The Green Equalizer

Providing Financial Relief to New York Households by Promoting Environmental Sustainability

By: Maria Isabel Olivera

I. Introduction

Prior to the Covid-19 pandemic, the United States had been experiencing a historically long recovery, yet many U.S. households never felt the effects of the economic boom. Wages had been stagnant while the cost of living had increased (Daco, 2016). During this same period the planet experienced 6 of the ten hottest years on record, according to the National Oceanic and Atmospheric Administration. With both climate change and income inequality having increasingly detrimental effects on American households, studies are showing that policies that promote environmental sustainability have the ability to both reduce our carbon footprint while encouraging economic growth. Using New York State's Energy Star program as a case study this research paper intends to measure both the economic and environmental benefits of residential energy efficiency retrofit projects for New York homeowners and the degree in which demographic characteristics influence these benefits. To do this, I will be utilizing the New York State Energy and Research Administration (NYSERDA) dataset "Residential Existing Homes (One to Four Family Units) Energy Efficiency Projects with Income Based Incentives by Customer Type: Beginning 2010", which provides data on the location and predicted first year utility savings of NYSERDA financed residential energy-efficient retrofit projects conducted throughout New York State beginning in 2010. County level demographic data compiled from the Census and the United States Department of Agriculture will be added to the NYSERDA data in order to understand which homeowners have benefiting the most from the NY Energy Star program.

II. Research Background

A. The Economic Impact of Environmental Policies

With the passage of historical environmental policies, such as the Clean Air Act of 1963, research studies appeared which suggested that such policies came with a steep economic price. In 2002, results of the US Census' Pollution Abatement and Cost (PACE) survey indicated that between the years of 1979 and 1988 the Clean Air Act had cost the manufacturing sector over 28 billion dollars (Becker, 2005). In turn it was found that manufactures responded to the higher operating costs associated with environmental regulations by eliminating jobs and closing plants. (Walker, 2011). Subsequently a 2006 study found that local governments, which were increasingly competing with one another for private investment, fearing the loss of jobs and private investment due to environmental regulations, pushed localities into a "race to the bottom" in which they loosened local enforcement of such regulations in an attempt to lure businesses away from other municipalities (Woods, 2006).

Other studies, however, have found that environmental policies that are well-designed and effectively administered by local government agencies have little to no negative effect on economic growth (Feoick, 2001). In his review of environmental policy implementation in the U.S. and its economic impact, Richard Feoick found that policies that were designed to be multidimensional, clear, and concise, reduced the uncertainty that was most likely to scare private investors away, therefore minimizing, and in some cases eliminating the economic costs of such polices. Additionally, a 2011 report published in Applied Energy, which created a model

100% renewable energy system designed around Denmark's current system found that investments in energy efficiency would not only spur economic growth by creating jobs in the green energy sector, but would also lower the health costs associated with environmental pollution and promote economic security by moving away from fossil fuels, whose prices can fluctuate unpredictably (Karlsson, 2011).

B. The United States Energy Burden

According to a 2019 report by the US Energy Information Administration (EIA), nationwide the average monthly electricity bill for U.S. households was $117.68 in 2018. For some U.S. households, however, their monthly utility costs are a significant financial burden (Hernandez, 2014). According to a 2014 report by the National Center for Children in Poverty, 18% of families in the Northeast were considered "energy insecure" (Hernandez, 2014). In such cases these families were unable "to adequately meet basic household heating, cooling, and energy needs" (Hernandez, 2014). Nationally, 12 percent of energy insecure families were homeowners (Hernandez, 2014).

In addition to struggling to meet their utility costs, American households face a myriad of other financial hardships. Despite years of consistent and strong job growth, annual wage growth had hovered just under 2 percent (Daco, 2016). Rates of "underemployment", at almost 10 percent, had remained unusually high as many part-time workers had failed to find full-time positions (Daco, 2016). Additionally, Americans are still burdened with historically high levels of household debt, which include a combination of home mortgage, consumer, and student debt now totaling over 13.5 trillion dollars (NYFR, 2018). As a result, the household savings rate has dropped from a historic average of 9 percent to less than 5 percent (Scott, 2015).

C. The Economic Benefits of Energy Efficiency

Though utility costs pose a financial burden for nearly a fifth of U.S. families and with wages remaining stagnant, there is evidence that investments in energy efficiency upgrades can lead to significant household savings. A 1999 study on attic insulation upgrades found an average annual rate of return of nearly 10%. Depending on what type of heating fuel the home used, that rate was as high as 14% and, in some cases, even higher (Hassett. 1999). These savings were present even after controlling for a possible "rebound effect", which occurs when households increase their energy and fuel consumption following the completion of an energy efficiency project (Hassett, 1999).

