Giving Workers the 'Green Light': Defining Green Jobs and Exploring their Distribution in the US

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Giving Workers the ‘Green’ Light: Defining Green Jobs and Exploring their Distribution in the US

by

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Honors Thesis submitted to the Peter T. Paul College of Business and Economics

University of New Hampshire

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Abstract

As the United States continues to adopt sustainable practices and policies to combat climate change, it is important to consider how these green changes affect the workforce. The term ‘Green Jobs’ has become the colloquial term to refer to sustainable occupations, and despite its popularity in the literature, it often has different meanings in different settings. Our first goal was to explore these definitions and establish one to contextualize our research. We used data from the Occupational Information Network, and used their green job definition, which classifies jobs as green if, and how, they are impacted by the greening economy.

Next, we investigated how green jobs compare to non-green jobs. Understanding the different levels of education, experience and training required for the different types of jobs could be useful for policymakers hoping to increase green job counts in their area. We found that directly green jobs tend to need more experience and training than non-green jobs, while indirectly green jobs need less education. This suggests that green jobs are often more specialized than non-green jobs. Finally, we explored the distribution of green jobs across states. We found that political affiliation and oil reserves have the strongest correlation to green jobs.

Our research supports previous findings about the differences between green and non-green jobs and extends prior research by describing the characteristics of states that are related to green job levels. It also provides policymakers with an idea of how the greening economy might affect their workers. We propose that further investigation could find which specific green jobs are driving these differences and could establish stronger links between state characteristics and green job levels.
Introduction

Climate change, pollution, and other environmental dangers continue to threaten global communities and affect our way of life. As economies adapt to these new conditions, greater focus is placed on creating sustainable practices to alleviate further harm. Governments, businesses, and organizations are evolving to incorporate sustainability in their core values, even those whose goals are not directly related to the environment. This has created a new wave of sustainably impactful jobs, dubbed “green jobs”. As defined by the United Nations Environment Programme (UNEP) in 2008, green jobs are jobs that “work in agricultural, manufacturing, research and development (R&D), administrative, and service activities that contribute substantially to preserving or restoring environmental quality” (UN Environmental Programme, 2008). Green jobs are an important part of creating long term, sustainable solutions for the world’s climate challenges.

The US is no exception to these trends, and green jobs exist across American industries. However, the US’s unique natural resources, cultures, and populations vary drastically across the country leading to interesting comparisons of the green job market from state to state. To support the growth of these valuable occupations, governments must understand how green jobs differ from non-green jobs, and how these differences translate to policy implications. In this paper, we will compare the levels of education, experience, and training typical for green and non-green jobs. This comparison will indicate to policymakers if extra support is needed for green workers, like training programs to transition workers from non-green jobs to similar green ones. This will address our first research question, “Are there differences between green and non-green jobs?”
To extend this idea, we will investigate the distribution of green jobs across the country and look for state characteristics that are associated with high concentrations of green jobs. We developed hypotheses about the qualities that we expect to have an impact and will use various measures to test them.

First, we expect that the past political leanings of a state will impact its green job levels. Left-leaning states might be more likely to have passed progressive climate policy in the past, supporting the growth of green jobs over the previous few decades.

Our second hypothesis is that a state’s commitment to education will affect the level of green jobs in the state. If green jobs require higher levels of education on average, then we predict that states that spend more on their students will have more green workers.

Our third hypothesis is that the natural resources in a state will be correlated with its green jobs. Specifically, states with fossil fuel energy reserves and strong energy industries will have more green jobs. We expect that the skills and knowledge current fossil fuel workers have will translate into green occupations. While there may be some reverse causality between a state’s energy capabilities and green jobs, we are trying to observe a connection between the two and therefore are not worried about endogeneity.

