy consumption. Additionally, Fitzgerald, Schor, and Jorgenson (2018) found a similar connection between working hours and emissions across states in the United States. Since unions can affect working hours, these finding may be connected with unionization. This body of research suggests that it is important to control for various aspects of working conditions when assessing the effects of unionization, as we do below.

It is clear that more research is needed to assess the general connection between labor unions and the environment, especially at the global level because most studies focus locally

(Silverman, 2006). At the state-level in the United States, Dietz et al (2014) found unionization did not have an effect on CO_2 emissions when controlling for population, affluence, and degree of support for environmentalism. However, as noted above, there is a lack of cross-national research addressing the issue. Based on the ToP framework, we argue that the unionization of workers is a gauge to evaluate the strength of labor. In the literature we reviewed above, we identify several reasons to expect that in nations where labor is more powerful, CO_2 emissions may be lower than in nations with disempowered labor. Key among these are (1) unions often resist mechanization in the production process, and mechanization is energy (and therefore CO_2) intensive; (2) unions work to protect the health of workers from exposure to pollution, which may lead them to support regulations on fossil fuel, chemical, and other energy intensive sectors; and (3) more broadly, unions have the potential to resistant the power of corporate actors that drive the treadmill to endlessly expand production and consumption despite social and environmental harm. None of these are singular mechanisms, but rather tendencies that may structurally affect national fossil fuel consumption and, therefore, CO_2 emissions.

Here, we employ union membership as an indicator of union strength to evaluate the influence of labor unions on CO_2 emissions per capita. The union density measurement we use is commonly employed by other researchers (Sano & Williamson, 2008). It does not include those individuals not working or not actively looking for work such as prisoners and students. Scholars have used similar data to those we use to investigate the connections between union density and various social, economic, and institutional factors (Sano & Williamson, 2008; Checchi & Visser, 2005; Scruggs & Lange, 2002).

Hypotheses

Based on the discussion above, we hypothesize two alternative outcomes regarding the relationship between union density and CO_2 emissions. Each hypothesis is based on the question: Is a nation's union density associated with CO_2 emissions per capita?

H1: Nations with higher levels of unionized labor have lower levels of CO_2 emission per capita.

H2: Nations with higher levels of unionized labor have higher levels of CO_2 emissions per capita.

H1 is derived from Obach's (2004a) extension of the treadmill theory and assumes that in nations with highly unionized labor forces there will be greater opposition to the treadmill of production, which will suppress CO_2 emissions by reducing the reallocation of profits into fossil fuel intensive processes. Inversely, H2 is based on the implication in the original formulation of the treadmill theory (Schnaiberg 1980) that unions operate as a facet of the treadmill, and therefore nations with high union density will have relatively high CO_2 emissions because big labor helps to drive continual intensification of production.

Note that each hypothesis above is about the general environmental implications of the unionization of the labor force across nations and does not address the specifics of union participation particular to each nation. Further, it is worth noting that union strategies are not monolithic and are often adversarial to one another. Also, we are not assessing whether unions take specific actions that affect CO_2 emissions, but rather whether the degree of unionization in nations is connected with emissions through multiple potential routes. Union density may be interpreted as a general indicator of the relative strength of labor, and, therefore, any estimated

effects from unionization may not be directly traceable to specific acts of unions themselves, but rather may reflect how the power of labor affects production processes more generally. Therefore, we are cautious with our interpretations since both hypotheses are about the average consequences of the degree of unionization in nations. Additionally, since, of course, we are not using experimental data, we cannot establish causality with high confidence (this is a limitation of nearly all sociological research, since sociologists rarely work with experimental data). Rather our models assess whether the associations expected from the processes proposed by theory exist in the data. Therefore, where in the interpretation of our results we use the terminology of cause and effect, it should not be taken to mean that the statistical analyses alone are sufficient to establish such relationships, but rather that the associations we find fit with theorized causal processes. The theorized processes we discuss above are not mechanistic, but rather are structural and diffuse (i.e., there is a variety of routes by which unionization may promote or suppress processes leading to CO_2 emissions). Thus, theory suggests that unionization creates a context that shapes processes that influence CO_2 emissions. In this, the connection between unionization and CO_2 emissions is theorized to be more of a formal (structural) cause than an efficient one, although unions may in some instances specifically push for environmental reforms and thereby have a direct, efficient influence.