A more recent 2013 study which analyzed the annual dollar savings of three energy efficient lighting upgrade projects at the Naval War College in Newport, Rhode Island found that the annual savings ranged from nearly 20 to over 70 percent of the total project cost (Lang, 2013). In some cases, the actual annual savings exceeded the estimated savings by up to 25 percent due to larger than expected savings during peak load times (Lang, 2013).

The benefits of energy efficiency upgrades are not strictly financial, however. A Department of Energy study found that efficiency upgrades can improve the health outcomes of household members by "reducing the prevalence of harmful indoor air pollutants and contaminants" (Wilson, 2016). At a time when 16 million Americans suffer from Chronic Obstructive Respiratory Disease at a projected cost of nearly 50 billion dollars by 2020 (CDC, 2018), improving indoor air quality may have a beneficial impact on both the finances and quality of life of millions of Americans.

Such rates of return provide individual household a concrete incentive to consider installing energy efficient upgrades. These upgrades can ultimately have an aggregate effect on the larger economy as well by promoting the green job sector. While funding cuts in 2013 resulted in the end of the GGS (Green Goods and Services) program within the Bureau of Labor Statistics, which collected data on green jobs in the United States, data from 2011 is still available and showed that at that time “there were 3.4 million Green Goods and Services jobs, accounting for 2.6 percent of U.S. employment” (BLS, 2013).

D. Demographic Determinates of Adoption of Sustainable Practices

Despite the clear economic benefits associated with the adoption of sustainable practices not all households are equally likely to adopt such measures. Past research has found that increased awareness and understanding of climate change and its risks results in stronger community responses (Shepherd and Zanocoo, 2018). Demographic factors such as income, education level, race, and geography can all influence levels of community awareness of the dangers associated with climate change and in turn the willingness of households to take actions in response to those perceived dangers.

A 2013 survey of 2034 adults in the U.S. found that greater levels of household income was associated with a greater willingness to adopt sustainable public policies (Kotchen and Boyle, 2013). International studies have shown that educational attainment plays an important role in promoting environmental consciousness as well (Lee, 2015). In a 2017 Pew Research Center study conducted in Latin America, it was found that educational attainment showed a stronger positive correlation to levels of environmental awareness than wealth (Evans. 2018). Regarding race, a 2016 national survey found that African American and Latino-Americans were more likely to view climate change as a greater threat than White-Americans (Collins, 2014). Despite their higher level of environmental awareness, however, minorities are "underrepresented in mainstream environmental organizations", which may undermine efforts to promote sustainability practices within their communities (Schult, 2016).

E. The Case of New York State

Like the rest of the country, New York State was enjoying a low unemployment rate of just over 4 percent just prior to the start of the Covid-19 pandemic. The low unemployment rate did not translate into greater financial security for most New Yorkers, however. New York State has the fourth highest amount of credit card debt in the nation at 58.2 billion dollars (OSC, 2018). Student debt in New York State has also ballooned, totaling 82 billion dollars in 2015, more than double what it was in 2006 (OSC, 2016). Mortgage debt, however, accounts for more than half of New York State's total household debt, totaling 481 billion dollars, an 8 percent increase from 2006 (OSC, 2016).

Along with their credit and mortgages expenses and rents, New York households must also take into account their monthly utility expenditures. In New York State, though the average monthly household utility bill is slightly lower than the national average at $111.93 compared to $117.68 (EIA, 2019), New York residents pay 20 percent more than the national average for each therm of natural gas consumed and 45 percent more than the national average for each kilowatt of energy consumed in 2018 (BLS, 2019).

The rising costs of housing and utility expenses in New York State are minor, however, when compared to the devastating costs of climate change. Within the last 10 years, New York State experienced two destructive hurricanes, Hurricane Irene in 2011 and Hurricane Sandy in 2012, which combined, resulted in 88 billion dollars in damages and the loss of 204 lives (Smith, 2019). Additionally, the 2014 National Climate Assessment report found that the "Sea levels along the New York's coast have already risen more than a foot since 1900" and are predicted to rise an additional 30 inches by 2050 (DEC, 2019). By that time, temperatures in New York State are also expected to increase by 6 degrees (DEC, 2019). These changes will pose both financial and health risks to all New Yorkers in the years to come.

New York State has attempted to respond to these two challenges by creating the New York State Home Performance with Energy Star Program. This program which is administered by the New York State Energy Research and Development Authority (NYSERDA) provides financing and incentives to New York State homeowners to install eligible energy efficiency upgrades to their homes. The list of eligible upgrades includes the installation of energy efficient heating and cooling systems, updating home insulation, and the purchasing of energy star appliances and LED lighting.