Using these hypotheses, we will seek to answer the question “What is the distribution of green jobs across states in the US, and are there state attributes that are related to green jobs?” Our results will provide insight into what factors are influential on the development of green jobs.
Defining Green Jobs

The idea of ‘Green Jobs’ has existed for decades, although precise definitions of the term have differed across research. One of the earliest official definitions comes from the 2008 *Green Jobs: Towards Decent Work in a Sustainable, Low-Carbon World* report by the United Nations Environmental Programme (UNEP), defining green jobs as “work in agricultural, manufacturing, research and development (R&D), administrative, and service activities that contribute substantially to preserving or restoring environmental quality” (UN Environmental Programme, 2008). This definition is still used (Stanef-Puică et al., 2022) along with similar descriptions that progress the idea. For example, the International Labor Organization (ILO) defines green jobs as “decent jobs that contribute to preserve or restore the environment, be they in traditional sectors such as manufacturing and construction, or in new, emerging green sectors such as renewable energy and energy efficiency” (United Nations ILO, 2016). These definitions help identify the fundamental characteristics of green jobs that are agreed upon between definitions. Green jobs are occupations that benefit the environment, and they can exist across all sectors.

For our analysis, we will be using job classifications from the Occupational Information Network (O*NET) and will therefore use their definition of green jobs. The O*NET is a Department of Labor sponsored database that classifies, tracks, and provides descriptions of US occupations and work activities. In 2008, the O*NET began a project to investigate how green economic activity impacts existing jobs, and if it generates new jobs. First, the researchers created a definition for the green economy, saying “The green economy encompasses the economic activity related to reducing the use of fossil fuels, decreasing pollution and greenhouse gas emissions, increasing the efficiency of energy usage, recycling materials, and developing and
adopting renewable sources of energy.” (Dierdorff et al., 2009). Next, instead of specifically defining green jobs, they used their definition of the green economy to describe the ‘greening’ of the workforce. Jobs considered to be greening were assigned one of three green categories depending on the extent to which the green economy affects them.

Other researchers have also used the O*NET definition in their analysis of green jobs. We reviewed a paper by Bowen et al. that compared green and non-green jobs. In their research, they used the green categories defined by the O*NET to explore how easily workers in non-green jobs could transition to green ones. Bowen et al. provided a strong example of how the O*NET classifications can be used and learned from, which supported our choice of definition. We also replicated some exploratory analysis from Bowen et al. that was relevant to our research questions.

The first green category is Green Increased Demand occupations. Increased Demand (ID) jobs do not change because of green economic activity but are required in greater numbers to support the sustainable growth. An example of an ID job as classified by the O*NET is Electrical Power Line Installers and Repairers. While their tasks are not necessarily sustainable, they will be necessary as the grid evolves to include more renewable and clean energy, like solar and wind. ID jobs are sometimes considered to be ‘indirectly green’ as their purposes and tasks are not inherently green (Bowen et al., 2018).

The second category of O*NET green jobs is Enhanced Skills (ES) occupations. ES jobs retain their original purpose but may need to acquire new skills or adapt to new tasks during economic greening. One example of an ES job as classified by the O*NET is Urban and Regional Planners. In an economy prioritizing sustainability, planners will need to learn new
ways to do their job as best as possible. ES occupations often need additional training or education to meet the new requirements of the job.

The final O*NET category is New & Emerging (NE) green jobs. NE occupations are created to fill a unique mix of worker skills and requirements that are born out of economic greening. These jobs are substantially different from prior O*NET occupations, and therefore require a new classification. Examples of NE jobs include Climate Change analysts, Fuel Cell Technicians, and Recycling Coordinators. NE and ES jobs are sometimes considered ‘directly green’ jobs, since their tasks directly pertain to sustainable goals (Bowen et al., 2018).

Data and Methods

Data

As discussed, the O*NET was a valuable tool for investigating green jobs. However, it also provided many other statistics including the average education, experience, and training levels for all jobs. The scales used for these ratings are ordinal, and unique to each descriptor.

Education is rated on a scale of 1-12, with significant milestones at 2, 6, 8, and 11 representing High School Diploma, Bachelor’s Degree, Master’s Degree, and Doctoral Degree respectively.

Related work experience is measured on a scale of 1-11, with values less than 6 indicating a year or less of experience. On-the-job training is measured on a scale of 1-9 with values under 5 indicating 6 months or less of job training.

Since we were interested in investigating employment levels in different states, we also gathered employment data from the Bureau of Labor Statistics (BLS) Occupational Employment
and Wage Statistics (OEWS) estimates at the state and national levels. Using crosswalks provided by the O*NET, occupational data classified by 8-digit SOC codes were aggregated to the 6-digit level, allowing us to merge the occupational and employment data.