Data and Methods

We use multilevel regression models to assess the association between labor union membership rates and growth in CO_2 emissions per capita using cross-national panel data spanning 1970-2014 for the 34 nations in the Organization for Economic Cooperation and

Development (OECD)[1]. We focus on OECD nations because there is consistent and reliable data on union membership for each nation, which is not the case for most other nations in the world. It is important to note that because we focus on OECD nations we are only assessing the effects of union membership in relatively affluent industrialized economies. We chose 1970-2014 to allow for the widest number of observations, but for some models the coverage is only for 1991-2014 since some of our independent variables are not recorded for before this time. We end our timeframe in 2014 because that is the most recent year for which data are available for the dependent variable, CO_2 emission per capita. All data are from the World Bank's World Development Indicators (2018), with the exception of the data on union membership and working hours which were obtained from the OECD (2018). We include as control variables the factors that most consistently have been shown in a number of studies to be connected with CO_2 emissions (e.g., York, Rosa, & Dietz, 2003a; York, Rosa, & Dietz, 2003b; York, 2008; Jorgenson, Clark, & Kentor, 2010; Joregonson & Clark 2012; Ergas & York, 2012; Knight, Rosa, and Schor 2013). We also include variables that characterize the labor force, since these may be connected with unionization. Summary statistics for all variables are presented in Table 1.

We proceed with multilevel modeling for the following reasons: first, the data has a hierarchical format with yearly estimates (level 1) nested within countries (level 2). We expect there to be significant differences among countries and the multilevel format can examine this

[1] Latvia joined the OECD in 2016, bringing it to 35 members. We examine the 34 nations that were members as of 2014, the last year of our data: Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Republic of Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom, and United States.

variation. Second, multilevel modeling is more flexible with unbalanced panel data (Hox 2010; Singer and Willett 2003). We chose to proceed with a two-level random intercept model. We estimate the following model:

Micro:

$$CO2pc_{ti} = \beta_{0i}x_{0ti} + \beta_1 union_{ti} + \beta_2 GDPpc_{ti} + \beta_3\, GDPpc_{ti}^2 + \beta_4 age\_dep_{ti} + \beta_5 urban_{ti} + \beta_k year1971_{ti} + \cdots + \beta_k year2014_{ti} + e_{0ti}$$

Macro:

$$\beta_{0i} = \beta_0 + \mu_{0i}$$

Combined model

$$CO2pc_{ti} = \beta_0 + \beta_1 union_{ti} + \beta_2 GDPpc_{ti} + \beta_3\, GDPpc_{ti}^2 + \beta_4 age\_dep_{ti} + \beta_5 urban_{ti} + \beta_k year1971_{ti} + \cdots + \beta_k year2014_{ti} + e_{0ti} + \mu_{0i}$$

Level 2: $[\mu_{0i}] \sim N(0, \sigma_{u0}^2)$

Level 1: $[e_{0ti}] \sim N(0, \sigma_{e0}^2)$

where t represents year and i represents country.

<< INSERT TABLE 1>>

Dependent Variable

CO_2 emissions per capita: emissions stemming from the combustion of fossil fuels (including solid, liquid, and gas fuels, as well as gas flaring) and the production of cement, in metric tons per capita.

Independent Variables

Unionization: Percentage of the workforce that is unionized. This is our main variable of interest. The OECD provided union density measurements from two sources: administrative and survey. The availability of the measurements varied between countries. For example, United States only offered survey data while Spain offered administrative and survey data. In nations that have both, the correlation between administrative and survey data is very high (over .99). We did the following procedure to maximize the coverage of the union density variable: if both measures were available, we took the average of the administrative and survey measurements. If one measure was available and other was not, we took the measurement that was available.

GDP per capita: 1000s of constant year 2010 US$. The connection between economic growth and CO_2 emissions is well established. We include a quadratic (squared) version of GDP per capita to assess whether there is a non-linear relationship between economic growth and emissions.

