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## Socioeconomic Attributes' Relationship to Green Commercial Office Buildings

Tianyang Zhou  
Colby College, [tzhou@colby.edu](mailto:tzhou@colby.edu)

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## Socioeconomic Attributes' Relationship to Green Commercial Office Buildings

### Cover Page Footnote

I would like to thank professor Nathan Chan, who introduced me to a huge variety of voluntary and information-based approaches to environmental management. With topics and theories I have learnt throughout his seminar discussion, I found my research interest in socio-economic factors' effects on commercial building sectors. I greatly appreciate professor Chan for his guidance and constructive suggestions during my study.

## 1. Introduction

In both theoretical analysis and empirical studies, economists demonstrated that consumers generally respond to eco-labeling positively when making purchasing decisions (Grankvist, 2004; Rodríguez-Ibeas, 2007; Newell and Siikamäki, 2013; Chan and Gillingham, 2014). People prefer greener products for various reasons: better quality, generated additional social welfare, corporate social responsibility, warm-glow effect from being altruistic, and peer effects in the community (Thøgersen, 2000; Eichholtz et al., 2010; Delmas and Lessem, 2014). Among all incentives to purchase green products, the increasingly strong awareness to protect the environment is the most dominant factor. The public's apparent willingness to use its purchasing power as a means to protect the environment has been increasing, as evidenced by many case studies, including dolphin-safe tuna (D'Souza, 2000; Teisl et al., 2002; Baird and Quastel, 2011) organic foods (Dimitri and Greene, 2002; Pimentel, 2005), and sustainably certified wood product (Ozanne and Vlosky, 1997; O'Brien and Teisl, 2004).

Socioeconomic status has important implications for consumer behavior, especially when comes to green products (Michael and Becker, 1973; Vinson et al, 1997; Straughan and Roberts, 1999). Scholars often find that demographic criteria play a central role to some degree for green product consumption, because when the consumers are more educated and exposed to the value of green goods, the purchase intent rises (Schlegelmilch et al., 1996; Mainieri et al., 1997;). Does high socioeconomic status always lead to high acceptance of green goods? I am interested in studying the influence of socioeconomic status' on the real estate sector. Since economists already thoroughly studied the relationship between socioeconomic attributes and residential as well as public buildings (Green, 2004; Eves and Kippes, 2010; Mwasha, 2011), I will focus my study particularly in the commercial office buildings.

Many green products' benefits are still ambiguous, such as hybrid electric vehicles (Taylor et al., 2010). Yet, researchers have proved that green buildings are superior to the common constructions with high cost-effectiveness and low environmental impact. Therefore, green building is appropriate for this case study. Green buildings are the buildings and constructions that are built or renovated using durable, environmentally friendly, non-toxic, energy efficient and recyclable construction materials. Based on the belief that eco-labeling is an effective way to differentiate products, and increases consumer's willingness to pay (Conrad, 2005),

plenty of researchers had already conducted studies on the eco-labels in the real estate market, various forms of green building certification, for investor's reference (Chau and Chuang, 2553; Fuerst and McAllister 2009; Alexander et al. 2012; Nyikos et al. 2012). The certification of a green building or constructions provides information, including a likely higher construction cost and an expected lower operating cost in the long term, to the tenants and investors.

The most prevalent certification in the United States is Leadership in Energy and Environmental Design (LEED) green building certification program, which is developed by the U.S. Green Building Council (USGBC). The LEED green building certification program is a rating system that consists of sets of evaluation for environmentally sustainable construction in six categories of assessment: sustainability of the site, water efficiency, energy and atmosphere, materials and resources, indoor environmental quality, and innovation and design process. Started from April 2009, a consolidated LEED rating system, LEED v3, assesses projects on a scale of 100 points, with six bonus points for green innovative design and four bonus point for the project's special importance in its region (U.S. Green Building Council, n.d. a). The project can be certified as a LEED building once it reaches 40 points in LEED v3, and it will be granted silver if reaches 50 points, good for 60 points, and Platinum for 80 points and above. The latest LEED rating system, LEEDv4 was introduced in November 2013, however, it will not be fully recognized till October 2016. The LEED rating system is well recognized in the United States, not only because it is standardized criteria, but also because the LEED rating system is monitored consistently (U.S. Green Building Council, n.d. b). All LEED projects are actively reviewed by over 12,000 USGBC organizational partners and more than 20,000 professional members. The growth of USGBC members is rapid, and in the past decade, the numbers of LEED buildings doubled every two years (Fuerst, 2009).

