2019

THE DECISION TO DECENTRALIZE GOOD PROVISION IN THE UNITED STATES: A STUDY IN CLEAN ENERGY POLICY

Whitney Michelle Davis
University of Kentucky, whitneymdavis001@gmail.com
Digital Object Identifier: https://doi.org/10.13023/etd.2019.250

THE DECISION TO DECENTRALIZE GOOD PROVISION IN
THE UNITED STATES:
A STUDY IN CLEAN ENERGY POLICY

_____

DISSERTATION
_____

A dissertation submitted in partial fulfillment of the
requirements for the degree of Doctor of Philosophy in the
Graduate School
at the University of Kentucky

By

Whitney Michelle Davis

Lexington, Kentucky

Co-Directors: Dr. Eugenia F. Toma, Wendell H. Ford Professor of Public Policy
and   Dr. Rebecca Bromley-Trujillo, Assistant Professor

Lexington, Kentucky

ABSTRACT OF DISSERTATION

THE DECISION TO DECENTRALIZE GOOD PROVISION IN THE UNITED
STATES: A STUDY IN CLEAN ENERGY POLICY

Normative economic theory provides justification for at least partially centralized renewable energy provision due to the large, positive externalities associated with renewable energy production. However, the United States is one of the few countries without centralized renewable energy policy. Instead, the federal government actively chooses decentralized renewable energy provision by using fiscal transfers to support subnational renewable energy development. This dissertation explores why U.S. legislators choose decentralized renewable energy provision by asking two primary questions. First, what is the motivation for using federal fiscal transfers for decentralized renewable energy output considering what we know about positive spillovers and market failure associated with decentralized renewable energy production? Second, do fiscal transfers for decentralized renewable energy provision increase renewable energy production at the local level? The theoretical model proposed in Chapter Four posits why policymakers choose decentralized renewable energy provision. The chapter argues that the current political price associated with a specific policy issue affects legislators' choices regarding good provision. I hypothesize that when the political price associated with vying for centralized good provision is high, legislators are incentivized to choose decentralized good provision. Chapter Five applies this theory to empirically evaluate the choice to decentralize renewable energy provision. The chapter examines whether the current political price of renewable energy policy affects the likelihood of a legislator proposing decentralized funding for renewable energy provision. I hypothesize that legislators will propose funding to support decentralized renewable energy development when the political price associated with renewable energy policies is high at a given time. The results show that when the political price of renewable energy policy is low, a policymaker is less likely to use grants to support renewable energy projects, finding support for the hypothesis. Chapter Six empirically evaluates the effectiveness of renewable energy grants at the local level to further understand the theoretical model proposed in Chapter Four. I hypothesize that receiving a renewable energy grant increases renewable energy output at the local level. The results support this hypothesis by showing that receiving a renewable energy grant is associated with significant and positive increases in solar energy production. These

findings provide further insight into legislative decision-making and the role of renewable energy grants in renewable energy development in the U.S.

KEYWORDS: Energy Policy, Energy Grants, Fiscal Federalism, Fiscal Transfers, Legislative Decision Making

Whitney Michelle Davis

June 15, 2019

THE DECISION TO DECENTRALIZE GOOD PROVISION IN
THE UNITED STATES:
A STUDY IN CLEAN ENERGY POLICY

By

Whitney Davis

Eugenia F. Toma
Co-Director of Dissertation

Rebecca Bromley-Trujillo
Co-Director of Dissertation

Eugenia F. Toma
Director of Graduate Studies

June 15, 2019

DEDICATION

I dedicate this work to my daughter, Harlee,
who inspires me to be a better person;
my late grandfather, Lenville,
who offered endless support and encouragement throughout my educational endeavors;
and my grandmother, Stella,
who inspires me with her resilience, determination, and self-sufficiency.

ACKNOWLEDGEMENTS

My ability to complete this dissertation would not have been possible without the guidance of my dissertation chair, Dr. Eugenia Toma. I am grateful for her willingness to provide thorough, constructive comments as she patiently guided me through the research process. Her passion for research and mentoring will forever serve as an inspiration for my career. My co-chair, Dr. Rebecca Bromley-Trujillo, was also instrumental in this process. I appreciate her willingness to share her vast knowledge of environmental studies and state politics and to involve me in research projects. I am thankful for her advice on research and teaching. I extend gratitude to my other committee members, who guided me through the process. I appreciate Dr. J.S. Butler for sharing his immense knowledge of research methods, especially regarding theoretical motivation for model selection. I also greatly appreciate his willingness to share his personal stories and engage with students. I thank Dr. Bill Hoyt for his insights on public economic theory he shared through his comments and courses. I thank Dr. Lala Ma for sharing her knowledge of environmental economics and research suggestions, especially early in the writing process. I am forever indebted to the Martin School faculty for exceptional teaching, course offerings, and guidance, and I am grateful to the Martin School staff for their support.