Urbanization: percentage of population living in urban areas. Urbanization is an indicator of modernization and development and has been linked in a number of studies to CO_2 emissions.

Age dependency ratio: the ratio of people under 15 years of age and over 64 to those 15-64. Since age structure is connected with labor force participation, this is an important control variable.

Unemployment: percentage of the workforce that is unemployed. The level of unemployment is likely to affect both the power of labor and the level of production, and therefore it is necessary to incorporate the unemployment rate in our models.

Employed in industry: percentage of the workforce employed in the industrial sector. Since unionization is typically highest in the industrial sector, it is necessary to control for the share of the workforce in this sector.

Working hours: average annual working hours for the labor force. Previous research (Knight, Rosa and Schor 2013) demonstrates higher working hours is connected with higher emissions. Hours calculated include all types of workers including full-time, part-time, part-year, and overtime.

Part-time workers: the percentage of workers working fewer than 30-35 hours per week. We include part-time workers as a labor condition control because part-time work captures non-standard employment. Part-time work does not include the benefits and stability of full-time employment. This variable was provided from the World Bank and is estimated by the International Labor Organization.

Wage and salaried workers: the percentage of workers with "paid employment jobs" with explicit or implicit employment contracts. Wage and salaried workers captures the type of economy. A high proportion of wage and salaried workers indicates a formal economy, while a

lower number of wage and salaried workers indicates an informal economy. This variable was provided from the World Bank and is estimated by the International Labor Organization.

<<INSERT TABLE 2>>

Results

The logic of multilevel modeling is to fit a variety of models beginning with the null model. Our goal is to assess the extent to which unionization is correlated with emissions independent of traditional drivers of emissions and other indicators of labor force participation. Results from the multilevel analyses are presented in Table 2. The null model (Model 1) has a fixed effect β_0, referred to as the constant/intercept, of 9.141 indicating the overall average of CO_2 emissions per capita across all countries and observations. The null model, and all subsequent models, have two random effects: first, the within-country variance (σ_{e0}^2) is 3.167 and second, the between country variance (σ_{u0}^2) is 23.248. We calculated the intraclass correlation coefficient to estimate the amount of variance explained at the level-2, i.e., the country level. For the null model the intraclass correlation coefficient is about 88.11%.

We added predictors based on our theory-driven hypotheses to Model 2 which includes unionization as well other important control variables indicated from previous research including GDP per capita, age dependency ratio, and urbanization. For Model 2 we used only controls that have good data coverage, so as to maximize the number of observations included in the models. Thus, model 2 include data from 1970-2014. Model 2 has a fixed intercept of 3.612 and includes year-dummies in order to control for period effects. The fixed effect of union density is negative and statistically significant, demonstrating that an increase in union density is associated with a

decrease of CO_2 emission per capita while controlling for other variables. Model 2 further demonstrates that an increase in age dependency ratio (e.g. working age population) is associated with a decrease in CO_2 emission per capita. The results also show that an increase in urbanization corresponds with an increase in CO_2 emission per capita. Finally, GDP per capita has a quadratic relationship. Results from the likelihood ratio test showed Model 2 is superior to Model 1.

The next model evaluates whether unions remain significant to carbon dioxide emissions per capita in presence of weak and strong labor conditions. Model 3 includes additional labor controls of working hours, part-time workers, wage and salaried workers, unemployment, and industrialization. Each labor control variable measures integral elements to job employment such as productivity, precarious employment, formal economy, and industry. For example, an average annual of working hours does not capture type of employment (i.e. a worker with multiple part-time jobs without benefits versus a worker with one full-time job with benefits) and industry (Lambert et al 2012).