Investing in LEED buildings is a way that investors and tenants can express their interests in raising the awareness of the importance of protecting the environment at large; Meanwhile, the Green buildings are also cost-effective in the long run (Fuerst and McAllister, 2011a). LEED buildings have been proven as energy efficient: on average, the energy consumption reduces by 18-39% compared to the average standard (Newsham et al. 2012). Furthermore, in the US commercial office market, LEED certification will gain the lessors a rental premium around 3-

5%, and it will gain the investors a sale price premium around 25% (Fuerst and McAllister, 2011b).

This paper focuses on the implication of the socioeconomic attributes of a state on its green commercial office space. I hypothesize that high socioeconomic status lead to green office building adoption. Additionally, I suppose that high levels of LEED certification are more sensitive to socioeconomic attributes, in other words, the marginal effect of socioeconomic attributes will influence the high levels LEED certified buildings more than the inferior levels. Socioeconomic attributes will also affect on the types of LEED certified projects differently.

## **2. Literature Review**

### *2.1 Public and residential buildings and socioeconomics*

Given the advantages in energy saving and emission reduction, many decision makers at state or municipality level have developed policies about green buildings practice in various forms: supporting the green building paradigms, advising green building benefits and providing guidance for LEED certification, constructing green public buildings, offering social or financial incentives for green building certification, or even progressively mandating green buildings outcomes in designed cities and regions (Pearce et al., 2007; Simons et al., 2009). Green public buildings generally help to save taxpayers' money, reduce greenhouse gas emission and extend infrastructure capacity. Colorado, Delaware, Maryland, Nevada, and Oregon included investing in green buildings in their budget, and various municipalities adopted fee reimbursement programs for public buildings to become LEED certified (Cidell and Cope, 2014; Simcoe and Toffel, 2014).

Retzlaff (2009) found the one of commonly mandated policy is to designate all newly constructed public building in one zoning districts to be green building certified. Such municipal policies have a strong impact on the acceptance of green building certification in the public eyes, as the idea of green building increases exposure on the news. As environmental policymaking influences public's opinion, the public attitude also impacts on the public green buildings as well. May and Koski (2007) discovered that, governors, as the representatives of public attitudes, often consider environmental sustainability policies in state requirements for governmental buildings, and sometimes choose to designate green building mandates. However, the mandates are less likely is issued in the Republican

governing states. Meanwhile, social and economic indicators also contribute to the green buildings policies; states with less average income and employment rate are less likely to designate zoning areas to adopt green building policies (Hofferbert, 1966; Wedding and Crawford-Brown, 2007).

While studies show a significant and positive influence of the demographic features for green real estate in the public sector, such findings are extended to the green residential sector as well. Brounen and Kok (2011) found that neighborhood characteristics have a distinct impact on residential housing's perspective on energy improvement. Park et al. (2013) revealed that a strong relationship between socio-demographic characteristics and preferences for the environmental factors of residential buildings to a certain degree. Ganguly et al. (2013) stated that household owners' education and environmental awareness determine the use of certified wood and their use of the LEED program.

## *2.2 Shortcomings of prior studies*

The previous studies reviewed LEED certification relationship to socioeconomic features of the green building site are majorly focused on the public and residential buildings. Yet, there has been little analysis focusing on how socioeconomic features may affect the green buildings in commercial sectors. After preliminary research, I decide to concentrate my paper on the commercial office buildings. A few of reasons make the study of commercial office buildings more appealing than reporting on the whole commercial real estate: First, the information about LEED ratings on commercial office spaces is generally more than the other commercial units. Second, the commercial office buildings are concentrated in the metropolitan area and relatively highly populated locations, therefore, I expect the factors that influence the interest in LEED certified commercial office buildings are homogeneous across states. Third, because LEED certified buildings require significantly more in construction and certification process, commercial office building investors are more likely to invest in green buildings to gain the price premium.

Unlike either public buildings or residential buildings, commercial office buildings lay in between public and private divisions. The commercial buildings are belonged to firms and institutions; however, the employees' attitudes and environmental awareness also affected the organizations' preference for green

office. Not only because an improved interior environmental design of green offices improves employee productivity (Singh et al., 2010), but also the implementation of environmental-friendly practices in companies and institutions is affected by employee's environmental knowledge and commitment (Fernández, 2003). I expect to see a similar trend in the green commercial office properties (LEED-certified) as the green residential and public buildings: States with high socioeconomic status will be more likely to own more LEED certified buildings, especially in the higher level (Silver, Gold, and Platinum) of LEED certifications. This paper seeks to make contributions to the green real estate literature, by investigating whether green commercial offices interest is influenced by economic and sociological measurement of a state, as well as what kinds of green office projects may be affected the greatest.