Additionally, income eligible households who make up to 80 percent of the state or county median income (whichever is higher) are eligible for the Assisted Home Performance program which provides grants which cover up to 50 percent of the total retrofit project costs. This paper will analyze the projected first year utility cost savings and energy use reduction experienced by household who installed energy efficiency upgrades as part of the New York Energy Star program in order to answer the following questions:

1. What economic and environmental benefits do New York State homeowners receive from performing energy efficient retrofits on their homes?

2. Do demographic determinants influence which New York homeowners participated in the NY Energy Star program and the degree to which they benefited from it?

3. How have low income New York State homeowners (those earning up to 80% the median County or State annual income) benefited from the New York Energy Star Assisted Home Performance program compared to all participating homeowners?

I expect to find that the NYSERDA Home Performance program reduced annual utility expenses while also reducing residential energy consumption for all participants, but especially for low income households.

III. Methodology

For my paper I will be utilizing the dataset, "Residential Existing Homes (One to Four Family Units) Energy Efficiency Projects with Income Based Incentives by Customer Type: Beginning 2010" from OpenData NY which has compiled statistics on the NY Energy Star program dating back to its inception in 2010. This dataset was compiled by the New York State Energy Research and Development Authority, which is the agency responsible for promoting and researching energy efficiency policy in New York State. It collected geographic, customer, and project data from all New York State homeowners who installed energy efficient retrofits under its NY Energy Star program starting in 2010.

In the dataset, homeowners who participated in the program were placed into two customer categories: "Market" customers, who were not eligible for the Assisted Home Performance program, and "Assisted" customers who were. All homeowners received at least a 10% discount for installing energy efficient retrofits, however, the incentives provided to "Assisted" customers were substantially larger. "Assisted" customers received state grants which funded 50% of the retrofit costs. For this paper, a separate analysis will be conducted which will focus on "Assisted" homeowners specifically in order to isolate the benefits of residential energy-efficient retrofit projects for lower income homeowners.

A. Independent Variable

The independent variable is the net cost of energy efficiency retrofit projects. This variable was created by subtracting the total project cost, which is the gross cost of the energy retrofit project, by the amount of the government incentives provided to homeowners for performing energy-efficiency retrofits.

B. Dependent Variables

i. Economic Variables

For this analysis, there are two categories of dependent variables. The first category measures the economic benefits of energy efficiency retrofit projects. This variable is the estimated first year utility cost savings in dollars, which is a numeric variable. It represents the amount of money homeowners are expected to save in the first year proceeding the completion of their energy efficiency retrofit.

ii. Environmental Variables

The second category of variables evaluates the extent to which energy efficiency retrofit projects had an environmental benefit by reducing the carbon foot print of household. The first of these variables is the predicted first year reduction of energy consumption in kilowatts. This is a numeric variable and it measures the expected first year reduction in energy consumption in kilowatts. The last variable in this category is the predicted first year reduction in household heating fuel consumption in British Thermal Units. This is also a numeric variable and it measures the expected first year reduction in heating fuel consumption in British Thermal Units.

C. Demographic Variables

Several countywide demographic measures will be included in the analysis to provide deeper understanding as to which homeowners participated in the New York EnergyStar program. Additionally, these variables will be used to evaluate which New York Energy Star participating homeowners benefited the most from their energy efficiency retrofit investment and why. The county demographic data was compiled from the Census and the United States Department of Agriculture.

Variables such as the county percentage of white residents, county poverty rate, and county population will be used to examine the role that race, poverty, and population may play in determining the number of energy efficiency retrofits performed in a county. These variables will provide insight on the demographic characteristics which determine which county homeowners are more likely to participate in the NY Energy Star program. County median income in dollars will be used to determine if homeowners from wealthier counties saw greater economic benefits from their retrofit projects than those Energy Star program participants from less affluent counties. The last variable, percent of county residents with a college degree will be used to understand if more educated counties saw greater economic and environmental returns on their energy efficiency retrofit projects.

D. Statistical Analysis

In order to answer the research questions, a univariate analysis will first be performed to gain insight into how many residential energy efficiency retrofits have been performed in New York State since, 2010, where they were performed, and which types of homeowners performed them. In this section, particular attention will be paid to examining the differences between "Market" and "Assisted" customers.

This will then be followed by bivariate analysis, which will analyze the relationship between the independent variables associated with energy efficiency project costs and the dependent variables associated with utility cost and consumption reduction and green job promotion. Lastly, a multivariate analysis will be performed where the dependent variables will be will be regressed on the independent variable, net project cost, along with the county-level demographic variables for all retrofit projects and then separately for “Assisted” retrofit projects.

IV. Expected Results

I expect to find that homeowners who participated in NYSERDA's NY Energy Star program obtained a clear economic benefit in the form of lower utility bills. I also expect to find significant environmental benefits in the form of a reduction of energy and fuel use amongst participating households. Additionally, I anticipate that low income families who participated in the Assisted Home Performance program experienced additional dollar savings on their utility bills.

