AN ANALYSIS OF THE EFFECTIVENESS OF TAX INCENTIVES FOR SOLAR ENERGY

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TC 660H
Plan II Honors Program
The University of Texas at Austin

December 1st, 2020

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Abstract

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Title: An Analysis of the Effectiveness of Tax Incentives for Solar Energy

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Tax expenditures are provisions in the tax codes which are designed to promote socially desirable and correct economic market efficiencies. However, because this specific type of government spending is not subject to an annual appropriations process and are not evaluated on a regular basis. These incentives cover a vast array of social concerns including education and healthcare. One major segment of the tax expenditure budget is aimed at promoting investments in renewable energy.

Many states offer financial incentives for their citizens to invest in renewable energy. However, very little research has been conducted to determine whether or not these incentives are successful in achieving their objectives. This lack of information creates the opportunity to empirically evaluate the effectiveness of state tax incentive programs. Through linear regression modeling, this study examines whether or states which provide incentives for investment in renewable energy experience greater levels deployment of solar technology. The results of this analysis indicate that between 2009 – 2017, state income tax incentives had a positive, statistically significant impact on the installation of solar technology. This impact is moderated by the average price of electricity in a state. Income tax incentives tend to be more effective in sates with higher electricity costs.

Following this empirical analysis, three different case studies provide insight into how states chose to design and evaluate their incentive programs for solar energy. Each state has a unique system in place to perform an evaluation of their incentive programs on a cyclical basis. The evaluations performed by Iowa, Hawaii, and Massachusetts reveal that these incentive programs often disproportionately benefit high income individuals. Lessons learned from these case studies can benefit other states who are considering offering a tax credit for solar energy.

Acknowledgements

I would like to express my gratitude to my primary advisor, Braden Williams, for his support throughout the process of writing my thesis. His Introduction to Taxation course inspired my interest in tax policy, and I am very glad he agreed to take on this project.

I would also like to thank my second reader, Wendy Wagner, for her insightful feedback and encouragement. This project began as a paper for her Science and Public policy class and I am very grateful for her help in continuing my research.

Thank you to Professor Kacey Faust, for helping me to develop the statistical models used in this project.

Thank you to my family and friends for their constant love and support.

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Introduction

Tax expenditures are economic incentive programs that are administered through the tax code. They can take several forms including preferential tax rates, exclusions for certain activities, and tax credits. Unlike direct forms of government spending, tax expenditures do not face an annual reauthorization process and there are no frameworks in place to ensure these incentives programs are evaluated regularly. Consequently, many tax expenditures remain effective for decades without any confirmation that they are achieving their desired effects. One major segment of these tax expenditures, at the federal and state level, are environmental incentives for renewable energy. The cost of these incentives amounts to nearly a billion dollars per year. These expenditures have high opportunity costs, and if they prove to be ineffective, the foregone tax revenue could be spent on other societal needs such as education, healthcare, or infrastructure.

This lack of information creates an opportunity for empirical research to explore the effectiveness of tax expenditure programs. Prior research has discussed the theoretical efficacy or distributional concerns regarding the equity environmental tax credits, but very little empirical research has been conducted in this particular subject area. This study expands upon prior research by utilizing an updated data set and refined statistical models to account for changes in the market for solar technology. This study uses panel data from 50 states over 10 years to explore whether or not states that offer tax incentives for solar energy tend to experience higher levels of investment in solar technology. The results of the study suggest that income tax incentives result in higher market deployment of solar technology in states with high electricity costs.

Finally, to supplement the findings from the empirical research, three states were chosen as case studies to examine how different jurisdictions chose to design, implement, and evaluate their solar energy tax credits. Each of these three states' policies differs regarding the amount of the credit offered, the technologies that qualify for the credit, and whether or not the credit is refundable. These factors can influence the effectiveness of the credits. Additionally, each state has unique systems in place to conduct evaluations of the effectiveness of their credits. The data and resources available to the state drive the insights gained from these evaluations. These case studies can serve as examples to other states who are considering offering a tax credit for solar energy. Additionally, many states do not perform formal evaluations of their tax credits, and these states could learn from the systems in place in Hawaii, Iowa, and Massachusetts.

History and Background

History of Tax Expenditures and Incentives

Although the primary purpose of taxation is to raise revenue for the government, tax laws can also be used to correct market inefficiencies and encourage certain social behaviors. Since the 1960s, the US Federal Tax Code has been used not only to raise revenue but also as a social policy and incentive tool (Batchelder et al.). The tax code serves multiple functions because one of the main criteria for a well-designed tax system is economic efficiency. Efficiency entails not only raising revenue in a cost-efficient manner but also correcting for market failures and addressing externalities (Batchelder et al.). Externalities occur when the market price for a certain good or activity is not equal to the total social benefit derived from the good or activity. For example, investing in solar technology is advantageous not only for the individuals who purchased the solar panels but also for other third parties who enjoy the environmental benefits of renewable energy. However, this third-party benefit is not reflected in the cost of solar panels. For this reason, governments or administrative agencies may intervene and correct for market externalities by providing incentives for the activities that generate the externalities. One way to address these externalities is through tax expenditures.

Tax expenditures are social incentive programs that are administered through the tax code. According to the Congressional Budget Act of 1974, tax expenditures are defined as “revenue losses attributable to provisions of the federal tax laws which allow a special exclusion, exemption, or deduction from gross income or which provide a special credit, a preferential rate of tax, or a deferral of tax liability” (U.S. Department of the Treasury). The Internal Revenue Service (IRS) and numerous state revenue agencies have incentive programs aimed at promoting homeownership, education, health care, and several other social causes. The largest segments of the Tax Expenditures Budget for Fiscal Year 2021 are Income Security (26%) and Commerce and Housing (24.3%) (Tax Policy Center).

The magnitude of tax expenditures has been large but has varied over time. In 1985, tax expenditures exceeded 8% of the national GDP (Batchelder and Toder). The following year, there were major cutbacks for tax expenditures, and in 1991 tax expenditures fell to below 6% of GDP. This instance, nearly 35 years ago, was the last time that tax expenditures were significantly cut back. Since then tax expenditures have grown substantially and these policies are commonly used to this day. The Joint Committee on Taxation estimated that the total budget for tax expenditures in 2021 will equal $1.6 trillion (Tax Policy Center).

Tax expenditures have become increasingly popular social policy tools for several reasons, but perhaps primarily, because these programs face less scrutiny than other more direct forms of government spending. This lessened scrutiny occurs because several tax incentives are structured as deductions or exclusions rather than actual cash payouts or refunds. Consequently, tax incentives are simply viewed as “tax cuts” rather than government spending. While this distinction might seem trivial to a rational decision-maker with full information, it does change policymakers’ and the general public’s views towards these policies. Tax cuts are typically seen as reducing the size of the government and cutting back revenue, whereas spending is viewed as increasing the size of the government and promoting the interest of politicians. Regardless of how they are perceived, tax expenditures do increase the size of the government by promoting causes and incentivizing behavior that lawmakers and lobbyists deemed socially desirable. For this reason, it is important to determine if these expenditures are economically efficient and effective in achieving their objectives.

Evaluation and Analysis of Tax Incentives

In theory, a tax system should be used to either accurately measure an individual's ability to pay taxes or to correct market inefficiencies and promote socially desirable behavior. However, due to its relative convenience as a social policy tool, the tax code has been expanded beyond its original purpose to address a vast array of societal concerns. As a result, the tax expenditure budget has grown rapidly over the past decades - and relatively little analysis has been conducted to determine whether or not these incentives have achieved their desired effect.