### 3. Data Collection

The data for LEED certificated commercial office buildings are collected from USGBC (2010). Information of commercial office locations, property type, certification level, and certification date are available. Table 1 shows the summary statistics of LEED project identified for this study.

Table 1. LEED commercial office buildings per capita at state level summary statistics

Level/Type	Total	Mean	Std. Dev.	Min	Max
Certified	1176	23.05882	27.61913	1	162
Silver	316	6.196078	7.987539	0	48
Gold	412	8.078431	11.56174	0	72
Platinum	108	2.117647	3.456282	0	20
Commercial	780	7.795203	11.25223	1.090597	83.70619
Core	276	4.606993	6.386051	0.9517266	47.38086
Existing	247	1.598549	2.089033	0	14.21426
New	679	0.4609496	1.334129	0	9.476173
Other	19	1.276026	1.963471	0	12.6349
Total	2000	39.21569	48.97563	1	302

Note: The LEED commercial offices listed “Other” when one project is not categorized as any of the subcategories, or not registered for any subcategories.

There are LEED commercial office buildings in all 50 states, and Washington, D.C. To generalize the amount of LEED commercial office buildings in each state, the quantity of LEED commercial office buildings in each state is divided by million populations. As introduced previously, there are four levels of LEED certifications in LEED v3 rating system: LEED certified, silver, gold, platinum. Before the consolidation in 2009, there were four different LEED rating systems (U.S. Green Building Council, n.d. b): The most common LEED rating system used was the LEED for New Construction (LEED-NC) rating system, which measures the performance of newly constructed buildings with green renovations. The LEED for commercial interiors (LEED-CI) is the second most adopted rating system, and it is designed to assess the existed building’s tenant improvements and refurbishments that do not involve building shell and structure (Diamond, 2006). Two other LEED rating systems are also adopted for suitable projects. The LEED Core and Shell (LEED-CS) system covers developers who have less than 50 percent control of tenant improvement, and LEED for Existing Buildings (LEED-EB) is a rating system used on ongoing building operations that the application for the LEED certification initiated after the project started. Four rating systems have slightly different requirements for the level of standards in each assessing category. After the consolidation of LEED v3, all the previous projects are identified as LEED certified buildings. LEED v3 also encompasses five overarching categories, and four of the subcategories correspond to the specialties available under the commercial office buildings: LEED for Commercial Interiors, LEED for Core & Shell, LEED for Existing Buildings, and LEED for New Construction.

Tables 2 and 3 present explanatory variable definitions and descriptive statistics for socioeconomic attributes used for this study.

Table 2. Explanatory variable definitions

Variables	Description
Urban	Percentage of urban area in a state
Female	Percentage of female population in a state
Work	Percentage of population from 18 to 65 years old



Minority	Percentage of minority population
H_I	Average household income (thousand dollars)
Green	Location quotients measure the concentration of environmental organization
Politics	Politics=1, if Democratic candidate won in 2012 presidential election
Vote	Percentage of vote Democratic candidate won in 2012 presidential election
LEdu	Percentage of population have an educational attainment lower than bachelor degree
HEdu	Percentage of population have an educational attainment higher than bachelor degree
M_LEdu	Percentage of male population have an educational attainment lower than bachelor degree
M_HEdu	Percentage of male population have an educational attainment higher than bachelor degree
F_LEdu	Percentage of female population have an educational attainment lower than bachelor degree
F_HEdu	Percentage of female population have an educational attainment higher than bachelor degree

Table 3. Explanatory variable summary statistics

Variable	Mean	Std. Dev.	Min	Max
Urban	9.228431	16.55112	0.05	100
Female	50.64682	0.8185227	47.77721	52.66367
Work	62.81396	1.790318	59.39411	71.67398
Minority	23.0749	13.60686	4.915672	74.81257
H_I	71.20655	11.84678	53.272	102.655
Green	0.9698039	0.6034484	0.11	2.47
Politics	0.5490196	0.5025426	0	1
Vote	49.02569	11.81094	24.75	90.91

LEdu	71.08837	5.95949	46.51249	81.15738
HEdu	10.84899	3.77877	7.17626	30.52227
M_LEdu	71.26916	6.226	45.31396	81.53762
M_HEdu	83.06491	14.96555	36.36417	119.2566
F_LEdu	70.90849	5.83933	47.57067	80.79866
F_HEdu	10.7184	3.76776	6.71103	30.08672