V. Results

A. Univariate Analysis

Since 2010, there has been a total of 57,924 residential energy efficiency retrofits performed in New York State. Of that total the majority of the homeowners were “Market” customers who received little government assistance or incentive. Nearly 60% of energy efficiency retrofits were performed by “Market” customers. Well over a third, or 23,897 where “Assisted” projects in which the homeowner received financial assistance in the form of government grants.

Table 1. Total Retrofits

Customer Type	Percent
Market	59
Assisted	41
N = 57,924	100

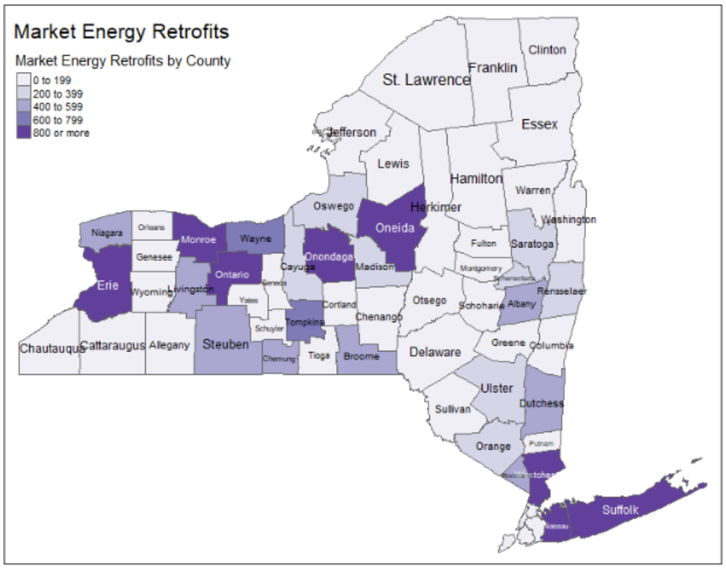
Table 2 shows the total dollar investment on residential energy efficiency retrofits in New York State since 2010. In total $484,170,341 has been invested in residential energy efficiency projects since 2010. Of that total, nearly two-thirds were spent on “Market” customer retrofit projects. New York State paid a total of $93,133,769 in incentives to participating homeowners with nearly 90% of all state incentives going to “Assisted” customers.

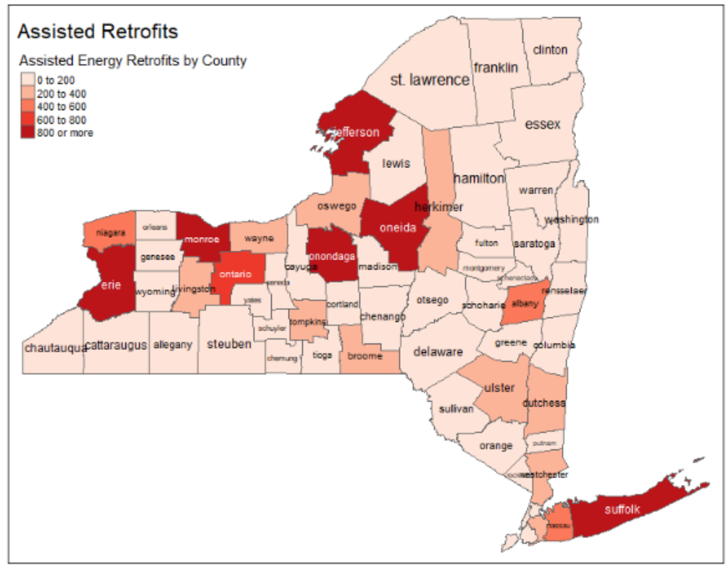
Table 2. Total NYS Investments in Energy Efficiency Projects				
Customer Type	**Total Amount Spent on Retrofits**	**%**	**Total State Incentives**	**%**
All	$484,170,341	100	$93,133,769	100
Market	$301,179,866	62	$20,657,733	22
Assisted	$182,990,475	38	$72,476,036	88

Table 3 looks at the three variables which examine the financial costs and incentives associated with the retrofit projects. In these tables the costs of the "Market" retrofit projects are compared with those of the "Assisted" retrofit projects. The gross costs of the "Market" retrofit projects were on average 26% higher than the "Assisted" retrofit projects. The incentives provided by New York State to homeowner, however, where 79% greater for "Assisted" retrofit projects than "Market" projects. As a result, the net cost of "Market" retrofit projects were on average 54% higher than "Assisted" retrofit projects.