Billions of dollars in tax incentives are offered every year. According to the Center for American Progress, the IRS is the federal "agency that administers the largest spending programs in the country" (Batchelder and Toder). Per the Congressional Budget Act of 1974, the US Treasury Department is required to report the estimated cost of all the tax expenditures offered in the federal tax code. To provide a sense of the magnitude of these programs, two of the largest tax expenditures are the exclusion of employer contributions for medical insurance and medical care from net income and the deferred taxation of defined contribution employer plans (U.S. Department of the Treasury). These policies exist to promote healthcare and retirement savings, respectively. According to the 2018 report by the Treasury Department, the exclusion of employer contributions for medical insurance premiums and medical care alone amounted to an estimated reduction in tax revenue of $205,080 million (U.S. Department of the Treasury).

Despite the high cost of offering these incentives, tax expenditures do not face the same level of scrutiny and evaluation as other forms of government spending. Tax expenditures are relatively easier to implement than other forms of government spending because these policies are not subject to the same annual reauthorization from Congress as regular discretionary spending (Batchelder and Toder). Once a provision is added to the tax code it becomes a permanent feature, meaning that unless explicitly stated otherwise it will be effective indefinitely (Toder). This means that the programs are relatively easier to approve, and harder to repeal if proved ineffective. As a result, many incentive programs can be effective for decades without any form of evaluation or review (Harris et al.).

Unlike discretionary or mandatory direct spending, there are very few oversight frameworks in place to evaluate tax expenditures. As discussed earlier, discretionary government spending programs are subject to an annual appropriation process. Agencies submit budget requests, which are then reviewed by subcommittees before being voted on by Congress. In addition to these annual appropriation reviews, spending programs are often audited by the Government Accountability Agency (GAO) per the request of Congress. The Office of Management and Budget also performs evaluations that are presented before Congress semiannually (Harris et al.). To supplement these federal reviews, many agencies have their own internal departments that conduct reviews of spending programs administered by the agency. Conversely, tax expenditures do not face official review unless they have expired.

There are, however, several avenues to improve the evaluation of tax expenditures going forward. A report published by the Tax Policy Institute in 2018 recommends policy evaluations by executive branch offices, congressional agencies, and external organizations. Extending these different types of evaluations, which are already used for discretionary programs, to tax expenditures would allow for more routine evaluations. Additionally, the authors of the report recommend periodic reauthorization to ensure that expenditures are not included in the tax code indefinitely without review.

Environmental Policy and Economic Incentives for Renewable Energy

One major category of tax expenditures pertains to Natural Resources and the Environment. In 2018, approximately $910 million was spent on this segment of tax expenditures. Tax expenditures are considered a subset of the economic incentives that can be used to promote environmental sustainability. Broadly, there are two major categories for environmental policy; regulations and economic incentives (US EPA). Regulations, also called “command-and-control” policies, include “emissions limits, product specifications, and pollution control guidelines” (Anderson). These regulations are imposed by the Environmental Protection Agency (EPA) in accordance with the environmental laws passed by Congress. Conversely, economic incentives utilize market forces to alter consumer behavior and encourage more sustainable business practices.

The scope of the environmental regulations imposed by the EPA is limited by Congress and has not increased significantly for several decades. Environmental regulatory policy can be traced back to the early 1970s when Congress passed the Clean Air Act of 1970 and the Clean Water Act of 1972. These two major pieces of legislation have guided American environmental policy for the last 50 years. These laws gave the EPA the jurisdiction to create regulations of pollutants that impact air and water quality (Meyer). In 1990, Congress passed a law allowing the EPA to establish new regulations pertaining to acid rain (Meyer). Since then, it has been nearly 30 years since the last substantial piece of environmental legislation was passed at the federal level. In fact, the recent expansion of the EPA’s authority can be attributed to the Judicial rather than the Legislative branch. In 2007, the Supreme Court ruled that greenhouse gases are also under the purview of the EPA (Meyer).

The process of implementing new regulations is lengthy and complex. Once a new rule is proposed, consultants are hired to compile research on the topic and evaluate the economic impact of the proposed regulation. A draft of this regulation is then brought before the Office of Management and Budget (OMB) where it must be approved by the President. After this regulation is posted to the Federal Register, it is subject to a notice and comment period from the general public (including corporations, interest groups, and citizens). The EPA then modifies these rules in accordance with the comments received before the regulation is made effective.

Economic incentives have also become a commonly used tool to supplement regulations, particularly in the last two decades (Anderson). There are several different forms of economic incentives including, but not limited to, pollution fees, subsidies, and legal liability for environmental damages. Tax expenditures are also considered economic incentives. The Energy Policy Act of 2005 included many tax provisions for clean energy including a $2.7 billion extension to the Renewable Energy Production Credit and 1.3 billion in tax reductions for energy conservation and efficiency (Barton).

A 2001 report published by the EPA outlines four reasons why economic incentives could, under certain circumstances, be preferable to regulatory policy (Anderson). First, economic incentives can achieve larger reductions in pollutants than regulations by encouraging entities to reduce emissions below the maximum amounts permitted by regulations. Second, economic incentives have lower enforcement costs than regulations. Third, economic incentives can be applied more broadly and extend towards areas that are not covered by regulations. Finally, economic incentives have the potential to promote innovative technological developments.

In addition to the factors addressed in the EPA report, there are also political considerations that lead policymakers to, at times, prefer economic incentives such as tax incentives rather than "command and control" regulation. Regulations often face pushback from the industries that they target. Whereas, because incentives are optional and do not impose hard and fast restrictions on certain activities, they tend to receive less backlash.

Evaluation of Environmental Tax Incentives

The Government Performance and Results Modernization Act of 2010 requires the OMB and other agencies to place a greater emphasis on evaluating performance and measuring the results of policies (White). This act spurred the evaluation of several tax incentives; however, these large-scale evaluations do not occur on a systematic or routine basis. Evaluations are typically conducted by independent agencies such as the Congressional Budget Office (CBO), the Congressional Research Service (CRS), and the Government Accountability Office (GAO).

For example, in 2018, the Congressional Research Service published an analysis of the Residential Energy Credits. This credit is used to incentivize individual investment in residential solar technology. The credit allows taxpayers to offset 30% of the cost of solar photovoltaic technology. This report examines different dimensions of this credit including economic efficiency, distributional equity, and administrative transparency. This report did not include a quantitative statistical analysis of the effectiveness of the credit, but the authors did note that this credit might not play a significant role in an individual's decision to invest in solar technology (Crandall-Hollick and Sherlock). Taxpayers might invest in solar technology, regardless of the credit, because of other market factors. Additionally, tax credits that are not refundable tend to benefit lower-income taxpayers to a lesser degree than high-income taxpayers. Non-refundability impacts both the efficiency and the equity of the policy. From an administrative standpoint, the IRS does not require taxpayers to provide receipts or report the address where the technology is installed. This reduces the burden on taxpayers and lowers administrative costs, but this lack of information makes it more challenging to verify the credit's efficacy.

Generally, federal evaluations help inform policy decisions, but they do not occur routinely, and they are only performed per request of members of Congress. As discussed earlier there is no framework in place that ensures that tax expenditures are reviewed routinely after they are enacted. Evaluations occur on a sporadic basis per the request of Congress members. If programs are evaluated, these reviews tend to be infrequent which makes it difficult to account for changes in technology or markets for renewable energy technology.

Policy Evaluation for Environmental Tax Incentives at the State Level

Although these in-depth evaluations are performed, albeit inconsistently, at the federal level - they are less common at the state level. In 2000, Good Jobs First published a report examining 122 audits of state economic development programs. This investigation found that many auditors struggled due to a lack of data and unclear objectives (Farmer). However, in recent years some states have begun placing a greater emphasis on performing evaluations of tax policies. For example, in Rhode Island, the Department of Revenue's Office of Revenue Analysis recently released 12 reports evaluating its various tax expenditures. These reports provide legislators with valuable information regarding the impact of these policies and allow auditors to provide useful recommendations (Goodman and Wakefield).