The urban area data is accessed from 2010 Census Urban and Rural Classification and Urban Area Criteria. The Census Bureau's urban areas include densely developed territory, and encompass residential, commercial, and other non-residential urban land uses. Two types of urban areas are counted for the urban areas: Urbanized Areas (UAs) of 50,000 or more people; Urban Clusters (UCs) of at least 2,500 and less than 50,000 people. I expect the percentage of urban areas is positively correlated to the LEED commercial office buildings per capita. The census data of each state are accessed from American Community Survey (ACS), 2011-2013 ACS 3-year Estimates. Gender, age, race, income, education level, and education level by gender are collected. Arcury (1990) found that females have less environmental knowledge measures than the counterpart, and incomes as well as knowledge have positive correlations with environmental knowledge. So I expect a high female population has a negative correlation with the LEED commercial office buildings acceptance and the same pattern for income and education.

To measure the environmental awareness of each state, I use the environmental organization member measurement, location quotient (LQ), which is evaluated by Wikle (1995). The LQ identifying the membership level in 18 environmental interest groups is weighted by spatial measures. The high LQ value indicates the presence of proportionally more environmentalists, and I expect high LQ value associated with high LEED commercial office buildings per capita. The LQ value of each state is presented in Table 4. The political stance is assigned by the United States 57th quadrennial presidential election in 2012. The political attitude is a dummy variable, and if Democratic candidate won at the state, the political attitude=1. As an alternative, the liberal standpoints also measure the

political stance, assessed by the percentage of vote Democratic candidate got in each state. I expect the liberal political environment will positively impact on the LEED commercial office buildings per capita.

Table 4. Green quotient (GQ) of every state

State	GQ	State	GQ	State	GQ
District of Columbia	2.47	Virginia	1.14	Indiana	0.54
Vermont	2.43	Pennsylvania	1.07	Kansas	0.53
Connecticut	1.95	New Mexico	1.06	South Carolina	0.49
Hawaii	1.83	Illinois	1.00	Texas	0.49
Maine	1.75	Montana	0.99	Georgia	0.48
New Hampshire	1.72	Florida	0.97	Nebraska	0.47
Colorado	1.67	Nevada	0.95	Iowa	0.42
Oregon	1.64	Wisconsin	0.91	Tennessee	0.39
Massachusetts	1.63	Minnesota	0.90	Kentucky	0.34
Maryland	1.61	Wyoming	0.83	Oklahoma	0.31
Washington	1.55	Ohio	0.80	Louisiana	0.30
New Jersey	1.54	Michigan	0.78	Alabama	0.26
Delaware	1.53	Idaho	0.74	Arkansas	0.25
California	1.50	Alaska	0.68	West Virginia	0.25
New York	1.44	Utah	0.64	South Dakota	0.21
Arizona	1.31	North Carolina	0.62	Mississippi	0.11
Rhode Island	1.26	Missouri	0.60	North Dakota	0.11

#### 4. Empiric studies

##### 4.1 *The regression model*

To investigate how the socioeconomic factors influence the adoption of LEED certificated buildings in the commercial office sector, I use the standard valuation model: the adoption of LEED certifications is related to total population, population density, male population, elderly population, youth population, white racial, higher education (above high school), average household income, and individual income per capita.

$$Y_i = \alpha + \beta_i * \vec{X}_i + \gamma_{political} * Politics + \varepsilon_i \quad (1)$$

In the formulation represented by equation (1), the dependent variable is the LEED buildings per capita.  $\alpha$ ,  $\beta$ , and  $\gamma$  are estimated coefficients, and  $\varepsilon$  is an error term.  $\vec{X}_i$  is the vector of socioeconomic characteristics of state  $i$ . and  $Politics$  is a dummy variable indicating the political environment of each state,  $Politics=1$  if Democratic candidate won in 2012 presidential election.

#### 4.2 Results

Table 5 presents results from estimation of socioeconomic attributes on the LEED commercial office buildings in general, using total LEED commercial office buildings per capita as the dependent variable. I use four different models to estimate, with various combinations of different variables to evaluate the effects of the political environment and education level. Political attitude is a binary variable while the percentage of votes is a continuum indicator of the scale of the political attitude. For education level, I used both whole population data and gender-divided data.