Table 3. Retrofit Costs and Incentives			
Customer Type	**Mean Gross Cost**	**Mean Incentive**	**Mean Net Cost**
All	$8,359	$1,608	$6,751
Market	$8,851	$607	$8,244
Assisted	$7,657	$3,033	$4,625
N = 57,924			

The following maps provides insight into where these retrofit projects were concentrated. While there is some overlap regarding where the "Market" and "Assisted" retrofit projects were performed, there is some variation between the two maps. While Monroe county had the greatest number of both "Market" and "Assisted" retrofits, nearly 3,000 "Assisted" retrofits were performed in Jefferson county while just over 100 “Market” retrofits were performed there. In general, retrofits were heavily concentrated in the western portions of New York State. More populated urban counties such as the counties which make up New York City as well as the surrounding suburbs such as Westchester and Nassau, had fewer “Assisted” retrofit projects.





The last univariate table looks at countywide demographic data associated with the retrofit projects to identify any significant demographic differences between those counties with the greatest concentration of “Market” and “Assisted” retrofit. Tables 3 shows that “Market” retrofits are concentrated in counties with a median income which is on average 10% higher than those of “Assisted” retrofits. Additionally, counties with a concentration of “Market” retrofits had an average of 11% more college graduate then the “Assisted” retrofit counties. Lastly, the “Market” retrofit counties had populations which were on average 13% greater than those of “Assisted” retrofit counties. There does not appear to be a significance difference in the racial makeup or poverty rate between the counties in which “Market” and “Assisted” retrofit were concentrated. It is worth noting, however, that there is a clear lack of racial diversity amongst both the “Market” and “Assisted” retrofit counties with over 80% of the county residents being white. This suggest a need to increase outreach efforts to homeowners who live in more racially diverse counties such as the Bronx or Brooklyn. Based on this univariate analysis the demographic variables to be included in the multivariate analysis are county income, education, and population. The race and poverty variables will not be included since there appeared to be very little difference between the racial make-up and poverty level of "Market" and "Assisted" retrofit counties.

Table 5. County-Level Demographics

Customer Type	Median Income	Percent College Graduate	Percent White	Percent In Poverty	Population
Market	$67,989	35	83	12	660, 808
Assisted	$61,529	31	84	13	571,695
N = 50,882					

B. Bivariate Analysis

For the bivariate analysis, a Pearson Correlation was performed in order to measure the degree of association between the net cost of the retrofit projects and the projected first year dollar, energy and fuel savings. Table 1 shows the results of the correlation. The variable with the strongest correlation was the estimated first year dollar savings with a correlation of 0.6. The variable with the weakest correlation was the estimated first year energy savings in kWh with a correlation of 0.06. This result doesn't necessarily come as a surprise, since some retrofit projects involve replacing oil or gas furnace heating systems with air heat pump HVAC systems which are powered by electricity. As a result, while a homeowner's overall utility costs may decline but their energy consumption may increase. This might also explain the strong correlation between net retrofit costs and estimated first year fuel savings which was the second strongest at 0.54.

Table 1: Pearson Correlation for Retrofit Project Net Cost (In Dollars) and Dependent Variables

Estimated First Year Utility Savings In Dollars	*Estimated First Year Energy Savings In kWh*	*Estimated First Year Heating Savings in Btu*
0.62	0.05	0.54

C. Multivariate Analysis

The two multivariate analyses below present 2 logistical regression models. In the first analysis, all retrofit projects were included in the regression. Model A examines the independent variable, net retrofit costs and the 3 projected first year dollar, energy and fuel savings variables. In Model B, the demographic variables which measure the countywide median income, education level, and population will be included in order to determine if these variables influence which types of homeowners are more to benefit from an energy efficient retrofit. The second regression has the same format as the first, but focuses on “Assisted” retrofit projects exclusively.

1. Net Costs and Dollar Savings

The first table shows the results of a regression in which the net cost of energy efficiency retrofit for all customers serves as the independent variable and predicted first year dollar saving serves as the dependent variable. The results showed that every dollar spent on an energy efficiency project resulted in an estimated first year utility cost savings of .08 dollars for an average estimated annual savings of $540.00. When demographic variables are included, the regression shows that, all else being equal, every dollar increase in county median income resulted in an additional estimated first year savings of 12.5% for a retrofit project. Education seemed to have the reverse effect however. An increase in the percentage of college graduates in a county resulted in a considerable decrease in the first-year dollar savings of a retrofit project. A possible explanation for this is that wealthier households may be able to install more efficient, and in turn more expensive, energy efficiency upgrades and therefore experience greater dollar savings. Additionally, having a greater number of college graduates in a county may not translate into having a greater number of homeowners who can afford more expensive retrofits.