One category of state tax incentives focuses specifically on promoting investment in renewable energy. According to the Database for State Incentives for Renewable Energy, eleven states currently offer personal income tax credits for solar energy technology (DSIRE). Most of these states produce "Tax Expenditure" reports on an annual or biennial basis. These reports indicate the dollar amount of the credits claimed. However, some states, such as Iowa provide more complete analyses of their tax incentives. Iowa is also one of the few states that require a formal application to receive this credit. To apply for the credit, taxpayers must submit the invoice for their solar technology purchase or statements from utility companies. They must also report the output capacity of the system they purchased (Iowa Department of Revenue). All of the information collected before this credit is granted facilitates the evaluation process and allows the state to measure outcomes more accurately. Because the other states do not have such stringent disclosure requirements, it is very difficult to perform quantitative analyses of the impact of their policies.

This trend has started to shift, and recently more states have placed a greater emphasis on policy evaluation. In 2018, Massachusetts passed a law that requires the department of revenue to perform an analysis of tax expenditures every 5 years. On October 1st of 2020, Massachusetts released a draft of its Tax Expenditure Evaluation Summary for the Renewable Energy Source Credit (Massachusetts Department of Revenue).

Conclusion

For the past several decades, tax expenditures have been used as an economic incentive tool to address a vast array of societal concerns from healthcare to education. One major segment of the tax expenditure budget pertains to renewable energy and natural resources. Tax expenditures as a whole are very rarely critically evaluated and do not always require periodic reauthorization like other more direct forms of government spending. This lack of systematic evaluation is particularly troublesome for incentive programs aimed at stimulating the market for renewable energy, which is continuously evolving and changing over time. The evaluations of environmental tax expenditures that do exist typically are performed sporadically and do not attempt to quantify the effectiveness of the policy.

Due to this lack of evaluation, there is a gap in knowledge surrounding the efficacy of tax expenditures. This is particularly true for incentives targeting investment in renewable energy because technological advancements and increasing market adoption can impact responsiveness to the credit. This creates an opportunity for researchers to evaluate the success of environmental tax expenditure programs.

Empirical Analysis

Introduction

Many states offer financial incentives such as grants, rebates, and tax credits aimed at encouraging individuals and corporations to invest in renewable energy. This study focuses specifically on tax expenditures for solar energy. These tax policies can take several forms including income tax credits, sales tax deductions, and property tax deductions. This study examines if states that implement these policies tend to experience greater adoption of solar technology on average than states that do not.

This question has several implications for state policymakers and taxpayers. These incentives can be very expensive and have several opportunity costs. For example, Hawaii provided over $83 million in Renewable Energy Technology Credits in 2017. The tax revenue forgone by offering these credits could be spent on other initiatives such as education, healthcare, or other public services. It is important to determine whether or not these incentives are reaching their objectives so that legislators can make informed policy decisions to spend taxpayer dollars as wisely as possible.

Past theoretical and empirical research has examined the effectiveness of financial incentives for clean energy. However, this study expands upon prior research by examining more recent data to ascertain how the presence of state tax incentives has impacted the adoption of solar technology in the past decade. Due to changes in the environmental, economic, and political landscapes over the last decade, it is important not to rely on stale analysis from two decades ago to make policy decisions today. Hence, this study's contribution is a reexamination of a fundamental question.

Prior Literature

One of the most relevant prior studies is a paper by Sarzynski, Larrieu, and Shrimali (2012). This is the only prior study, to my knowledge, that has attempted to quantify the impact of state financial incentives for solar energy. This study does not only focus on tax credits but rather examines four different types of financial incentives: cash, property tax, sales tax, and income tax incentives. The authors use a linear regression model to examine if these incentives impacted statewide Solar PV Module Shipments in the period between 1997 and 2009. They find that cash incentives are associated with a 248% increase in Solar PV installations. However, states that offer income, sales, or property tax incentives do not demonstrate "systematically more deployment of PV technology than states without income tax incentives" (Sarzynski et al.).

Although this paper does not find a statistically significant association between income tax incentives and Solar PV Module Shipments; it is worth re-examining the effectiveness of tax credits with more recent data to account for changes in the market for solar energy and technological advancements. The Sarzynski study examines the period from 1997-2009. Since the publication of that paper, the output capacity of solar technology installed annually has increased drastically, reaching a peak of 15,128 (MWdc) in 2016 compared to a mere 849 in 2010 (Solar Energy Industries Association). In addition to greater market adoption, the cost of solar technology has also gone down in the past decade. According to the Solar Energy Industries Association, the Blended Average PV System Price ($/Watt) has dropped from $5.58 to $1.34 between 2010 and 2020 (Solar Energy Industries Association). Both of these factors could influence the effectiveness of credits over time.

Examining additional theoretical research on tax credits can provide insight as to why these incentives may have been ineffective in the past. Borenstein and Davis (2016) examines the distributional effect of clean energy tax credits. The authors focus on three federal tax credits pertaining to clean energy, including the Residential Energy Efficiency Property Credit. They find that taxpayers in the top quintile for Adjusted Gross Income (AGI) received 60% of the credits aimed at energy-efficiency whereas individuals in the bottom quintile only received 10% of these credits.

The authors' findings clearly demonstrate that these credits disproportionately benefit higher-income Americans. The paper noted that there are two primary reasons for this trend. First, solar technology is very expensive and requires a high up-front investment. Due to these cost barriers, individuals who chose to invest in solar technology tend to have higher incomes. Second, all of the tax credits examined in the paper are non-refundable. This means that they can only be used to reduce an individual's tax liability. The excess credit will not be refunded to the taxpayer in cash. Consequently, nonrefundable credits do not benefit taxpayers who do not owe any taxes. This excludes a large segment of the population. In 2012, about 35.7% of taxpayers did not owe any taxes.

Although Borenstein and David (2016) do not explicitly examine the effectiveness of this tax credit, their findings point to a fundamental limitation of environmental tax credits. These incentives have been historically designed in a manner that benefits a very limited segment of the population. For this reason, most non-refundable tax credits are not conducive to promoting the mass deployment of solar energy technology.

Another study on the effectiveness of tax credits is a paper written by Felix Mormann (2014). This paper discusses the theoretical effectiveness of federal tax credits for renewable energy and proposes alternative methods of encouraging the deployment of solar energy. The author argues that tax credits are very costly and identifies different characteristics that make tax credits ineffective as an incentive tool. Mormann posits that the primary reason why tax incentives are less effective than cash incentives (such as grants and rebates) is that nonrefundable credits are only beneficial to individuals who have a tax liability to offset. As a result- many of these incentives are only beneficial to individuals with higher incomes.

Design and Methodology

Similar to the methodology used by Sarzynski in her 2012 paper, this study uses cross-sectional time-series data to assess the cross-sectional impact of state tax incentives on solar technology over time. The model includes data for all 50 states and Washington DC from 2009 to 2018. The dependent variable of interest is the annual Solar PV Module shipments per state. This metric captures the total output capacity of solar technology that is installed in a state each year (in peak kilowatts). This output variable is indicative of the success of credits because the objective of these policies is to promote investment in solar technology and consequently increase the total capacity for solar energy installed in the state.