Table 5. Estimation of overall socioeconomic attributes on LEED commercial office buildings

	1.a	1.b	1.c	1.d
Urban	0.3358148***	0.3280752***	0.2774544***	0.2601071***
Female	-8.146998***	-7.904266***	-6.966183***	-7.054619***
Work	0.6400402	0.6454991	1.738342***	1.670818***
Minority	0.2084418***	0.2035493***	0.2080141***	0.1852817***
H_I	-0.9401094***	-0.9175617***	-0.9029995***	-0.8763355***
Green	-2.906863*	-2.259231	-2.177208	-2.603179
Politics	1.169955		1.123837	
Vote		0.0011681		0.0873164
LEdu	-0.5366662*	-0.5335919*		
HEdu	3.092219***	3.048812***		
M_LEdu			-3.790615***	-3.902294***
M_HEdu			-4.155282***	-4.214193***
F_LEdu			0.52153	0.6378131
F_HEdu			1.110304	1.122573
Cons	446.0244***	432.1761***	596.3601***	601.1496***
R <sup>2</sup>	0.8595	0.8581	0.8772	0.8775

\*Statistically significant at the 10% level.

\*\*Statistically significant at the 5% level.

\*\*\*Statistically significant at the 1% level.

The result shows that the percentages of urban area, minority population, and highly educated population all have significant positive effects on the adoption of LEED certifications in commercial office buildings. High educational attainment plays a major role: one more percentage point of highly educated population ratio will increase roughly three commercial buildings per capita. The percentages of female population, and population with relatively low educational attainment all have negative significant value. Female population ratio is the greatest unconstructive influence, and one more percentage point of female population ratio will decrease at least seven LEED commercial buildings per capita. The result supports my hypothesis that certain high socioeconomic attributes positively correlated with LEED commercial office buildings per capita, and the people with a high educational degree are more likely to be aware of the benefits of green buildings, thereby more likely to support green commercial offices. The negative estimated coefficient of low educational level once again reinforces that education is a determining factor for LEED commercial office buildings supports. The estimated coefficients of the percentage of the working force population, and political attitude are positive, yet not all statistically significant. Nevertheless, this

estimate also supports the hypothesis that high socioeconomic status positively impacts on LEED commercial office buildings per capita. Unexpectedly, household income and green organization memberships have moderate inverse relationship with LEED certification in commercial office. One of the potential explanations is that the cross-sectional data analysis may include some state-specific features that are included in those estimates, and those features decrease the power of those socioeconomic attributes.

For the estimation of gender-divided educational level's impact on LEED commercial office building estimation, both estimates low level and high education level of the male population are negative and significant, and both estimates low level and high education level of the female population are positive yet insignificant. This further investigates on the education level's influence on LEED commercial office building adoption rate: male residents with bachelor degrees are more supportive of LEED commercial office building, while female residents with bachelor degrees may be less supportive of LEED commercial office building.

To investigate the orders of socioeconomic status' effect on different levels and types of LEED certified commercial office buildings, I use varied levels and types of LEED commercial office buildings per capita as the dependent variables. Table 6 presents estimations of socioeconomic attributes on LEED commercial office buildings across different levels, using the same models as the estimation for all LEED commercial office buildings. As the estimation for general implications, the result shows that the percentages of urban area, minority population, and working force population all have positive effects on the adoption of LEED certifications in commercial office buildings, and most of the estimates are significant. The magnitudes of the estimates decrease as the LEED level increases. The estimated coefficients for political attitude are positive, yet mostly not statistically significant, and the largest estimate for political influence is the platinum level LEED commercial office buildings. Yet, the estimates for the percentage of the female population and green organization membership are negative, and the magnitude commonly increases as certification level increases. Those outcomes agree with the general estimation, however, the weights of those estimates largely do not increase for higher levels of LEED certifications.

Table 6. Estimation of socioeconomic attributes on different levels of LEED commercial office buildings