It is important to note that Model 3 includes roughly half of the observations from the previous models, covering only the period 1991-2014, due to missing data on the additional control variables. The number of countries represented declined to 33 because Iceland does not provide data on annual working hours. In Model 3[2], unions, age dependency ratio, and urbanization all maintain their direction and their significance. Only the quadratic term for GDP

[2] An alternative modeling approach is to focus on total rather than per capita emissions. In models not presented here, we estimated STIRPAT (York et al. 2003a, 2003b) versions of our models, where population was included as an independent variable, total emissions was used as the dependent variable, and all variables were logged. These models suggest findings similar to those we present here. For example, in the STIPRAT version of Model 3, unionization has a significant (at the .001 level) negative effect on emissions, and population has a coefficient of almost exactly 1.0, which indicates that it proportionately scales emissions (which supports the implicit assumption behind using per capita values).

per capita is significant. Amongst the labor control variables, Model 3 indicate that increases in the percentage of workers in industrial jobs is associated with an increase in CO_2 emission per capita. Furthermore, Model 3 demonstrates that increases in part-time and wage and salaried workers corresponds with an increase in CO_2 emissions per capita. Working hours and unemployment did not have significant effects.

Finally, Model 4 includes only variables that had significant effects in Model 2 or 3. All variables remain significant except GDP per capita and the age dependency ratio. Model 2 is a parsimonious model with the widest coverage. Model 4 is perhaps the most important model, since it controls for a wide range of factors, and yet still has reasonable coverage. Model 3 has low coverage compared to Model 1 and Model 4, but it has the most extensive controls. Nonetheless, all of the models indicate that unionization has a significant, negative effect on emissions that is independent of other drivers of emissions and other indicators of labor force participation. These findings provide clear support for the hypothesis that nations with more highly unionized workforces have lower CO_2 emissions per capita than nations with a lower proportion of unionized employees (H1), and contradicts the hypothesis that unionization contributes to higher emissions (H2).

Discussion & Conclusion

Previous research demonstrates moments of antagonism between labor unions and environmentalists (Foster, 1993; Kojola, 2017). Despite these tensions, labor unions have played an important role in environmental activism (Dewey, 1998; Mayer, 2009). Workplaces are an arena where many economic and environmental decisions take place, and labor unions are an institution affecting environmental conditions. Here, we empirically assessed the connection

between the degree of unionization in OECD nations and CO_2 emissions in those nations. Our analysis shows that nations with highly unionized workforces have lower CO_2 emissions than nations with less unionized workforces, controlling for a number of factors. This finding demonstrates that labor unions are an important part of understanding anthropogenic drivers of CO_2 emissions, and suggests that labor unions may have environmentally beneficial effects on production processes. Our analysis demonstrates that efforts for workers rights around the world may help efforts to reduce CO_2 emission and to mitigate climate change.

The treadmill of production theory as further refined by Obach (2004a) provides a framework for explaining why labor unions mitigate environmental impacts. Unions and environmentalist organizations have a common struggle in fighting against the excesses of the global capitalist system. There are a variety of ways unions can act as propellers of changes in environmental practices through political advocacy and collective bargaining agreements. Labor unions are organizations that provide a space for discussions of social and environmental issues. The treadmill slows down if surplus resources are placed towards social needs instead of profit expansion (Schnaiberg, 1980), and unions appear to encourage a focus on social benefits. If profits are directed toward the general social good, there is less opportunity for the elites to reinvest surplus into practices harmful to the environment.

Future research should investigate the nuances of labor unions and environmental impacts such as the mechanisms within workplace arenas and collective bargaining processes where workers make decisions that influence the environment. Even further, future research should explore case studies in specific nations of the local dynamics among labor unions and environmental impacts. Our analysis suggests that the strength of labor unions may help to

mitigate environmental problems by encouraging environmental stewardship, redistributing resources to social programs, and emphasizing factors other than corporate profits.

Table 1: Descriptive statistics of all variables

	mean	s	min	max	n
CO_2 emission per capita	9.500	4.832	1.223	40.590	1148
union density	37.718	21.532	5.291	92.468	1148
GDP per capita	$32,318.53	$17,266.45	1,815.02	108,577.40	1148
age dependency ratio	51.936	7.170	36.323	100.819	1148
urbanization (%)	75.244	11.339	38.234	97.818	1148
working hours	1757.1	202.2	1362.1	2422.0	916
unemployment (%)	7.65	3.99	1.78	27.47	701
industrialization (%)	26.678	5.824	10.983	43.543	701
part-time (%)	24.88	8.99	4.96	46.21	627
wage and salaried workers (%)	82.339	8.253	45.206	93.471	701