Table 1: Regression Models Predicting Estimated First Year Dollar Savings By Energy Efficiency Retrofit Net Costs for All Customers

Controlling for County Level Demographics

	Model A		Model B	
	Unstandardized Coefficient	Beta	Unstandardized Coefficient	Beta
Constant	$85.00		-$435.00	
Net Cost	$0.08	$0.60	$0.08	$0.58
County Demographic				
Median Income			$0.01	$0.30
Percent College Graduates			-$13.00	-$0.13
Population			$0.00	$0.003

Table 2 displays the same regression analysis, but looks at "Assisted" customers exclusively. In Model A, the regression results show that compared to all customers, "Assisted" saw an additional first year dollar saving of over 10% for every dollar spent on a retrofit project. Similar to the regression for all customers, "Assisted" customers who resided in counties with a greater percentage of college graduates also saw a reduction in dollar savings, but to a lesser degree.

Table 2: Regression Models Predicting Estimated First Year Dollar Savings by Energy Efficiency Retrofit Net Costs for Assisted Customers

Controlling for County Level Demographics

	Model A		Model B	
	Unstandardized Coefficient	Beta	Unstandardized Coefficient	Beta
Constant	$138.00		-$402.00	
Net Cost	$0.09	$0.54	$0.08	$0.49
County Demographic				
Median Income			$0.01	$0.31
Percent College Graduates			-$6.00	-$0.08
Population			$0.00	$0.00

2. *Net Cost and Energy Savings*

Table 3 displays the results of a regression in which the predicted first year energy saving in kilowatts serves as the dependent variable. The table shows that every dollar spent on a retrofit project resulted in first year energy savings of .02 kWh for an average annual savings of 165 kWh's. When the demographic variables are added to the regression, the results are the opposite of those seen in the last regression. County median income reduced first year energy savings, while an increase in the percentage of college graduates in a county increased energy savings. A possible explanation for this may lie in the "rebound effect", in which some households increase their energy consumption after completing an energy efficiency project. In such cases, an energy efficiency project alone is not enough to reduce energy use. Changes in household behaviors may also be required in order to significantly reduce household energy consumption. Education may play a role in promoting energy efficient household behaviors and may partly explain the increased energy savings for retrofits performed in more educated counties.

Table 3: Regression Models Predicting Estimated First Year Energy Savings (kWh) by Energy Efficiency Retrofit Net Costs for All Customers

Controlling for County Level Demographics

	Model A		Model B	
	Unstandardized Coefficient	Beta	Unstandardized Coefficient	Beta
Constant (kWh)	289		381	
Net Cost	0.02	0.06	0.02	0.05
County Demographic				
Median Income			-0.001	-0.009
Percent College Graduates			4	0.014
Population			-0.0004	-0.06

In table 4 the same regression is performed for "Assisted" customers exclusively. The results are similar to those seen for all customers although the correlations appear stronger. Every dollar spent on a retrofit project resulted in first year energy savings of .07 kWh for an average annual savings of 324 kWh, an energy savings which is nearly twice as high as those seen for all customers. The negative impact of median income on energy savings was four times greater amongst "Assisted" customers compared to all customers, while the positive impact of education was nearly three times greater.

Table 4: Regression Models Predicting Estimated First Year Energy Savings (kWh) by Energy Efficiency Retrofit Net Costs for Assisted Customers

Controlling for County Level Demographics

	Model A		Model B	
	Unstandardized Coefficient	Beta	Unstandardized Coefficient	Beta
Constant (kWh)	175		315	
Net Cost	0.07	0.15	0.08	0.17
County Demographic				
Median Income			-0.004	-0.04
Percent College Graduates			11	0.05
Population			-0.0004	-0.12

3. Net Cost and Fuel Savings

The last two regression tables look at the correlation between retrofit net cost and predicted first year fuel savings in British Thermal Units. Table 5 shows the results for all customers. The findings show that every dollar spent on a retrofit project resulted in first year fuel savings of .003 Btu's for an average annual savings of 25 Btu's. The median income and population appear to have a very weak effect on the relationship between retrofit net cost and fuel savings. County percentage of college graduates, however seems to have a considerable negative impact on fuel savings. The negative influence of education on fuel savings may be explained by the rise of "energy insecure" households in the United States. Due to high fuel costs, many households (and homeowners), consume less fuel than is required to meet their heating needs. Performing an energy efficiency retrofit may result in lower utility costs, allowing homeowners to use the appropriate amount of fuel to meet their household heating needs. This result may suggest that homeowners who reside in counties with a greater percentage of college graduates are also experiencing some degree of energy insecurity.

Table 5: Regression Models Predicting Estimated First Year Fuel Savings (Btu) by Energy Efficiency Retrofit Net Costs for All Customers Controlling for County Level Demographics

	Model A		Model B	
	Unstandardized Coefficient	Beta	Unstandardized Coefficient	Beta
Constant (Btu)	11		9	
Net Cost	0.003	0.53	0.003	0.57
County Demographic				
Median Income			1 e-4	0.06
Percent College Graduates			-0.3	-0.08
Population			2 e-6	0.03

Table 6 shows the regression results for “Assisted” customers. Predicted annual fuel savings were 25% higher for “Assisted” customers than all customers for an average 19 Btu’s. As seen in the regression results for all customers, the county median income and population appear to have a very weak relationship to fuel savings. Once again, however, county percentage of college graduates seems to have a negative effect on fuel savings, albeit weaker than that for all customers.