	1.a	2.a	3.a	4.a	5.a	1.b	2.b	3.b	4.b	5.b
Urban	0.3358148***	0.1745887***	0.0707809***	0.0684235***	0.0439835***	0.3280752***	0.176984***	0.0695548***	0.0664733***	0.04083***
Female	-8.146998***	-4.387832***	-1.646827***	-1.657639***	-0.8175508***	-7.904266***	-4.217476***	-1.635622***	-1.59888***	-0.7846936***
Work	0.6400402	0.4213033	-0.2524413**	0.1665554*	0.0440129	0.6454991	0.506506*	-0.2612218**	0.1670795	0.0228594
Minority	0.2084418***	0.0930975***	0.0294815**	0.0581766***	0.0246393***	0.2035493***	0.1027498***	0.027803**	0.056864***	0.0204563***
H_I	-0.9401094***	-0.4510438***	-0.1856349***	-0.2182058***	-0.1124773***	-0.9175617***	-0.4534941	-0.1825654***	-0.2125685***	-0.1045084***
Green	-2.906863*	-1.452273	-0.2297479	-0.1898252	-0.6322459**	-2.259231	-0.889486	-0.2118691	-0.034111	-0.5737064*
Politics	1.169955	-0.0067327	0.1459009	0.2913284	0.3810954*					
Vote						0.0011681	-0.04547	0.0051923	0.0007364	0.0126121
LEdu	-0.5366662*	-0.1515145	-0.0433649	-0.2924564**	-0.0706636*	-0.3335919*	-0.1738412	-0.0405051	-0.2914722***	-0.0636601
HEdu	3.092219***	1.856332***	0.6919201***	0.2320521*	0.3501233***	3.048812***	1.79967***	0.6928243***	0.2218009	0.3512956***
Cons	446.0244***	220.7746***	108.1432***	106.9514***	47.76614***	432.1761***	210.6059***	107.5538***	103.6035***	46.0125***
R <sup>2</sup>	0.8595	0.8271	0.713	0.7441	0.8051	0.8581	0.8285	0.7125	0.7417	0.7972

	1.c	2.c	3.c	4.c	5.c	1.d	2.d	3.d	4.d	5.d
Urban	0.2774544***	0.1400145***	0.0590749***	0.0560417***	0.0369001***	0.2601071***	0.140142***	0.0555931***	0.0519696***	0.0316235***
Female	-6.966183***	-3.497622***	-1.452221***	-1.50381***	-0.7731112***	-7.054619***	-3.504045***	-1.491561***	-1.518334***	-0.7874117***
Work	1.738342***	1.11016***	-0.0363603	0.3829998**	0.1593642*	1.670818***	1.109613***	-0.05556046	0.3680691**	0.1406832*
Minority	0.2080141***	0.0924223***	0.0294629**	0.0583332***	0.0247905***	0.1852817***	0.0924435***	0.0241045**	0.0531257***	0.0181357**
H_I	-0.9029995***	-0.4234109***	-0.1789274***	-0.2131731***	-0.1107462***	-0.8763355***	-0.4238615***	-0.1749649***	-0.2066896***	-0.102182***
Green	-2.177208	-0.9518615	-0.0938659	-0.068768	-0.5792408*	-2.603179	-0.9702543	-0.2967924	-0.1497839	-0.6704704**
Politics	1.123837	-0.0247175	0.1357674	0.2783158	0.3711656*					
Vote						0.0873164	0.0003655	0.0230202	0.0196085	0.0247656*
M_LEdu	-3.790615***	-2.353621***	-0.7429394***	-0.5952143	-0.3616967***	-3.902294***	-2.354682***	-0.7756214***	-0.6197703**	-0.3923146***
M_HEdu	-4.155282***	-2.901761***	-0.8167299**	-0.4551067***	-0.275571*	-4.214193***	-2.902848***	-0.8368486**	-0.4675949*	-0.2907821*
F_LEdu	0.52153	0.5766774	0.077258	0.1397138	-0.0242428	0.6378131	0.5765624	0.104632	0.1663578	0.0098105
F_HEdu	1.110304	1.04451	0.1375137	0.2497508	-0.0544916	1.122573	1.044246***	0.1390394	0.2527821	-0.0504538
Cons	596.3601***	298.8284***	147.2183***	102.9347	70.32554***	601.1496***	299.3127***	151.0141***	103.6009***	70.85695***
R <sup>2</sup>	0.8772	0.8524	0.7295	0.7564	0.8137	0.8775	0.8524	0.7326	0.7564	0.8126

Total LEED commercial office buildings per capita applies to Model 1.a, b, c, and d; Basic level of certified LEED commercial office buildings per capita applies to Model 2.a, b, c, and d; Silver certified LEED commercial office buildings per capita applies to Model 3.a, b, c, and d; Gold certified LEED commercial office buildings per capita applies to Model 4.a, b, c, and d; Platinum certified LEED commercial office buildings per capita applies to Model 5.a, b, c, and d

\*Statistically significant at the 10% level. \*\*Statistically significant at the 5% level. \*\*\*Statistically significant at the 1% level

Table 7. Estimation of socioeconomic attributes on different types of LEED commercial office buildings