The independent variables for this study are binary variables for each type of tax incentive (i.e. Property, Sales, and Income tax incentives). This includes incentives for both residential and commercial installations of solar technology. Most states which offer these incentives extended them to both corporate and individual taxpayers, but some states only cover one sector. Property tax incentives exempt taxpayers from paying property taxes on solar technology. Sales tax incentives typically take the form of exemptions, where taxpayers are exempt from paying sales tax for purchases of solar energy technology. Income tax incentives are usually structured as tax credits, which are a dollar for dollar reduction in tax liability. For each year, the pertinent variable is set to “1” if the state offered that type of incentive. The variable is set to “0” if the state did not offer that particular type of incentive in a year. This process is repeated for each state for all years from 2009-2018. Through the use of regression analysis, this study will examine whether or not the presence of these different state incentives has a statistically significant impact on the adoption of solar energy.

These state incentives can be used in conjunction with the federal Solar Investment Tax Credit. This federal credit was equal to 30% of the purchase cost of the solar technology throughout the time period covered by this study. Since the federal credit is the same for all states and years analyzed in this study, differences observed between states can be attributed to state policies rather than the federal incentive. Therefore, this study examines the marginal impact of the state incentive programs, in excess of the federal credit to determine if state incentives influence consumers decisions to invest in solar energy.

Data Collection

This study uses archival data and regression analysis to identify the incremental impact that state tax credits have on the adoption of solar energy. Data on the independent variable, Solar Photovoltaic Module Shipments is available from the U.S. Energy Information Administration. This metric measures the shipments of solar energy technology (in peak Kilowatts) in each state per year. To standardize these observations by population size, I calculated the Solar PV Module Shipments per Capita using annual population data by state obtained from the U.S Census Bureau. The Energy Information Agency collects this information through surveys. This survey is mandatory for producers of solar technology under 15 U.S.C. 772(b) (U.S. Energy Information Administration).

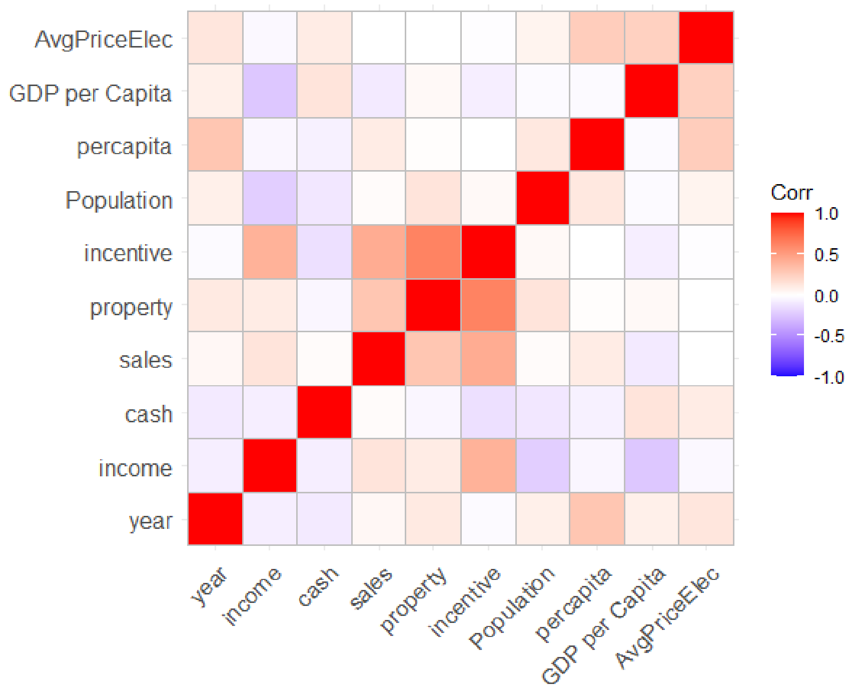
The Database of State Incentives for Renewable Energy (DSIRE) collects information regarding state incentives for renewable energy. This database was used to determine what incentives were offered in each state from 2009 to 2018. Although this resource is quite exhaustive, there may be some incentives from prior years that are missing from the database. I supplemented this research by examining information from states' departments of revenue to ensure the information I have is correct and complete.

Table 1 provides a summary of the variables in the data set, including the control variables included in the statistical model. Table 2 shows the correlation between variables in the data set.

Table 1: Descriptive Statistics

Variable	Min	1st Quarter	Median	Mean	3rd Quarter	Max
Shipments	1	1742	10583	117634	66896	3671381
Income	0	0	0	0.4059	1	1
Sales	0	0	0	0.4647	1	1
Property	0	0	1	0.6569	1	1
Incentive	0	1	1	0.8275	1	1
Shipments per Capita	0	0.00053	0.00269	0.01426	0.01362	0.23495
GDP per Capita	$33,144	$43,554	$49,415	$53,243	$56,987	$181,691
Avg. Price Elec	6.08	8.42	9.39	10.63	11.78	34.04

Table 2: Correlation Table



Controls

Several factors might impact the amount of Solar PV Module Shipments in a given state besides the presence of tax credits. The model contains several control variables to address other potentially confounding effects that influence the adoption of solar technology. The statistical model contains a fixed effect variable for each state and each year. This captures the systematic variance that is inherent to each state. For example, California might receive more sunlight or have a higher average income than other states. The fixed effect variable for each year captures trends that occur over time and impact all states (i.e. the decreasing cost of solar energy and macroeconomic trends, among others).

Another necessary control variable is the annual State GDP per Capita. States with high-income levels might experience higher levels of investment in solar energy due to greater disposable income. This data was obtained from the U.S Census Bureau.

Finally, I also included the Average Retail cost of electricity per state over time. The cost of electricity influences how likely people are to adopt solar energy. For example, in Hawaii, the average retail cost for electricity was $0.25 per kilowatt-hour (compared to the US average of $0.13). This information is reported annually by the Energy Information Agency.

Limitations

This study does have certain research design considerations and limitations driven by data availability that should be taken into consideration when interpreting the results and conclusions.

Firstly, Solar PV Modules Shipments was chosen as the outcome variable to evaluate the success of the tax incentive. However, this variable may not the most accurate proxy for incentive effectiveness. This variable measures the total amount of capacity for solar PV energy installed in a state in a given year. The goal of the study is to examine how the presence of a tax incentive influences the deployment of solar technology. However, not every solar energy investment project is eligible to receive a tax credit. For example, Iowa imposes a cap of $5 million for their Solar Energy System Tax Credit. As a result, only approximately 24% of the capacity for solar technology installed in 2018 qualified for the credit. Other states, such as Hawaii impose output capacity restrictions which limits the types of technologies that qualify for the credit. Because not all solar installations qualify for credits, the differences observed in the outcome variable may not be entirely attributable to the tax incentive.

Additionally, there are some limitations regarding the independent variables chosen for this study. Utilizing binary variables simplifies the data collection process - however not all credits are equivalent. States differ a great deal on the total value of credits offered, the scope of the credits, and how accessible or salient they are to taxpayers. Therefore, only considering whether or not a State offers a particular type of incentive does not account for the fact that incentive effectiveness might vary depending on the design and execution of the policy in each State.

Second, it is possible that certain significant variables have not been considered. The omission of other potential variables could skew the results of the statistical analysis by incorrectly attributing the impact of these excluded factors to the other variables that were included in the model. The use of State and Year fixed effects helps mitigate the omitted variable problem by controlling for unobserved, yet systematic differences across States and years. These fixed effects capture characteristics unique to each state such as sun exposure, cultural values, and other unobserved or unquantifiable differences across states that could potentially impact the adoption of solar technology and confound the results of the statistical model. However, it is possible other certain significant variables were overlooked and not included in the model.