The faculty at Centre College provided a strong educational foundation with their exceptional teaching and mentoring. Thank you for sparking my curiosity, teaching me to take nothing at face value, and for encouraging me to pursue a graduate degree.

I appreciate the support of my professional acquaintances during the last two years of my doctoral studies. In particular, I thank my boss, Jon, for his patience and understanding.

My sincerest appreciation is reserved for my loving family. I offer the most gratitude to my daughter, Harlee, who showered me with love and patience during my graduate studies. I am so grateful for the sacrifices she made so that I could focus on my school commitments. Thank you to my other family members who continually provide a strong support network. My grandmother, Stella, has supported me emotionally in every endeavor and raised me as her child. My grandfather, Lenville, ensured that I had the necessary resources to navigate life. I appreciate the unconditional love and cheerfulness he expressed along the way. To my mother, aunts, uncles, and cousins who expressed support during my academic career, thank you to Kim, Shonda, John, and Michelle for being present at my school engagements and acknowledging my accomplishments. I would especially like to thank Stacey, who inspired me with her ability to persevere through life's obstacles. Her words of encouragement are always greatly appreciated.

I am grateful for my friends who have stood by my side. I thank Alex J. for his endless love and support. I sincerely appreciate our stimulating conversations and his inclination to offer advice or help with life's daunting tasks. I appreciate Kelli, David, and Michael for elevating my spirits and helping to celebrate even my smallest of victories. I cannot fully express the gratitude for the lifelong friends I met while in the Martin School. To Jue Young, Alex C., SaeRim, Nate, Cole, Jeeyen, Kyung Ha, and Andrew, I am forever

grateful for your academic and emotional support and for the laughs, tears, and stories we shared as we progressed through the program.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE: INTRODUCTION

1.1 Grants for Decentralized Renewable Energy in the U.S.

The U.S. federal government distributes fiscal transfers to subnational governments to support decentralized renewable energy development. The U.S. Department of Energy (DOE) allocated $250 million in renewable energy and energy efficiency grants to state and local governments in fiscal year 2017 ("Table 12.3," 2019).[1] The DOE's Office of Energy Efficiency and Renewable Energy awards competitive and formula grants for energy efficiency and renewable energy to state and local governments through the State Energy Program. The office also awards block grants to local communities through the Energy Efficiency and Conservation Block Grant Program. Other federal fiscal transfers for renewable energy and energy efficiency occurred through the American Recovery and Reinvestment Act of 2009 (ARRA) during President Obama's administration. ARRA invested $31 billion total in clean energy mostly through fiscal transfers for clean energy projects ("Recovery Act," n.d.). Additionally, other federal agencies offer temporary and ongoing grant programs for small-scale renewable energy projects.[2]

The use of federal fiscal transfers in the U.S. to promote decentralized renewable energy provision is unique compared to centralized renewable energy provision in other countries. This anomaly provides motivation to ask why U.S. federal policymakers choose decentralized renewable energy provision and whether this approach is effective at increasing renewable energy output. Most countries in Europe and several in Asia have

---

[1] This amount does not include renewable energy grants through other federal departments.
[2] For example, the U.S. Department of Agriculture offers the Rural Energy for America Program to provide grants to agricultural producers and small, rural businesses for renewable energy systems, among other things. Another example, the National Science Foundation, frequently offers Science and Technology and other Research and Development grants that allow for renewable energy development. Funding announcements are posted to Grants.gov.

feed-in tariffs, payments made to individual renewable energy producers ("Global Renewable Energy," 2017). European countries have adopted green certificate programs, utilizing tradeable certificates to award renewable energy production and penalizing energy producers for not meeting a specific renewable energy production threshold, such as the Green Certificate Program in Norway and Sweden and the Renewables Obligation policy in the United Kingdom. Countries in South America and Russia have capacity auctions for renewable energy that allow contracts for renewable energy production. On the other hand, comprehensive renewable energy policy in the U.S. has failed while the federal government supports decentralized renewable energy development.