	1.a	6.a	7.a	8.a	9.a	1.b	6.b	7.b	8.b	9.b
Urban	0.3358148***	0.2354264***	0.0201229	0.0493984***	0.0293505	0.3280752***	0.2250668***	0.0224227	0.0453147***	0.0337328
Female	-8.146998***	-3.734864***	-0.9201474***	-0.793938***	-2.665022***	-7.904266***	-3.729137***	-0.8625054***	-0.737483***	-2.548718***
Work	0.6400402	0.8458715**	-0.1180139	-0.0260801	-0.0431501	0.6454991	0.740205**	-0.0737015	-0.048551	0.0435758
Minority	0.2084418***	0.1323664***	0.0161782	0.036169***	0.0238979*	0.2035493***	0.1152371***	0.0219341*	0.0312132***	0.0350801**
H_I	-0.9401094***	-0.5328191***	-0.0811308***	-0.0907807***	-0.2323541***	-0.9175617***	-0.5085269***	-0.0854372***	-0.0802047***	-0.2404405***
Green	-2.906863*	-2.893846**	-0.6768632*	-0.3403649	0.9782998*	-2.259231	-3.01932**	-0.4658383	-0.2213231	1.400515**
Politics	1.169955	1.103926	-0.159797	0.5136374*	-0.2951236					
Vote						0.0011681	0.0602113	-0.0241932	0.013777	-0.0472881
LEdu	-0.5366662*	-0.3908505*	-0.007797	-0.1265736**	-0.0098576	-0.5335919*	-0.3389445*	-0.0200103	-0.1187151*	-0.033693
HEdu	3.092219***	1.61602***	0.650658***	0.1243514	0.6987021***	3.048812***	1.649056***	0.626501***	0.1220987	0.6508244***
Cons	446.0244***	184.1105***	54.4694***	55.56216***	148.7372***	432.1761***	184.3682***	50.94318***	52.47243***	141.6372***
R2	0.8595	0.8691	0.656	0.6318	0.6067	0.8581	0.8681	0.6606	0.6136	0.6174

	1.c	6.c	7.c	8.c	9.c	1.d	6.d	7.d	8.d	9.d
Urban	0.2774544***	0.1934711***	0.0003641	0.0450371***	0.0382563*	0.2601071***	0.1717942***	0.0012106	0.0391348***	0.0477303**
Female	-6.966183***	-3.51507***	-0.3716967*	-0.8991393***	-2.151504***	-7.054619***	-3.779787***	-0.4147818**	-0.8780438***	-1.952834***
Work	1.738342***	1.5274***	0.2883417**	0.0196584	-0.0981437	1.670818***	1.42028***	0.2846457**	0.0042331	-0.0390885
Minority	0.2080141***	0.1333674***	0.0157535*	0.0365179***	0.0225085*	0.1852817***	0.1017812***	0.0158852*	0.0298389***	0.0380245**
H_I	-0.9029995***	-0.5235232***	-0.0640578***	-0.0934347***	-0.2191896***	-0.8763355***	-0.4957561***	-0.0670654***	-0.0823199***	-0.2283382***
Green	-2.177208	-2.594826**	-0.3787075	-0.3543365	1.117109**	-2.603179	-3.596373***	-0.5021622	-0.3433123	1.8073355***
Politics	1.123837	1.045471	-0.163141	0.5014827*	-0.2638443					
Vote						0.0873164	0.1310668**	0.0024887	0.0224203	-0.0690983**
M_LEdu	-3.790615***	-1.872107***	-1.149139***	-0.0975037	-0.6456151***	-3.902294***	-2.052685***	-1.156301***	-0.1218853	-0.5446168**
M_HEdu	-4.155282***	-1.319506*	-1.555205***	0.1688233	-1.436515***	-4.214193***	-1.426265*	-1.362519***	0.1597813	-1.37202***
F_LEdu	0.52153	0.0703727	0.6275977***	-0.144142	-0.0605404	0.6378131	0.2318006	0.6268794***	-0.1099294	-0.1397686
F_HEdu	1.110304	-0.1699131	0.8984238***	-0.2618098	0.6290367*	1.122573	-0.1583259	0.8966744***	-0.2563928	0.6259868*
Cons	596.3601***	274.3305***	54.84858**	69.59656***	196.1624***	601.1496***	291.6422***	58.09647**	67.46657***	182.5017***
R2	0.8772	0.8825	0.8151	0.6312	0.6652	0.8775	0.888	0.8139	0.6182	0.6899

Total LEED commercial office buildings per capita applies to Model 1.a, b, c, and d; Certified LEED commercial office buildings of Commercial Interiors projects per capita applies to Model 6.a, b, c, and d; Certified LEED commercial office buildings of Core & Shell projects per capita applies to Model 7.a, b, c, and d; Certified LEED commercial office buildings of Existing Buildings projects per capita applies to Model 8.a, b, c, and d; Certified LEED commercial office buildings of New Construction projects per capita applies to Model 9.a, b, c, and d; \*Statistically significant at the 10% level; \*\*Statistically significant at the 5% level; \*\*\*Statistically significant at the 1% level.