In addition to these design considerations, the results of this study are limited to the time between 2009-2018. Certain external economic, political, or even environmental factors unique to this period may have influenced the results of the study. The time fixed effect variable was included to control for changes in the adoption of solar energy over time within the period covered by this study. However, these results may not be generalizable to other periods outside of the study.

Analysis and Findings

The first model in this study examines the relationship between state “incentives” and Solar PV Module Shipments. The independent variable in this model is a binary variable indicating whether or not a state offers any sort of tax incentive in a year. This includes income, property, and sales tax incentives. Two control variables were included in this model: the average price of electricity for each state per year, and the annual GDP per Capita for each state. This model also included fixed effects for both years and state. These fixed effect terms are included to capture unobserved, systematic differences across states, and years. This study uses Prais-Winsten estimation and panel corrected standard errors to account for serial correlation amongst observations and address the heteroskedasticity of standard errors. According to this first model, there is not a statistically significant relationship between tax incentives (as a whole) and Solar PV Module shipments. The P-value for the “incentive” variable is .229, meaning that we cannot reject the null hypothesis that tax incentives do not influence the adoption of solar technology in a state. Table 3 displays the results of this model.

Table 3: Analysis of Incentives

prais_winsten(percapita ~ incentive + gdppercap + AvgPriceElec +factor(State) + factor(year))

	Estimate	Std. Error	T Value	P-Value
(intercept)	0.3667475	0.30447062	1.2045	0.2291052
Incentive	-0.0005746	0.00298072	-0.1928	0.8472407
GDP per Capita	-0.03817497	0.02890785	-1.3206	0.1874118
Avg. Price Electricity	0.0033290	0.00104117	3.1974	0.0014990 **

R^2 = .5407

Although the results of the first model suggest that tax incentives, on average, are not effective in increasing the adoption of solar technology, different types of incentives may have varying levels of effectiveness. To address this possibility, the second model examines the effectiveness of the different types of tax incentives by replacing the general “incentive” term with a unique term for each incentive type “Income”, “Sales”, and “Property”. The same controls used in the “incentive” model are also included in this model. As shown in Table 4, none of the inventive variables were statistically significant. Therefore, we cannot reject the null hypothesis.

Table 4: Analysis of Different Incentive Types

prais_winsten(percapita ~ income + sales + property + gdppercap + AvgPriceElec + factor(State) + factor(year))

	Estimate	Std. Error	T Value	P-Value
Intercept	0.32838079	0.29093669	1.1287	0.2597157
Income	-0.0030655	0.00331117	-0.9258	0.3551225
Sales	0.00373742	0.00518149	0.7213	0.4711541
Property	0.00509134	0.00841763	0.6048	0.5456346
GDP per Capita	-0.0345054	0.02769392	-1.2460	0.2135260
Avg. Price Electricity	0.00321739	0.00107439	2.9946	0.0029226 **

R^2 = .543

After examining the effectiveness of the different incentive types, an interaction term was added to capture the multiplicative effect of tax incentives and the Average Price of Electricity on the market deployment of solar technology. This model was used to determine if the impact of tax incentives on solar energy deployment is moderated by the Average Price of Electricity in a state. The results of the regression analysis suggest that income tax incentives tend to have a greater impact in States with higher electricity costs. Taxpayers might be more responsive to incentives in states where the cost of electricity is very high. In theory, solar technology is a more economically viable incentive in states where electricity is higher. Therefore, the effectiveness of income tax credits is moderated by the price of electricity. Tables 5.1 and 5.2 display the results of the models with the interaction terms.

Table 5.1: Interaction between Incentive and The Average Price of Electricity

prais_winsten(percapita ~ incentive + gdppercap + AvgPriceElec + AvgPriceElec*incentive + factor(State) + factor(year))

	Estimate	Std. Error	T Value	P-Value
Intercept	0.38407161	0.31919706	1.2032	0.2296085
Incentive	0.00433710	0.01325884	0.3271	0.7437591
GDP per Capita	-0.04021985	0.03070711	-1.3098	0.1910342
Avg. Price Electricity	0.00378199	0.00133781	2.8270	0.0049393 **
incentive:AvgPriceElec	-0.00049075	0.00122706	-0.3999	0.6894175

$R^2 = 0.5408$

Table 5.2: Interaction between Incentive Types and the Average Price of Electricity

prais_winsten(percapita ~ income + property + sales + gdppercap + AvgPriceElec + AvgPriceElec*income +AvgPriceElec*property + AvgPriceElec*sales + factor(State) + factor(year), data=solar)

	Estimate	Std. Error	T Value	P-Value
Intercept	0.4010053	0.2978529	1.3463	0.1789853
Income	-0.0292069	0.0138571	-2.1077	0.0356958 *
Sales	0.0255009	0.0179758	1.4186	0.1568105
Property	-0.0208746	0.0145834	-1.4314	0.1531203
GDP per Capita	-0.0398325	0.0284651	-1.3993	0.1625078
Avg. Price Electricity	0.0013717	0.0014509	0.9454	0.3450283
income:AvgPriceElec	0.0026697	0.0013562	1.9685	0.0497230 *
property:AvgPriceElec	-0.0021411	0.0013355	-1.6032	0.1097039
sales:AvgPriceElec	0.0027669	0.0014814	1.8678	0.0625439 .

$R^2 = 0.5496$

In 2017, Congress passed the Tax Cuts and Jobs Act. This tax reform resulted in several significant changes to the federal tax code. Some of the most significant changes included: a reduction in the top corporate tax rate, 100% bonus depreciation, and a significant increase in the standard deduction for individuals. This change in federal tax policy likely had an impact on individuals' and corporations' decisions to invest in solar technology.

In order to mitigate the possibly confounding impact of this change in federal tax policy, the data set was divided into two subsets (Pre and Post-2017). For the "Pre-2017" subset, the "income" incentive, and the "income: AvgPriceElec" interaction were statistically significant (Table 6.1). As such, we can reject the null hypothesis that income tax incentives have no impact on the deployment of solar energy technology. The estimate for the "income" tax incentive variable was significantly higher for the Pre-2017 subset when compared to the original interaction model. However, in this model, both Sales and Property tax incentives do not have a statistically significant impact on the adoption of solar technology. There are two primary reasons why this could occur. Income tax incentives for solar technology are typically structured as credits, which are a dollar for dollar reduction in tax liability. Sales and property tax incentives, on the other hand, are normally structured as exclusions or deductions. This means that the economic value of income tax incentives is typically higher. Additionally, in most states, taxpayers pay more income taxes than sales or property tax. This could explain why income tax incentives are effective when sales and property tax incentives are not.

Table 6.1: Pre 2017 Analysis

prais_winsten(percapita ~ income + sales + property + AvgPriceElec + AvgPriceElec*income + factor(State) + factor(year), data=pre2017)

	Estimate	Std. Error	T Value	P-Value
Intercept	-0.00905968	0.01419586	-0.6382	0.5238066
Income	0.03790733	0.01551109	-2.4439	0.0150714 *
Sales	0.00183191	0.00621519	0.2947	0.7683793
Property	0.01103070	0.00983660	1.1214	0.2629638
Avg. Price Electricity	0.00053818	0.00163742	0.3287	0.7426184
income:AvgPriceElec	0.00365314	0.00146674	2.4906	0.0132594 *

R^2 = 0.5636

For the period from 2017-2018, none of the incentives were statistically significant, as shown in Table 6.2. The interaction term was also statistically insignificant. These results indicate that the change in federal tax policy may have influenced the effectiveness of tax credits. Provisions in the 2017 tax reform such as, a lower corporate tax rate and 100% bonus depreciation for assets might have impacted corporation’s decisions to invest in solar technology. It is also possible, however, that this non-result is due to low statistical power caused by a small sample.