1.2 A Case for Centralized Renewable Energy

The current literature provides the foundation to explore the motivation to decentralize renewable energy in the U.S. and the effectiveness of renewable energy grants. Scholars argue for centralized renewable energy provision in the U.S. Laird and Stefes (2009) explain that the U.S. has an advantage compared to other counties regarding availability of natural resources and advanced technology to develop renewable energy systems. Studies also point out that the majority of the public has supported federal involvement in renewable energy policy since the 1970s (Stoutenborough et al., 2014; Laird and Stefes, 2009; Farhar, 1994). According to a survey by the Yale Program on Climate Change Communication, approximately 71 to 89 percent of a county's residents support funding for renewable energy research, and an average of 80 percent of a county's residents support funding for renewable energy development (Howe et al., 2015).

1.2.1 Positive Spillovers and Market Failure with Renewable Energy Production

Climate and energy scholars talk extensively about positive externalities associated with renewable energy, arguing for centralized provision of renewable energy policy. Climate sustainability is most commonly discussed, because renewable energy produces less greenhouse gas emissions than fossil fuel energy. Thus, renewable energy production results in cleaner air and climate mitigation (Brown, 2001; Menanteau et al., 2003; Longo et al., 2008; Roe et al., 2001; Wiser, 2007; Goett et al., 2000; Batley et al., 2001; Beck and Martinot, 2004). Public health is also a positive externality of renewable energy production. Switching from fossil fuel energy to renewable energy has a positive impact on the environment, resulting in cleaner air and water sources for human consumption (Longo et al., 2008; Beck and Martinot, 2004; Roe et al., 2001; Wiser, 2007; Goett et al., 2000; Batley et al., 2001). Beck and Martinot (2004) add that renewable energy is less harmful to forests and fisheries. Finally, new technology investments and research provides information and innovation externalities for other energy producers (Jaffe et al., 2004; Beck and Martinot, 2004).

Scholars make the case that marketc failure has created an undersupply of renewable energy production and distortions in pricing (e.g. Beck and Martinot, 2004; Menanteau et al., 2003; Brown, 2001). Beck and Martinot (2004) provide a detailed discussion of market barriers to renewable energy consumption and development, arguing that the markets "unfairly discriminate against renewable energy" (p.366). They argue that market prices for renewable energy fail to account for several benefits of renewable energy compared to fossil fuel energy, including no variable fuel costs; shorter

transmission distances; and environmental and public health externalities.[3] Painuly

(2001) argues this creates a free-rider problem with renewable energy investments.

Furthermore, Beck and Martinot point out that fossil fuels are subsidized, which are

politically difficult to remove.[4] Subsidies for fossil fuels make fossil fuel energy an

artificially cheaper choice of energy as the market prices do not account for the negative

externalities associated with fossil fuel energy production. Therefore, market failure for

both renewable energy and fossil fuel energy arises from property rights to environmental

and public health goods that are not clearly defined or enforced.

In addition to issues with market prices, renewable energy cannot currently

compete with fossil fuel energy due to other barriers. First, there are large upfront capital

costs associated with renewable energy investments. The energy infrastructure in the

United States is primarily set up for the fossil fuel industry, and transitioning away from

this infrastructure will impose significant costs on investors (Longo et al. 2008; Painuly

2001). Beck and Martinot (2004) discuss additional market performance and legal and

regulatory barriers. They argue that a greater perception of risks associated with

renewable energy and an information and skills deficit can hinder investments. Finally,

legal and regulatory barriers discriminate against renewable energy. Examples include

interconnection requirements that are burdensome or inconsistent for installation of

---

[3] Scholars also argue that market prices do not accurately capture the externalities associated with renewable energy (e.g. Beck and Martinot, 2004; Menanteau et al., 2003; Brown, 2001; Painuly, 2001).
[4] According to the US Energy Information Administration, renewable energy received approximately $6.7 billion in subsidies in fiscal year 2016 ("Federal Financial Interventions," 2018). Tax expenditures accounted for 80 percent of subsidies, and the other 20 percent was from research and development, the DOE's Loan Guarantee Program, and direct expenditures. Subsidies declined from approximately $15.5 billion in fiscal year 2010, which was primarily due to the expiration of the American Recovery and Reinvestment Act subsidies for renewable energy. In fiscal year 2016, coal received approximately $1.3 billion in subsidies, and 72% was from tax expenditures. Nuclear energy received $365 million in that year. This amount does not include all subsides to fossil fuels or fossil fuel-related activities.

renewable energy technology in homes and businesses; lack of procedures for installation; and restricted transmission access by current standards. The market has not overcome these barriers in part because it does not take into account positive externalities of renewable energy. However, states can implement state-level and negotiate regional policies to allow and encourage local renewable energy production (Fischlein et al., 2014).