We also gathered data to test our hypothesis about the effects of education, political affiliation, and natural resources on a state’s level of green jobs. For this information, a variety of sources were used. For education, we used a measure from the National Science Foundation (NSF) of the state support in dollars for higher education per full-time equivalent student (National Science Board, 2023). For political affiliation, each state was assigned a category based on the general election results in the state over the past 6 election cycles. States with at least 5 Democrat voting results were labeled D (for Blue/Democrat), states with at least 5 Republican voting results were labeled R (for Red/Republican) and states with less that 5 of the same voting results were labeled P (for Purple/ Mixed Results) (270toWin, 2024). Finally, to capture the effect of natural resources, we found records of states measurable oil and coal reserves from the Energy Information Administration (Energy Information Administration, 2021).

In addition to the data included to test our hypotheses, we included two other variables that we anticipated would be significant. First was a basic measure of population density for each state, taken from the US Census Bureau (U.S. Census Bureau, 2021). This measure is intended to capture the differences in the labor force of urban and rural areas. Next, we considered if a state’s past commitment to energy standards would affect their current green job levels. This is related to our hypothesis about political affiliation, but is more specific to green policies, and what the state has done in the past. For this, we gathered data about state level energy standards dating pre-2010, from the National Conference of State Legislatures (NCSL, 2021). Using this data, we
compiled the variables to create a dataset with 51 observations (one for each state and the District of Columbia) and the descriptors above for each state.

Exploratory Data Analysis

Before diving into our regression, we used some basic exploratory data analysis to investigate the differences between green and non-green jobs and explore their distribution in the US. First, we replicated work by Bowen et al. comparing jobs across education, experience, and training levels.

<table>
<thead>
<tr>
<th>Table 1: Comparing Green and Non-Green Jobs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skill Measure</td>
</tr>
<tr>
<td>Education (1-12 Scale)</td>
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<tr>
<td></td>
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<td></td>
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<tr>
<td></td>
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<tr>
<td>Related Work Experience (Scale 1-11)</td>
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<td></td>
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<tr>
<td>On the Job Training (Scale 1-9)</td>
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</tbody>
</table>

* Indicates significantly different from Non-green at a level of 0.1

Our results compare well to those done by Bowen et al. in their 2018 paper. We found that Enhanced Skills and New & Emerging green jobs tend to need more related work experience and training on average than Non-green jobs. Increased Demand green jobs require less
education on average than Non-green jobs, while ES and NE jobs were not significantly different. While these are simple measures, they help give an idea of the skill levels of the different green job categories. They also suggest that ES and NE jobs require more specialization than Non-green jobs on average. This makes sense, as these categories are defined by the new tasks and skills required in a greener economy.

Following these descriptive statistics, we visualized the green job levels across the US using heat maps. We were looking for any regional patterns that might be linked to our hypotheses, like Southern oil states having greater numbers of green jobs. While there is some regionality, it is difficult to tell from these initial tests what is connected to our hypotheses.

Increased Demand Green Jobs per 1000

(Fig. 1.1)
DEFINING GREEN JOBS AND EXPLORING THEIR DISTRIBUTION IN THE US

Enhanced Skills Green Jobs per 1000

(Fig. 1.2)

New and Emerging Green Jobs per 1000

(Fig. 1.3)
In addition to our green job data, we also gathered basic descriptive statistics for the explanatory variables to be used in our model.

<table>
<thead>
<tr>
<th>Variable (n = 51)</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spending per FTES</td>
<td>8686.68</td>
<td>5199.86</td>
</tr>
<tr>
<td>Population Density</td>
<td>417.88</td>
<td>1518.32</td>
</tr>
<tr>
<td>Oil Reserves = 1</td>
<td>0.27</td>
<td></td>
</tr>
<tr>
<td>Coal Reserves = 1</td>
<td>0.35</td>
<td></td>
</tr>
<tr>
<td>Energy Standards pre-2010 = 1</td>
<td>0.69</td>
<td></td>
</tr>
<tr>
<td>Party Red</td>
<td>0.48</td>
<td></td>
</tr>
<tr>
<td>Party Blue</td>
<td>0.44</td>
<td></td>
</tr>
<tr>
<td>Party Purple</td>
<td>0.1</td>
<td></td>
</tr>
</tbody>
</table>