Figure 6.2: Post-2017 Analysis

lm4 = lm(percapita ~ income + sales + property + AvgPriceElec + AvgPriceElec*income + factor(State) + factor(year), data=post2017)

	Estimate	Std. Error	T Value	P-Value
Intercept	-5.261e-03	6.972e-02	-0.075	0.94037
Income	2.944e-01	2.759e-01	1.067	0.29481
Sales	1.055e-03	2.216e-02	0.048	0.96235
Property	4.625e-03	1.897e-02	0.244	0.80911
Avg. Price Electricity	1.156e-03	6.544e-03	0.177	0.86102
income:AvgPriceElec	-1.733e-02	1.931e-02	-0.897	0.37698

$R^2 = 0.8834$

Areas for Future Research

Future studies could perform a more detailed quantitative analysis of different policy attributes that may influence the effectiveness of tax incentives. As established earlier, not all tax credits are the same. State policies differ significantly regarding the monetary value of the credit offered, the refundability of the credit, and the scope of technology that qualifies for the credit. Future studies could explore how different policy attributes influence the effectiveness of the credits. Greater detail in the statistical model could also account for fluctuations in state policies over time. Relying on publicly available data, this study utilized a binary variable to represent the presence of a tax incentive. This approach simplifies the statistical model and provides insight into whether or not states with incentives tend to experience higher levels of solar technology. However, State lawmakers and revenue agencies could benefit from more detailed information regarding the effectiveness of specific policy attributes.

Since this study focuses specifically on tax incentives, future research could examine other types of environmental incentives offered by state governments such as rebates, grants, and loans. For example, New York State offers a loan program that is implemented by the New York State Energy Research and Development Authority. Prior literature has questioned whether revenue departments are the appropriate agency to implement specific economic incentive programs. Environmental or Energy agencies have more industry-specific knowledge and resources which could, in theory, improve their ability to implement and execute targeted economic incentives. Future research could examine how the effectiveness of tax incentives compares to other economic incentive programs that are not enacted through the tax code. If on balance, tax incentives tend to be less effective than other forms of government spending, then states might need to reconsider how they structure incentive programs for renewable energy. Additionally, the presence of other economic incentives might influence the effectiveness of tax incentives. If states offer multiple types of incentives, the tax incentives might be redundant and ineffective.

Additionally, this study only analyses incentives for solar energy. This category of renewable energy was chosen for the study because solar energy has been widely adopted in both the residential and commercial sectors. Additionally, a higher proportion of states offer tax incentives for solar energy than any other form of renewable energy. However, future research could examine the effectiveness of tax incentives for other forms of renewable energy such as wind, biomass, and hydroelectric technology. There may be systematic differences in the markets for each type of renewable energy technology which results in differing responsiveness to incentives. Expanding the scope of the study and examining different types of renewable energy could help identify which types of incentives have the greatest impact.

Case Studies

State Case Studies

The following case studies provide insight into how different states design, implement, and evaluate their tax incentives. This section focuses specifically on Iowa, Hawaii, and Massachusetts. Each of these states offers income tax credits for solar photovoltaic energy. However, the terms of these credits and the processes through which they are evaluated differ significantly. The purpose of this section is to draw lessons and key takeaways from these case studies so that other states can design and evaluate their policies effectively. These case studies focus, in particular, on the amount of the credit offered, which sectors the credits are available to (i.e. residential or commercial), and whether or not they are refundable. Additionally, these case studies examine the various methods used by the states for evaluating their tax incentives including how data is collected, what metrics are used, and how often reports are produced.

Iowa

According to Iowa Code section 422.11L, the Iowa Department of Revenue is required to release a report regarding the value of the Solar Energy System Tax Credits claimed annually. In Iowa, the tax credit is calculated based upon the federal Residential Energy Efficient Property Tax Credit. The Iowa tax credit is equal to 50% of the federal credit but cannot exceed $5,000 for individuals and $20,000 for businesses. The total amount of credits offered has been capped at a maximum value of $5 million, since 2015. Capping the total amount helps with budgeting by imposing an upper limit for how much tax revenue is foregone by offering the credit. However, this limitation may potentially hinder the efficiency of the credit by limiting the credit to a select group of people who submit their applications early enough.

Since the program's inception in 2012, Iowa has offered over $26 million in solar tax credits for 4,202 unique solar installations (Iowa Department of Revenue). Iowa's credit managed to subsidize 12.7% of the total cost of installation. This credit may be used in conjunction with the 30% tax credit offered by the federal government. The Iowa Department of Revenue estimates that, with both of these incentives, approximately 43% of the cost of installing Solar PV technology is subsidized for Iowa taxpayers. Iowa also tracks the output capacity of the systems installed by tax credit recipients. According to the report for 2018, the total output capacity for the systems installed under the credit was nearly 2,000KW. However, the Energy Information Agency reported that over 8,000 KW of solar capacity was installed in Iowa in 2018. The credit was only applied to about ¼ of the total installations in the state. Due to the cap of $5 million, not all solar technology installations are able to receive the credit.

Iowa is one of the few states that requires a formal application process for their tax credits. In order to receive the credit, applicants must disclose the total cost and output capacity of the qualifying technology. This process allows the Iowa department of revenue to collect data regarding how this credit is being used. Additionally, information regarding the total cost of the system helps to determine the relative value of the credit to taxpayers and allows the Department of Revenue to calculate what percentage of the total cost is subsidized through the credit.

However, this does impose a nontrivial burden on taxpayers. Iowa has an online system called the Credit Award, Claim, and Transfer Administration System (CACTAS). When completing their applications, taxpayers must provide a copy of their invoice for the solar technology, verification that they are a qualified applicant, and a Tax Credit Applicant

Certification. These applications are accepted on a first come first serve basis until the cap of $5 million is met.

Hawaii

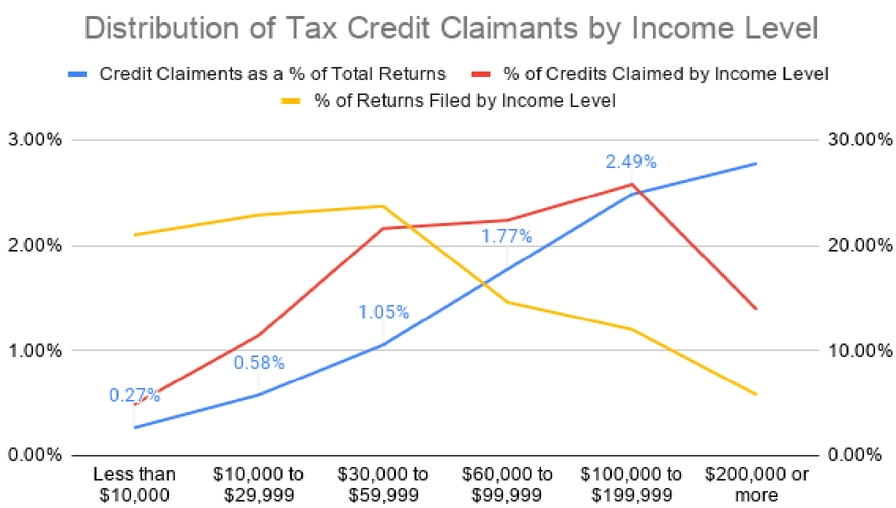
In 2018, Hawaii offered over $70 million in Renewable Energy Technology Income Tax Credits (Choy). However, this credit applies to several different types of renewable energy including wind energy. For solar PV technology, the credit equals 35% of the cost of the systems and is capped at $5,000 for single-family homes and $500,000 for commercial buildings. Additionally, Hawaii imposes an output capacity minimum of 5 kilowatts for single-family residences. These output requirements ensure that the incentives include a minimum amount of investment in solar energy. In 2018, 5,744 taxpayers claimed the tax credit for solar technology. Of the $70 million offered in renewable energy credits, approximately $26 million went towards solar energy specifically. It is worth noting that in 2018 Hawaii offered nearly the same value of credits that Iowa offered in total between 2012-2018. Hawaii does not restrict the total amount of credit that can be claimed by taxpayers. While this does increase the number of individuals that could potentially benefit from this credit, it also increases the cost of offering the credit and makes it more difficult to budget for how much will be spent on the expenditure per year.