Studies in fiscal federalism discuss the effectiveness of centralized provision of goods that create large spillovers and are underprovided in the market. In general, the federal government typically provides environmental goods as they produce positive externalities (Oates and Portney, 2003).[5] In addition to positive externalities, Oates (2008) explains that local governments typically abide by centralized environmental policies, even if they impose uniform requirements on heterogeneous governments. Finally, there are sometimes economies of scale with centralized provision since the federal government typically has greater financial and informational resources relative to local governments (Musgrave 1961; Oates 1972; Oates 2008). Economies of scale is especially advantageous when goods require large investments in research and development.

1.2.2 Insufficient Subnational Policies

Studies find mixed results on the effectiveness of subnational clean energy policies (e.g. Carley 2009; Menz and Vachon 2006; Delmas and Montes-Sanchos 2011). Scholars note the benefits of local energy policies but generally agree that federal policy would be more

---

[5] The Clean Air Act and the Clean Water Act are two examples of centralized environmental policies in the U.S.

effective in developing renewable energy in the U.S. (Sovacool, 2009).[6] Disparate

renewable energy policies across jurisdictions are not necessarily efficient. Local

governments are not equipped to internalize the externalities imposed by local policies, as

greenhouse gas emissions and savings are not contained within jurisdictional borders.

This is inefficient when local governments produce disproportionate spillovers on

neighboring localities (Ogawa and Wildasin, 2009). Local renewable energy policies can

also cause carbon leakage, the increase in emissions in one jurisdiction from energy

producers who move from another jurisdiction with stricter emissions policies. However,

scholars suggest that policy design can influence the amount of carbon leakage from local

policies (Böhringer et al., 2017; Carley, 2011).

1.3 Explanations for Federal Inaction

Scholars speculate that the federal government's unwillingness to adopt a centralized

renewable energy policy is largely due to politics. A plausible explanation for

decentralized renewable energy development is that renewable energy is regarded as the

primary solution to climate change (Moniz, 2015). Therefore, renewable energy policy

could be subjected to the same political conflicts as climate change policy. The

differences in congressional voting on environmental issues, especially climate change,

have become increasingly polarized among Republicans and Democrats (Krosnick et al.,

2000, Fiorina and Abrams 2008, Dunlap and McCright, 2008). These studies help to

---

[6]Sovacool (2009) argues that the most effective method to promote renewable energy and energy efficiency is a comprehensive federal approach to include a federal feed-in tariff, wealth redistribution to lower income households, and federal funding for education and energy management. These conclusions are based on a survey of energy experts from types of electricity companies; regulatory agencies; energy manufacturers; interest groups including nonprofits; and consumers and consumer advocates.

explain why the federal government has not adopted a centralized renewable energy policy. This dissertation builds on this literature by focusing on federal policymakers' decisions to financially support decentralized renewable energy development.

1.4 Dissertation Outline

This dissertation focuses on the motivation to choose decentralized renewable energy provision in the United States as revealed by decision makers' policy choices. Scholars argue for some central provision of renewable energy given its large positive externalities and market failure. However, the United States is one of few countries without a centralized renewable policy. Instead, the federal government chooses decentralization by using fiscal transfers to support subnational policies and investments. To my knowledge, no study has specifically considered the motivation to use renewable energy grants, which are unique given the arguments for centralized clean energy policy. Instead, energy scholars study effectiveness of subnational renewable energy policies (e.g. Carley, 2009; Menz and Vachon, 2006). Other studies focus on the optimal choice between centralization and decentralization (e.g. Besley and Coate, 2003; Lockwood, 2005), and numerous studies consider effectiveness of federal fiscal transfers.

I contribute to the literature by focusing on two questions: First, what motivates federal legislators to propose fiscal transfers for decentralized renewable energy development considering what we know about positive spillovers and market failure associated with renewable energy investments? Besley and Coate (2003) argue that studying political decision-making furthers our understanding of the centralization-decentralization tradeoff. Second, does the United States' unique strategy of using fiscal

transfers for renewable energy provision effectively increase renewable energy output? I rely on studies in economics for the theoretical foundation to explore these two questions.