Table 6: Regression Models Predicting Estimated First Year Fuel Savings (Btu) by Energy Efficiency Retrofit Net Costs for Assisted Customers

Controlling for County Level Demographics

	Model A		Model B	
	Unstandardized Coefficient	Beta	Unstandardized Coefficient	Beta
Constant (Btu)	12		11	
Net Cost	0.004	0.5	0.003	0.5
County Demographic				
Median Income			-7 e-5	-0.04
Percent College Graduates			0.1	0.04
Population			4 e-6	0.08

VI. Conclusion

The results of the analysis showed that New York State homeowners who participated in NYSERDA's Energy Star program saw significant financial and environmental benefits. Assisted costumers reaped additional benefits by performing an energy efficiency retrofit on their home compared to all participants. Once socioeconomic factors are taken into account, however, there are clear variations in the degree in which some homeowners benefited from the program.

Race and Energy Efficiency Retrofits in New York State

The univariate analysis showed that the majority of the home retrofit projects occurred in counties where the residents were predominantly White. In boroughs such as the Bronx and Brooklyn where White residents made up 50% or less of the county population and have a large number of one to four family homes, the number of retrofit projects in the two boroughs combined was less than half the state county average. This suggests that greater efforts can be made to recruit homeowners from more racially diverse counties to participate in the NY Energy Star program.

Income and Dollar Savings

While the majority of homeowners saw first year dollar savings once completing their energy efficiency retrofit project, homeowners who lived in wealthier counties saw larger dollar savings compared to less wealthier counties. This may be due to the fact that homeowners in wealthier counties can afford to perform more extensive energy efficient retrofit and as a result they can generate additional dollar savings.

Income and the Rebound Effect

While wealthier counties saw greater dollar savings, they also saw lower energy savings. This may be evidence of a rebound effect, in which households that have recently completed an energy efficiency upgrade over-estimate the amount of energy they are saving and ultimately use more energy than they did prior to the upgrade. The results suggest that homeowners in wealthier communities may be more vulnerable to the rebound effect than those of less affluent communities.

Education and Energy Conservation

While greater levels of income were associated with a reduction in energy savings, greater levels of education were associated with an increase in energy savings. Homeowners who resided in counties with a greater percentage of college graduates where more likely to see higher energy savings after completing their retrofit projects. This may be evidence that more educated communities are more likely to adopt environmentally conscious behaviors.

Energy Insecurity and Fuel Consumption

While education was associated with greater energy savings, it was also associated with decreased fuel savings. This finding may be indicative of some level of energy insecurity amongst New York State homeowners including those who are college graduates. Many households across the country are financially unable to meet their heating needs. With lower overall utility expenses, these same households may finally be able meet their heating demands by using more fuel.

Research Limitation

This analysis was limited by the fact that household level demographic data was unavailable. As a result, county-level demographic data was utilized instead. Future research into the influence that socioeconomic variables have on the economic and environmental benefits of energy efficiency projects should attempt to include household level demographic data.

Despite these limitations, it is clear that government financed residential energy efficiency projects provide clear economic and environmental benefits. Such program have the ability to simultaneously address growing concerns regarding climate change while providing economic assistance to individual households.

BIBLIOGRAPHY

1. Becker, Randy. "Air Pollution Abatement Costs Under the Clean Air Act: Evidence from the Pace Survey". *Journal of Environmental Economics and Management*. Vol. 50, (2005)

2. Bureau of Labor Statistics. "Green Goods and Services". March 19, 2013. Available at: https://www.bls.gov/ggs/news.htm
   - "Average Energy Prices, New York – New Jersey City – August 2018". December 13, 2019. Web.

3. Bureau of Labor Statistics. "Average Energy Prices, New York – New Jersey City – August 2018". December 13, 2019. Available at: https://www.bls.gov/regions/new-york-new-jersey/news-release/averageenergyprices_newyorkarea.htm

4. Center for Disease Control and Prevention. "Chronic Obstructive Pulmonary Disease (COPD)". June 6, 2018. Available at:
   https://www.cdc.gov/copd/index.html
   https://www.cdc.gov/copd/infographics/copd-costs.html

5. Collins, Jonathan. "Race to Sustain: The Policy Implications of Racial Differences in Climate Change Public Opinion Attitudes". Harvard Journal of African American Public Policy, 2014, pp.45-60.