Unlike Iowa, Hawaii does not collect information regarding the total capacity (in Kilowatts) installed in a given year. Hawaii also does not collect data regarding the total cost of the system. This lack of information makes it difficult to determine how much of the solar PV installation in the state can be attributed to the credit. Consequently, the state also cannot report what percentage of the total cost of solar technology is subsidized through the credit. Without this information, it is difficult to determine how much a consumer's decision to invest in solar technology is driven by the existence of the state credit.

However, Hawaii's Department of Taxation does report the income level distribution of individuals who claim the tax credit. Of the $34 million of Renewable Energy tax credits offered to individuals, $3.7 million went towards taxpayers with income less than $30,000. Collecting and reporting this information is important because it allows the States to be aware of which come groups are deriving the most benefits from these credits. Lawmakers should be cognizant of the distributional impacts of their policies to ensure that policies are equitable and fair. Hawaii is unique because it is the only state that offers a renewable tax credit for individuals whose tax credit exceeds the tax liability they owe. This means that the credit is more accessible to lower-income taxpayers who do not owe large tax liabilities.

However, making credits refundable does not automatically solve the issue of inequitable distribution. As shown in Figure 1 below, the credit is disproportionately claimed by individuals in high-income brackets. Despite the fact that there is a larger proportion of returns filed by lower-income individuals, only a small fraction of these individuals have claimed the credit. Furthermore, it is worth noting that this does not include individuals who are not required to file returns.

Figure. 1 Distribution of Tax Credit Claimants by Income Level



Massachusetts

In 2018, Massachusetts created the Tax Expenditures Review Commission which is responsible for evaluating tax incentives based on revenue loss, jobs created, and the return on investment. This commission is required under Chapter 207 of the Acts of 2018 to produce a report with their analysis of each tax expenditure every five years. This act was an important step in promoting policy evaluation and increasing accountability for policymakers. Prior to the establishment of the Tax Expenditures Review Commission, Massachusetts did not have a designated group responsible for evaluating specific incentive programs. The only information reported by the state is the total value of credits offered each year.

The first report for the Renewable Energy Source tax credit was published on October 1st of 2020. In Massachusetts, the Renewable Energy Source Credit is equal to 15% of the taxpayer's renewable energy expenditures, capped at $1,000. In 2018, Massachusetts offered approximately $4.2 million in Renewable Energy Source tax credits (*Tax Expenditure Review Commission | Mass.Gov*).

This report also contains a section discussing whether or not the incentive is achieving its desired effect. The utilization of this credit increased very rapidly in the past decade. In 2010 under $1 million of credit was claimed, growing substantially to a peak of over $5 million in 2016. The report, however, does not contain information regarding the cost or the total output capacity of the technology installed. This lack of information makes it difficult to determine how much of the new capacity for solar energy installed in a state can be attributed to the credit. Additionally, without knowing the total cost of the systems installed - the state cannot determine how much of the cost is subsidized by the state credit. However, requiring individuals to report this information would increase the burden on taxpayers and might discourage them from utilizing the credit due to high complexity or concerns about confidentiality.

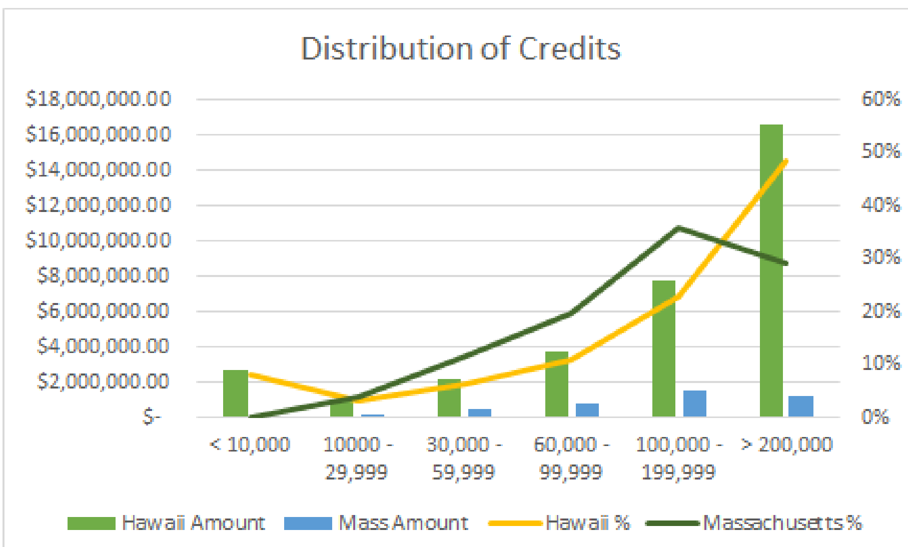
The Massachusetts Department of Revenue also provides a clear breakdown of the distribution of this tax credit by income level. The majority of the tax credits went towards individuals with incomes higher than $150,000. Approximately 24% of the total amount of the credit went towards taxpayers in the $200,000 - $250,000 income level. In Massachusetts, only 4% of the total credits went towards taxpayers with income below $30,000. This disproportionate distribution occurs for several reasons. First, solar panels require a large capital investment that is typically inaccessible to lower-income families. Secondly, this particular tax incentive is not refundable, therefore it is not applicable to individuals who do not owe a tax liability. Based on the statistics in this report, the policy disproportionately benefits higher-income individuals. If the purpose of the credit is to increase the adoption of solar energy and make renewable energy more accessible, the credit should be available to all taxpayers regardless of their tax liability.

Commentary

Distributional Effects and Refundability

One key takeaway from these reports is the importance of examining the distributional impact of these solar credits. In both Hawaii and Massachusetts, solar energy credits were disproportionately claimed by taxpayers in higher-income groups. We could not draw conclusions regarding the distribution of Iowa's Solar Energy Systems Tax Credit because they did not report information regarding the income level of the individuals claiming these credits. Figure 2 shows the distribution of the income levels of taxpayers who claimed the solar energy tax credits for the year 2018.

Figure 2. Distribution of Tax Credits by Income Levels



There are two primary reasons for this unequal distribution of tax credits. First, solar energy systems require a high upfront investment that might be prohibitive to families with lower incomes. According to the 2018 report produced by the Iowa Department of revenue, the average (unsubsidized) cost for a residential solar photovoltaic system is about $25,650. Federal and state financial incentives can help reduce this cost, however, the investment is still inaccessible for many families. The aim of environmental tax credits is to promote investment in renewable energy technology by making it more accessible and affordable to more families. However, when creating these policies, state agencies face budget constraints. Consequently, it is not possible to fully subsidize the cost of solar technologies for all families. Although, agencies can make solar technology more accessible to low-income families by making credits refundable.