Chapter Two defines renewable energy, discussing the development and prevalence of solar, wind, hydroelectric, geothermal, and biomass energy separately. The chapter briefly explains decentralized residential and commercial renewable energy systems in the U.S. and the magnitude of these developments. Then the discussion continues on energy policy at the federal and subnational levels. The chapter explains the federal and subnational policies and actions that have contributed to decentralized renewable energy development in the U.S. The discussion explains that subnational governments have adopted financial incentives and regulations to encourage renewable energy development while the federal government has partially supported subnational renewable energy development with financial incentives, including fiscal transfers for renewable energy.

Chapter Three reviews the fiscal federalism literature that discusses the centralization-decentralization tradeoff. The chapter provides an overview of the three primary levels of government—the national government, states, and local governments—describing the purpose and functions of each level as they are discussed in the literature. The chapter then focuses on the tradeoff between centralization and decentralization, outlining the advantages and disadvantages of each type of public provision. This leads to the discussion of the purpose and effectiveness of intergovernmental fiscal transfers, which the federal government uses to encourage decentralized provision. The chapter concludes with implications for renewable energy grants in the U.S.

Chapter Four proposes a theoretical model to explain why legislators choose decentralized public provision for goods with large spillovers. The theoretical foundation begins with legislative bargaining models that show how strategic behavior affects public provision. Following the literature, I assume that legislators respond to institutional incentives by showing that the political price associated with proposed policies affects legislators' choices. I theorize that the utility-maximizing choice for legislators is to choose decentralized output when the political price associated with a specific proposal for centralized output is high. The model is then used to explain why legislators choose to fund decentralized renewable energy in the U.S. despite normative economic justification for centralized provision.

Chapter Five offers a direct empirical test of the theoretical model proposed in Chapter Four. I hypothesize that when there is a low political price associated with renewable energy policymaking, legislators are less likely to propose funding for decentralized renewable energy. To test this hypothesis, I look at the first observable moment in the legislative decision-making process: bills introduced in Congress by legislators. I analyze a sample of renewable energy bills introduced during the 103rd to 113th Congresses to observe whether legislators proposed funding for centralized or decentralized renewable energy. Using a proxy variable for low political price, I run a linear probability model to estimate a legislator's likelihood of including funding for decentralized renewable energy. The findings suggest that legislators are less likely to propose a bill that includes funding for decentralized renewable energy development when the political price of renewable energy policymaking is low. Robustness checks

offer weak support for this finding and suggest that this result is unique to renewable energy provision.

Chapter Six offers an additional empirical test to evaluate the theoretical model proposed in Chapter Four, which explains that legislators choose to invest in decentralized renewable energy when the political price of renewable energy policymaking is high. I assume that reelection and a good's output at the local level increase under decentralized provision of renewable energy. Therefore, I hypothesize that renewable energy grants increase renewable energy output at the local level. I test this hypothesis by empirically evaluating the impact of one-time renewable energy grants distributed through the American Recovery and Reinvestment Act on renewable energy production at the county-level. I find support that renewable energy production increases at the local level, at least for solar energy. Additional empirical evaluation suggests that these results are the most significant in warmer climate regions, as expected, but are not affected by state or regional policies.

Chapter seven concludes the dissertation by providing an overview and the contributions of each chapter. The chapter concludes by discussing how the findings in this dissertation can be extended to future studies.

CHAPTER TWO: AN OVERVIEW OF RENEWABLE ENERGY IN THE U.S.

2.1 An Introduction to Renewable Energy

Renewable energy refers to energy generated by naturally occurring and replenishing resources ("Renewable Energy Explained," 2018). Examples include solar, wind, hydroelectric, geothermal, and biomass waste energy. Renewable resources that emit heat, such as solar or geothermal energy, can be consumed directly. Renewable resources can also power turbines or similar structures to create energy, which is then turned into electricity by a generator. Renewable energy technology can be installed on a residential property or industrial scale, powering individual homes, businesses, or communities. Renewable energy resources are disbursed unevenly across the United States. Each state has at least one type of renewable energy source (Aslani and Wong, 2014). The following paragraphs briefly describe each main type of renewable energy source (biomass, geothermal, hydroelectricity, solar, and wind), including which regions in the United States are the most optimal for producing each type of energy.[7]

Biomass energy is derived from organic material from plants and animals and is primarily converted to biofuels (ethanol) ("Renewable Energy Explained," 2018). Biomass is broken down by burning it directly or burning byproducts to release heat, which can be used directly or indirectly to generate electricity. Examples of biomass include wood and wood waste; municipal solid waste, landfill gas and biogas, ethanol, and biodiesel. The availability of biomass energy varies by type, but every state has the potential to utilize at least one type.