6. Daco, Gregory "Sluggish Wage Growth and Depressed Labor Force Participation" *Business Economics*, 2016, Vol.51(2), p.105

7. Energy Information Administration (EIA), "2018 Average Monthly Bill – Residential" October 1, 2019. Web. https://www.eia.gov/electricity/sales_revenue_price/pdf/table5_a.pdf,

8. Evans, Claire; Zechmeister, Elizabeth. "Education and Risk Assessments Predict Climate Change Concerns in Latin America and the Caribbean"; Latin American Public Interest Project; Vanderbilt University; 2018.

9. Federal Reserve Bank of New York (NYFR). "Household Debt and Credit Report". *Center for Microeconomic Data*. February 2018

10. Feiock, Robert and Stream, Christopher. "Environmental Protection versus Economic Development: A False Trade-Off". *Public Administration Review.* 61.2 (2001).

11. Hassett, Kevin A. and Metcalf, Gilbert E.. "Measuring the Energy Savings from Home Improvements Investment: Evidence from Monthly Billing Data" *Review of Economics and Statistics.* 81.3 (1999) Pages 516-528.

12. Hernandez, Diana; Aratani, Yumiko; Jiang, Yang. "Energy Insecurity Among Families with Children". *Columbia University.* 2014.

13. Karlsson, Kenneth, Lund, Henrik, Van Mathiesen, Brian. "100% Renewable Energy Systems, Climate Mitigation, and Economic Growth". *Applied Energy.* 88.2 (2011) Pages 488-501.

14. Kotchen, Matthew J ; Boyle, Kevin J ; Leiserowitz, Anthony A. "Willingness-to-pay and policy-instrument choice for climate-change policy in the United States". Energy Policy, April 2013, Vol.55, pp.617-625

15. Lang, Corey; Siler, Matthew. "Engineering estimates versus impact evaluation of energy efficiency projects: Regression discontinuity evidence from a case study". *Energy Policy*. October 2013, Vol.61, pp.360-370

16. Lee, Tien Ming, Markowitz, Ezra, Howe, Peter, Ko, Chia Ying, Leiserowitz, Anthony; "Predictors of Climate Change Awareness and Risk Perception Around the World"; Nature Climate Change; DOI: 10:1038; NClimate2728; (2015)

17. New York State Department of Environmental Conservation (DEC). "Impact of Climate Change in New York". Web. https://www.dec.ny.gov/energy/94702.html

18. Office of the State Controller (OSC), New York State. "Housing Affordability in New York State". March 2014. Available at: https://www.osc.state.ny.us/reports/housing/affordable_housing_ny_2014.pdf

19. Office of the State Controller (OSC), New York State. "Student Loan Debt in New York State". September 2016. Available at: https://www.osc.state.ny.us/reports/highered/student_loan_debt.pdf

20. Office of the State Controller (OSC), New York State. "Credit Card Debt in New York State". May 2018. Available at: https://www.osc.state.ny.us/reports/economic/credit-card-debt-2018.pdf

21. Schuldt, Jonathon; Pearson, Adam. "The role of race and ethnicity in climate change polarization: evidence from a U.S. national survey experiment". Climatic Change, 2016, Vol.136(3), pp.495-505

22. Scott, Robert H.; Pressman, Steven, "Inadequate Household Deleveraging: Income, Debt, and Social Provisioning". *Journal of Economic Issues*, 03 April 2015, Vol.49 (2), p.483-492.

23. Shepard, Stephanie ; Boudet, Hilary ; Zanocco, Chad ; Cramer, Lori ; Tilt, Bryan. "Community climate change beliefs, awareness, and actions in the wake of the September

2013 flooding in Boulder County, Colorado". Journal of Environmental Studies and Sciences, 2018, Vol.8(3), pp.312-325

24. Smith, Adam B.; Katz, Richard W. "U.S. Billion Dollar Weather and Climate Disasters 1980-2019". *National Oceanic and Atmospheric Administration (NOAA).* 2019. Web. https://www.ncdc.noaa.gov/billions/events.pdf

25. U.S. Energy Information Administration. "2017 Average Monthly Bill – Residential". October 12, 2018. Web. https://www.eia.gov/electricity/sales_revenue_price/pdf/table5_a.pdf

26. Walker, Reed. "Environmental Regulation and Labor Reallocation: Evidence from the Clean Air Act". *The American Economic Review.* Vol. 101, No. 3 (2011).

27. Wilson, Jonathan; Jacobs, David; Reeding, Amanda; Tohn, Ellen; Cohen, Jonathan; Jacobsohn, Ely. "Home Rx: The Health Benefits of Home Performance". *Department of Energy*. December 2016.

28. Woods, Neal D. "Interstate Competition and Environmental Regulations: A Test of the Race-to-the-Bottom Thesis". *Social Science Quarterly*. Vol. 87, No. 1, pp. 174-189.