The second major factor influencing the distribution of solar tax credits is the fact that nonrefundable tax credits are only beneficial to individuals that have a tax liability. If a person does not owe taxes for a given year, the credit cannot be used. Hawaii does offer the option to receive a refund for their tax credit, however, this option is only open to individuals whose income is below $20,000 (or $40,000 for married individuals filing jointly). This explains why Hawaii has a higher proportion of lower-income individuals who claim the credit, compared to Massachusetts which does not offer a refundable credit. Making credits refundable does not automatically solve the unequal distribution of the credit but it does make these incentives more accessible to individuals who do not owe taxes.

Aside from these distributional considerations, making credits refundable is also more economically efficient. In the absence of evidence suggesting that people of different income groups respond differently to incentives - then incentives should not be designed in a way that excludes certain groups (Batchelder et al.).

Data Collection, Evaluation, and Administrative Costs

Hawaii, Massachusetts, and Iowa were chosen as case studies because these are the states which report the most information on their credits. Most states at least report the monetary value of the credits offered in a given year. However, many states do not provide detailed information regarding the number of kilowatts installed under the credit, the cost of the systems installed, or demographic information regarding the distribution of income levels of credit recipients. This information is very useful for states when analyzing who the credit is going towards, how much of the technology is being subsidized, and how much of the increase in solar technology can be attributed to the credit.

Each of these three states has different systems in place to collect data and perform evaluations. Massachusetts established the Tax Expenditure Review Commission in 2018 (Massachusetts Department of Revenue). This commission is tasked with evaluating tax expenditures based on their impact on state revenue, job creation, and return on investment. This group performs evaluations on a 5-year schedule with the information provided by the Massachusetts Department of Revenue. The data provided for these evaluations is limited to protect taxpayer confidentiality.

Hawaii’s Tax Research and Planning Office publishes an annual report on the Credits Claimed by Taxpayers. These reports provide valuable information regarding the total amount and the distribution of tax credits claimed. This information is similar to what is reported in the Massachusetts Tax Expenditure Review Commission's reports, however, it occurs on an annual basis rather than every 5 years. In addition to these annual reports conducted by the Tax Research and Planning Office, Hawaii also has a Tax Review Commission which conducts a holistic review of Hawaii’s tax system every 5 years (State of Hawaii Department of Taxation). The Tax Review Commission evaluates Hawaii’s tax system based on economic efficiency and distributional equity.

Iowa's Department of Revenue is required by state law to submit an annual report regarding the monetary value of the Solar Energy Systems Credits claimed (Iowa Department of Revenue). In addition to these annual reports, the Legislative Tax Expenditure Committee performs cyclical evaluations of Iowa's tax expenditures every 5 years. The committee was established in 2016 and has not yet performed an extensive evaluation of the Solar Energy Systems credit. However, based on past reviews of other tax credits, these evaluations typically consist of an overview of the history of the incentive program, information regarding the value of the credits claimed during the relevant time period, and economic analysis of the impact of the credit.

Data collection and reporting is necessary to accurately evaluate tax credits. Data allows legislators to make informed decisions and ensure that ineffective policies are redesigned or repealed. However, increasing data collection can increase the administrative costs associated with offering the credits. Lawmakers must balance collecting information with imposing additional administrative costs and increasing the burden upon taxpayers. Introducing tax incentives inherently complicates the tax system and increases administrative costs. This is especially true in states that require a formal application process. Applications impose an additional burden on taxpayers and also require state agencies to unitize additional resources to process these applications.

To reduce the administrative costs of offering tax credits, many states choose to perform evaluations of tax credits on a cyclical basis (ranging from every year to every 10 years). This allows state agencies to perform routine evaluations of credits without having to evaluate every incentive annually. Spacing out these evaluations spreads out the workload for analysts and allows lawmakers to focus on a select number of incentives each legislative session (Chapman and Goodman). The frequency of these cycles is contingent upon the number of incentives that are being evaluated and the resources available to the revenue agency. For example, Washington only performs evaluations every ten years because, in addition to tax credits, they also evaluate other tax preferences including exemptions and deductions. The broader scope of the evaluation process makes it difficult to perform evaluations on a more frequent basis.

Conclusions from Case Studies

These case studies provide insight into how different states chose to design and evaluate their tax incentives for solar technology. Each state has different systems in place to perform evaluations of their incentive programs. The insights gained from these evaluations are determined by the data available to analysts and the frequency with which the evaluations are performed. Iowa can provide a more technical analysis of the effectiveness of its credits based on the data collected through their application program. The Hawaii Department of Taxation and the Iowa Department of revenue do not have access to the same technical information as Iowa. Due to these data constraints, their evaluations focus on the distributional impacts of their incentive programs.

Iowa requires a formal application process which requires taxpayers to disclose the output capacity and cost of the qualifying technology. Having access to their information allows the state to determine how much of the increase in solar technology can be attributed to the credit, and how much of the costs of the technology is subsidized by the credit. This application process increases the burden on taxpayers, but it does provide states with valuable information to accurately evaluate the effectiveness of their credits. Generally, states must balance the need for information and the administrative costs associated with data collection.

Hawaii and Massachusetts both evaluate the distributional impacts of their credits by reporting the value of credits claimed by different income groups. Credits were disproportionately claimed by high-income taxpayers. There are two primary reasons for this trend. Firstly, solar technology requires a large initial investment that can be cost-prohibitive for lower-income families. Additionally, in most states, solar tax credits are non-refundable. This means that the credits cannot be used by taxpayers who do not have a positive tax liability. States can make their tax credits more accessible to taxpayers of all income levels by making credits refundable and extending the credit to include leased technology.

Conclusion

Tax expenditures have been a popular social policy tool for the past several decades. Legislatures, at times, prefer tax expenditures to direct government spending for several reasons. First, tax expenditures face less pushback because they are often perceived as reducing the size of the government by cutting taxes (when in reality, tax expenditures increase the size of government, like any other type of spending program). Additionally, tax expenditures do not undergo the annual appropriations process where different programs must compete for limited resources. Due to its relative convenience as an incentive tool, the tax expenditure budget has grown significantly since 1986. A review of the history of tax expenditures reveals that these incentive programs do not face the same scrutiny as other types of government spending. After these measures are passed in Congress, they become permanent features of the tax code, unless a "sunset" date is explicitly stated. Despite the high costs of offering these credits, there is no framework in place to ensure that these incentive programs are evaluated regularly.

The lack of evaluations presents an opportunity to empirically examine the historical success of environmental tax expenditures. The results of this study suggest that, between 2009 and 2017, the average price of electricity has a moderating impact on the effectiveness of tax credits. Solar technology is a more economically viable option in states where the cost of electricity is particularly high. This explains why tax incentives are more effective in states with high electricity costs. Based on the results of this study, property and sales tax incentives seem to be less effective than income tax credits. This may be because income tax incentives typically take the form of credits, a dollar for dollar reduction in tax liability rather than a deduction. Additionally, in most states, taxpayers have higher income tax liability than sales or property tax and for this reason, income tax incentives might be more valuable. Future research could expand upon these findings by examining incentives for different types of renewable energy, comparing tax incentives to other forms of economic incentives, or identifying attributes that make some incentives more effective than others.

Three case studies, Hawaii, Iowa, and Massachusetts are used to provide insight into how different states administer and evaluate their tax credits. Iowa requires an application for taxpayers who would like to claim the Solar Energy System credit. The Iowa Department of Revenue is required to produce a report every year outlining the total value of credits claimed, the output capacity of the solar energy systems installed under the credit, and the total cost of these systems. The application process makes data more available and facilitates the evaluation of the credit in Iowa. Massachusetts and Hawaii's evaluations focus more on the distribution equity of their tax credits. In both of these states, tax credits are disproportionally claimed by high-income taxpayers, and often do not benefit taxpayers with no, or very little tax liability. Generally, each state's evaluation process is guided by data availability and the resources at the state agency's disposal.

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