Model

To address our hypotheses, we used a linear regression model structured as follows to test for the significance of each variable.

\[ \text{GreenPer1000} = \beta_{1:2}(\text{OverallParty}) + \beta_3(\text{FTESSpending}) + \beta_4(\text{OilReserves}) + \beta_5(\text{CoalReserves}) + \beta_6(\text{PopulationDensity}) + \beta_7(\text{Energy Standards Pre-2010}) + e_i \]

GreenPer1000: The number of green jobs of a specified category (ID/ES/NE) per 1000 employed people in a state. The regression was run 3 separate times, using a different category of green job each time, allowing the results to be compared across the three types. The different categories of green jobs are important, because they tell us different details about the states’ green labor force.
ID jobs are representative of potential green human capital, while ES and NE jobs are the existing green jobs. By running a regression with each category, we can observe which types of states are associated with potential or existing green labor.

OverallParty: A categorical variable indicating the states party affiliation based on historical election results since 2000. The categories are labeled as B (Blue/Democrat), R (Red/Republican), or P (Purple/Mixed Results). B is used at the omitted category in the regression.

FTESSpending: State spending on higher education per Full-Time Equivalent Students in dollars.

OilReserves: A binary variable returned as 1 if a state has measurable oil reserves, and 0 otherwise.

CoalReserves: A binary variable returned as 1 if a state has measurable coal reserves, and 0 otherwise.

PopulationDensity: State population density, measured as 1000 people per square mile.

Energy Standards Pre-2010: A binary variable returned as 1 if the state had energy standards before 2010, and 0 otherwise.

e: Error term

While creating our model, we used a few sensitivity checks to improve our model. We tested using the log values of the GreenPer1000, FTESSpending, and PopulationDensity. None of these changes improved the model, or affected our conclusions. We also tested a model that used the total green jobs in the state, adding up all ID, ES, and NE jobs. This model led to less
significant results, which is explained by the disproportionate number of ID and ES jobs compared to NE jobs. Using the green categories as our dependent variable led to more insightful results, which we discuss in a later section.

Results

We used our model to test which explanatory variables were significant indicators of green job levels. Our results are divided into three sections, one for each category of green job.

| Table 3: Estimated Coefficients (and Standard Error) |
|---------------------------------|----------------|----------------|----------------|
|                                 | New & Emerging | Enhanced Skills | Increased Demand |
| Intercept                       | 2.851 (0.588)  | 91.769 (6.310)  | 91.290 (7.176)  |
| Party: Purple                   | -0.268 (-0.496)| 5.902 (5.325)   | 6.999 (6.056)   |
| Party: Red                      | -0.886 (0.368) | 9.274 (4.146)   | 16.470 (4.715)  |
| FTESpend                       | -0.008 (0.037) | 0.299 (0.399)   | -0.655 (0.453)  |
| Oil Reserves                    | 1.063 (0.394)  | -0.234 (4.228)  | -10.230 (4.809) |
| Coal Reserves                   | 0.002 (0.354)  | 3.763 (3.805)   | 6.987 (4.327)   |
| Pop. Density                   | 0.0007 (0.0001)| 0.0006 (0.001)  | -0.004 (0.002)  |
| Energy Standards pre 2010      | -0.595 (0.391) | 4.704 (4.253)   | 0.998 (4.837)   |
| Adjusted R-Squared             | 0.546          | 0.0491          | 0.560           |

For Increased Demand green jobs, there were a few significant variables. First, we expect Red states to have 16.47 more ID jobs per 1000 than Blue states on average, ceteris paribus. We also expect states with measurable oil reserves to have 10.23 less ID jobs per 1000 than states...
without oil reserves on average, ceteris paribus. Finally, we expect states with higher population density to have less ID jobs on average, ceteris paribus.

Compared to ID and NE green jobs, the Enhanced Skills regression showed fewer significant variables. Only political party was significant and suggests that Red states will have 9.27 more Enhanced Skills jobs per 1000 than Blue states on average, ceteris paribus.