---

[7] In this context, optimal describes an area where the greatest amount of the resource can be utilized relative to other areas. For example, optimal areas for solar energy are areas where the most amount of sunlight can be accessed.

Geothermal technology utilizes heat from underneath the earth's surface. Geothermal heat is used to generate steam from water or another liquid or to heat water ("Renewable Energy Explained," 2018). Steam and water can then be used directly to heat buildings or can be used to power a turbine to generate electricity. The west and southwestern regions in the United States are optimal locations for geothermal energy, but geothermal energy resources can be found in many regions including mountainous areas.

Hydroelectricity is generated from moving water that powers a turbine, which is then used to generate electricity. Hydroelectric technology exists in almost every region as it can be installed in rivers, dams, and oceans. Hydroelectricity is the most prevalent and among the oldest forms of energy ("Energy from Moving Water," 2017).

Solar photovoltaic (PV) converts sunlight into electricity, often through solar panels. Concentrated solar power (CSP) technology uses mirrors to reflect sunlight, which is then captured and converted into heat ("Renewable Energy Explained," 2018). The solar heat is used to make electricity. All states have potential for some solar photovoltaic (PV) power energy, although there is very little in most northern states across the U.S. The greatest potential for solar PV is in most southern states including Texas; along the west coast; and in the Great Plains, West, and Southwest regions. Concentrated solar power is optimal primarily in the southwestern region of the U.S. and surrounding areas.

Wind powers a turbine, which creates energy to convert electricity ("Renewable Energy Explained," 2018). Open areas without windbreaks are some of the most resourceful areas for wind energy production. Wind farms can be installed onshore and

offshore, including tops of rounded hills, open bodies of water, and gaps in mountains where wind funnels through intensely. The majority of wind energy potential is located in and surrounding the Great Plains area and along oceanic coastlines.

2.2 Renewable Energy Production in the United States

Renewable energy systems in the United States are mostly developed locally. Consumers can install renewable energy power directly into residential or commercial buildings. Examples include rooftop solar panels and individual geothermal heat pumps. Larger, industrial renewable energy systems, can be installed by local governments, businesses, or organizations. Examples include wind or solar farms, which include several individual generating units. The latitude to install and utilize renewable energy depends on the processes for permitting and approving installation in each jurisdiction. States have primary authority over the electricity market (Schragger, 2016; Fischlein et al., 2014; Sautter and Twaite, 2009). Therefore, large-scale renewable energy operations are subject to the same permitting process as other energy systems. Utility companies also have control over the ability of renewable energy systems to connect to the power grid and are responsible for the associated fee structures, which vary by provider. Ultimately, the potential for renewable energy development in an area depends on existing energy infrastructure and its capacity to incorporate renewable energy sources.

While individual consumers can install renewable energy systems on homes and businesses, renewable energy is also produced by power plants dispersed across the United States. Generally, renewable energy power plants generate more renewable power than individual residential or commercial systems. The location of renewable energy

power plants varies by location and type of renewable energy produced. Renewable energy plants cover most states but are more sparsely disbursed across the west (U.S. Energy Mapping System, 2019). Hydropower plants are the most dispersed of all renewable energy power plants. Geothermal power plants are the most concentrated, existing only in the West. Biomass and solar power plants are dispersed throughout the United States but are less concentrated across the Midwest. Finally, wind power plants are heavily concentrated in the Midwest and northeast. Appendix A shows the distribution of renewable energy power plants by type of energy as of March 2019 in the 48 contiguous states.