Table 2: Multilevel regression results of factors influencing CO_2 emissions per capita

Variable	Model 1 *(1970-2014)*	Model 2 *(1970-2014)*	Model 3 *(1991-2014)*	Model 4 *(1991-2014)*
Time (level 1) variables				
union density (%)		-.028 (.007)***	-.046 (.012)***	-.033 (.012)**
GDP per capita (1000s US$)		.207 (.026)***	-.016 (.035)	.017 (.031)
(GDP per capita)^2		-.002 (.000)***	.001 (.000)**	.000 (.000)
age dependency		-.072 (.011)***	-.084 (.022)***	-.028 (.020)
urbanization (%)		.129 (.014)***	.099 (.022)***	.082 (.023)***
working hours			-.002 (.001)	
unemployment (%)			-.033 (.019)	
Industrial work (%)			.184 (.031)***	.261 (.027)***
part-time (%)			.053 (.015)***	.054 (.014)***
wage and salaried workers (%)			.119 (.022)***	.079 (.022)***
year dummies				
1971		-.257 (.434)		
1972		-.053 (.441)		
1973		.273 (.443)		
1974		-.180 (.444)		
1975		-.797 (.434)		
1976		-.665 (.446)		
1977		-1.008 (.438)*		
1978		-.680 (.436)		
1979		-.532 (.444)		
1980		1.101 (.434)*		
1981		-1.774 (.443)***		
1982		-2.016 (.455)***		
1983		2.486 (.448)***		
1984		-2.370 (.453)***		
1985		-2.393 (.458)***		
1986		-2.469 (.462)***		
1987		-2.768 (.462)***		
1988		-2.575 (.473)***		
1989		-2.346 (.475)***		
1990		-2.712 (.477)***		
1991		-2.611 (.481)***		
1992		-2.753 (.478)***	-.156 (.309)	-.156 (.305)
1993		-2.698 (.480)***	-.004 (.318)	.491 (.308)
1994		-2.560 (.483)***	.124 (.322)	.156 (.316)
1995		-2.591 (.480)***	-.018 (.293)	.061 (.293)

1996		-2.316 (.491)***	.415 (.295)	.538 (.294)
1997		-2.864 (.502)***	.195 (.298)	.308 (.293)
1998		-3.048 (.500)***	-.002 (.297)	.079 (.296)
1999		-2.847 (.523)***	-.133 (.315)	.154 (.313)
2000		-2.960 (.527)***	-.550 (.325)	-.108 (.322)
2001		-2.948 (.528)***	-.444 (.332)	.086 (.327)
2002		-3.054 (.536)***	-.493 (.343)	.135 (.334)
2003		-3.029 (.539)***	-.190 (349)	.414 (.342)
2004		-3.001 (.552)***	-.384 (.361)	.299 (.352)
2005		-3.254 (.559)***	-.725 (.373)^	.009 (.364)
2006		-3.216 (.567)***	-.666 (.388)^	.127 (.376)
2007		-3.389 (.581)***	-1.054 (.403)**	-.169 (.389)
2008		-3.611 (.576)***	-1.137 (.406)**	-.264 (.390)
2009		-4.215 (.570)***	-1.538 (.406)***	-.587 (.393)
2010		-3.928 (.575)***	-1.022 (.417)*	-.084 (.404)
2011		-4.314 (.578)***	-1.464 (.423)**	-.519 (.411)
2012		-4.539 (.582)***	-1.705 (.431)***	-.734 (.418)
2013		-4.620 (.582)***	-1.696 (.436)***	-.727 (.425)
2014		-4.946 (.590)***	-2.115 (.449)***	-1.084 (.436)*
Constant (β_0)	9.141 (.829)***	3.612 (1.554)*	-4.097 (3.982)	-9.900 (3.011)**
variance terms				
σ^2_{e0}	3.137	1.885	0.448	0.529
σ^2_{u0}	23.248	19.17	11.386	13.657
N (total)	1148	1148	519	555
number of countries	34	34	33	34

p<.05;**p<.01;p<.001**

Note: For Model 2, 1970 is the reference category for the year-dummies. For Models 3 and 4, 1991 is the reference category.

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