The New & Emerging regression shared similar results to the ID model, with political affiliation, Oil reserves, and population density being significant. We expect Red states to have 0.89 less NE jobs per 1000 than Blue states on average, and states with oil reserves to have 1.06 more NE jobs than states without oil reserves on average, ceteris paribus. States with greater population density are also expected to have more NE workers on average, although the coefficient is very small.

**Discussion**

Considering our regression results, we found multiple interesting insights. First, only the political affiliation variable was significant in the ES model. This is a surprising result, as both the ID and NE models produced multiple significant results. This begs the question, what is different about ES jobs that they are seemingly randomly distributed across states? We sought answers first from checking our heat map in Fig 1.2. While it does demonstrate that there are some areas with higher counts of ES workers, a more in-depth consideration of what specific jobs or industries are driving these numbers could provide more answers.

Due to the insignificance of the ES results, we focus our discussion on the ID and NE results, and how they inform our hypotheses. First, our model found no significant connection between education spending and green employment levels in states. Our measure of education,
higher education spending per full-time equivalent student, sought to capture how improving education could correlate with more green workers. There are some flaws with the measure that could’ve impacted the results. For example, many college students will end up working in other states than the one they attended school in. This demonstrates that there is a lot of overlap in the investments and benefits states pursue with education spending. Other population measures, such as the number of citizens with a college degree, might be better able to capture a relationship between education and green job rates, but our results found no significant evidence.

We were also interested in finding a connection between a state’s political affiliation and its green job levels, and our model provides some answers. Our findings suggest that there is a significant difference between Red and Blue states in terms of their ID and NE populations, with Red states having more ID and less NE workers on average. Red states’ reluctance to pursue green initiatives and policies could explain the NE deficit, as they are not creating the environment for NE jobs to exist. Since NE occupations are unique to green economic activity, it is not surprising that less enthusiastic states have less NE workers. Contrastingly, Red states are expected to have about 16.5 more ID jobs per 1000 on average than blue states. This may be indicative of the kinds of jobs that are classified as ID, like more blue-collar work, or of the industries with more ID workers, like energy.

Our final hypothesis was that the natural resources in a state would correlate with the green jobs in the state. In this area, we found a significant connection between oil reserves and the number of ID and NE jobs. However, having measurable oil reserves was positively correlated with having NE jobs, and negatively correlated with having ID jobs. This difference in relationships was unique to the natural resource variable, and presents an interesting story. While our research is observational, we can propose an idea for why this outcome occurred. In a state
with an oil industry, economic greening means changing from oil to clean or renewable energy. When this occurs, the workers who are specialized in oil would not be able to easily transition, so those jobs are lost, explaining the decrease in ID jobs compared to non-oil states. Meanwhile, the growing renewable sector will require new workers, who would fall into the NE category, explaining the increase in NE workers compared to non-oil states. By digging into what jobs are driving these numbers, future researchers may be able to further explain these unexpected results.

**Conclusions**

While our research is generally observational and cannot draw clear causality between state characteristics and green job levels, there are some lessons that can be learned from it that could be valuable to policymakers and future researchers. First, we support the findings of prior research, that green jobs (ES and NE in particular) are more specialized, and require more work experience and job training, and often more education. If leaders hope to bolster green growth in their state, they could support programs to provide workers with the extra education and training they need to be successful in their green roles.

Another potential lesson comes from the ID results for Red states. Based on our model, Red states have more ID jobs per 1000 than Blue states. Since ID jobs experience greater demand and increased employment during economic greening, this finding suggests that Red states would create more of these jobs by investing in green initiatives and projects. While this does not take into account the non-green jobs that would also be affected, it does provide some justification for embracing green change in traditionally reluctant Red states.
Our main finding from our regression is that there are state attributes that are correlated with green employment levels. We found that political affiliation, population density, and oil reserves are all related to green jobs, in both positive and negative ways. However, our research does not answer why these correlations occur, or if there are certain industries that are driving these relationships. Future research could investigate these questions, which would provide policymakers with even more valuable insight. Economic greening is inevitable as the US becomes more sustainable, so understanding how these changes affect the workforce, and how the nation can maximize the benefits for its workers, will be valuable knowledge.

References


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