Power plants can produce energy from several types of energy sources, although power plants generally have one predominant energy source. As of December 2017, there were 1,458 power plants with conventional hydroelectricity as the predominant source and 4,174 power plants with another type of renewable energy as the predominant source ("Electric Power Annual 2017," 2018). For comparison, natural gas was the predominant energy source for 1,820 power plants, and petroleum was the predominant energy source for 1,080 power plants. Although there are several renewable power plants, renewable energy still accounts for a small percentage of total energy produced in the United States. In 2017, renewable energy accounted for 17 percent of electricity generation at utility facilities, whereas natural gas, coal, and nuclear accounted for 32.1, 29.9, and 20 percent, respectively ("What is U.S. electricity," n.d.). Table 1 shows the share of total electricity produced by each type of renewable energy in the U.S. Hydropower, one of the oldest utilized forms of renewable energy, accounted for the largest share of electricity generated at utilities from renewable sources. Wind energy, the second largest share of

renewable energy, is one of the most widespread renewable energies in the U.S.

(Fischlein et al., 2014).

Table 2.1
Percentage of U.S. Electricity Generation by Utilities in 2017
by Renewable Energy Source

Renewable Energy Source	Percentage of Total Electricity
Hydropower	7.4%
Wind	6.3%
Biomass	1.6%
Solar	1.3%
Geothermal	0.4%

Source: U.S. Energy Information Administration

2.3 Federal Renewable Energy Policies

The federal government has adopted few renewable energy regulations. Currently, there

are federal energy goals and regulations for federal buildings set in place by the Energy

Policy Act (EPAct) of 2005, which were subsequently expanded and updated by the

Energy Independence and Security Act (EISA) of 2007 and executive orders in 2009 and

2015 ("Green Power Purchasing," 2018). The goals specify targets for energy reduction.

The requirements set guidelines for building design for energy efficiency and options to

invest in renewable energy. The Clean Power Plan, adopted in 2015 during President

Barack Obama's administration, was an attempt at a centralized policy to reduce

greenhouse gas emissions. The plan set requirements for carbon emissions for each state,

listing renewable energy as one option to achieve requirements ("The Clean Power Plan,"

2017). The Clean Power Plan was repealed by the U.S. Environmental Protection Agency

during Present Donald Trump's administration and never went into effect ("Proposal:

Affordable Clean Energy," 2018).[8] Although these federal policies incorporate renewable energy, none currently support renewable energy development directly.

The federal government also offers financial incentives for businesses and individuals to encourage renewable energy investments. Some are tax credits administered through the U.S. Internal Revenue Service (IRS). Examples include the Renewable Electricity Production Tax Credit (PTC), a tax credit for businesses for investing in renewable energy, and the Residential Renewable Energy Tax Credit, a tax credit for investments in residential energy technologies ("Green Power Purchasing," 2018). Loans, another common financial incentive offered by the federal government, are administered through federal agencies such as the IRS, U.S. Department of Energy (DOE), and U.S. Department of Agriculture (USDA). Financial incentives may have declining benefits or sunset dates. Laird and Stefes (2009) argue that sunset dates for wind energy financial incentives were correlated with a decline in wind energy development. However, there is no study to my knowledge on the effects of sunset dates or financial incentives on total renewable energy development.

This dissertation focuses on another type of financial incentive: federal grants to support renewable energy investments by states, local governments, and tribes. Most fiscal transfers for renewable energy are awarded through two main programs within the DOE. The State Energy Program, the largest grant program, uses regional and state offices to provide funding and technical support to states to assist with energy conservation and alternative energy development. This program's purpose is to reduce fossil fuel emissions and energy use and to increase energy efficiency through

---

[8] In August 2018, the Trump administration proposed to replace the Clean Power Plan with the Affordable Clean Energy (ACE), which would reduce greenhouse emissions from existing coal power plants.

investments in energy efficiency and renewable energy. The State Energy Program has awarded at least $300 million to states and territories since 2010 ("About the State Energy Program," 2019). The Energy Efficiency and Conservation Block Program awards grants to subnational governments. The program was created with funding from ARRA in 2009 to provide grants and technical assistance to develop renewable energy and increase energy efficiency ("Program Evaluation," 2015).