Similar to the basic estimation, the estimated coefficients of low educational attainment of the whole population, low educational attainment of the male population, and high educational attainment of the male population are mostly positive and significant, and the largest estimations of both male educational levels are the estimated coefficients on the basic level of LEED certification. The estimated coefficients of high educational attainment of the whole population, and low and high educational attainment for the female population are mostly negative and significant, and the largest estimations of high educational level and both female educational levels are the estimated coefficients on the basic level of LEED certification. Those outcomes also coincide with the general estimation, that high socioeconomic status result in high interest in all levels of LEED commercial offices. Nonetheless, opposite to my expectation, the weights of those estimates often do not arise for the higher level of LEED certifications, and the basic level of LEED certification is most sensitive to the socioeconomic attribute changes.

Table 7 presents estimations of socioeconomic attributes on LEED commercial office buildings across different types, using the same four models as previous estimation. Similarly, the estimated coefficients of percentage of urban area, working force population, as well as political attitudes are mostly positive; the estimated coefficients of environmental organization memberships, household income, and percentage of female population are negative and significant; the estimated coefficients of low educational attainment for the whole population and educational attainments for the male population are positive and mostly significant; the estimated coefficients of high educational attainment for the whole population and educational attainments for the female population are mostly negative. All above analyses continue to support the hypothesis that high socioeconomic status positively impacts on LEED commercial office buildings of all project types. The largest impacts of typical socioeconomic attributes are in the LEED commercial office of Commercial Interiors projects, and the largest of educational level effect is on LEED commercial office of Core & Shell projects.

## 5. Conclusion

As one of the most prevailing Green building certification program, LEED was a way to encourage architects and investors to the adoption of sustainable building practices. Researches have been done on the LEED

certification and other Green building certification's price premium, cost-effectiveness, and environmental policy implications. The environmental regulatory policy has been a strong tool to promote LEED in the publicly owned buildings in the states with high socioeconomic status. This paper contributes to the implications of the states socioeconomic status' relationship to the commercial sectors' acceptance of LEED certifications. The results of this research support that socioeconomic attributes of a state not only affect on the public and residential green building certification concentrations, but also motivate the commercial sector to pursue LEED certified buildings for commercial office buildings.

Overall, the state with high socioeconomic status owns more LEED commercial office buildings of all levels and types. However, the higher levels of LEED certifications are not most sensitive to the most of socioeconomic attributes. In other words, the high socioeconomic status state does not necessarily pursue a higher quality of Green buildings. Commercial Interior LEED projects for commercial offices are the type of LEED commercial office projects that is affected by the socioeconomic attributes the most.

The estimates for the green organization membership and average household income contradict the hypothesis. The higher concentration of environmentalists and the more household income result in even lower LEED commercial office buildings per capita. For the average household income, the state-specific features may reduce and bias the value of the estimation. This is a common disadvantage of cross-sectional data, which sometimes do not provide definite information about cause-and-effect relationships. The data only studies a single moment in time, but do not consider what happens before or after. For the future research, I'll try to collect time-series data of socioeconomic attributes, and the variation in LEED certification adoption rates over the years. For the green organization memberships, the members' information is confidential, so the memberships are counted repeatedly and Wikle was very likely overestimated LQ value of each state, and the negative effect of LQ may be over calculated. Additionally, the LQ value is collected two decades ago, and as the membership information is often confidential, there are no up-to-date data available to measure the environmental awareness at each state. I would suggest contacting the environmental organizations to get access for to the membership database, if anyone is interested in getting an accurate estimate for environmental knowledge of this state.

Even with its rapid growing reputation, LEED certification is still a relatively new approach to encourage investors to switch over to more environmentally friendly office space. Ultimately, the future market trend of green buildings will be determined by regulatory interventions from the state or municipal legislation. If the government can provide a financial incentive for the green buildings, especially LEED certification, eco-labeling in the real estate will more likely to be motivated to construct green buildings, and invent more environmentally friendly innovations. Future researches may focus on the specific green buildings environmental policy of each state and how different policies support green buildings in the U.S. The future research can enumerate positive externalities and deadweight lost associated with green building policies in each state.

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