The federal government increased grants to states through ARRA. The §1603 energy grant program was one component of a total energy package to expand clean energy by offering cash payments for investments in wind, residential and nonresidential solar, biomass, geothermal, and other types of renewable energy ("Overview and Status Update," 2017). As of March 2017, the grant program contributed $25.7 billion to fund 105,972 renewable energy projects, which accounted for about 22% of total project investments. Part of the funding went to expand the DOE's two major programs: ARRA allocated $3.1 billion through the State Energy Program for formula grants and $3.2 billion through the Energy Efficiency and Conservation Block Program ("Energy Efficiency and Conservation," n.d.).[9]

Figure 2 shows total outlays to state and local governments for energy efficiency and renewable energy.[10] In 2008, approximately $39.7 million was awarded to

---

[9] Although the State Energy Program and the Energy Efficiency and Conservation Block Grant Programs are two of the largest programs, there are other programs that offer smaller federal awards for renewable energy. For example, the DOE's Tribal Energy Program Grant offers energy grants to tribes residing on tribal lands. The USDA offers at least one grant program to all levels of government, tribes, schools, agriculture, industry, and other organizations for renewable energy investments and development.

[10] This figure includes only grants awarded through the U.S. Department of Energy.

subnational governments for energy efficiency and renewable energy. Energy efficiency

and renewable energy fiscal transfers peaked in 2011 at approximately $5.1 billion,

corresponding with the distribution of ARRA's §1603 energy grants. Energy efficiency

and renewable energy grants declined to approximately $418.2 million in 2013 and

remained relatively steady in subsequent years. Total energy grants for energy efficiency

and renewable energy were less than one percent of total transfers to state and local

governments in all years.

Figure 2.1
Outlays for Energy Efficiency and Renewable Energy Grants to
State and Local Governments, 2008 to 2018
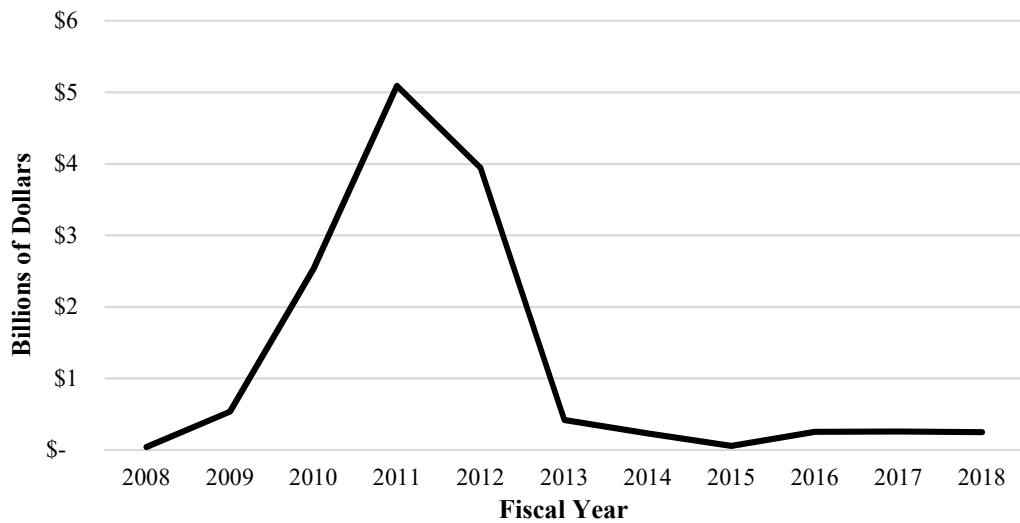
Note: Data are adjusted for inflation and are not available prior to 2008. The amount for 2018 is estimated.
Source: Office of Management and Budget, "Table 12.3"

2.4 Decentralized Renewable Energy Policies

Perhaps the lack of federal action has spurred decentralized renewable energy in the

United States (Rabe, 2008). State and local governments have been adopting a variety of

renewable energy policies primarily since the 1990s, although some were adopted as

early as the 1970s (Bromley-Trujillo et al., 2016). Financial incentives to encourage

investments are the most commonly adopted types of policies (Aslani and Wong 2014).

Examples include monetary incentives, such as tax incentives, rebates, grants, and loans

for renewable energy equipment or investments. States also adopt regulations to mandate

requirements for levels or types of renewable energy production.[11] Examples include

renewable portfolio standards, net metering, and interconnection standards (Carley,

2011).[12] Furthermore, local governments sometimes collaborate with each other or with

nonprofit organization or businesses to pass renewable energy policies. However, the

types of renewable energy policies adopted by subnational governments vary by

jurisdiction. There has been no nationwide, collaborative effort to adopt policies that

coalesce to develop clean energy in the United States.

The next chapter turns to the fiscal federalism literature to understand the

motivation for using grants for public provision. Chapter Three reviews studies in fiscal

federalism to discuss the role of the federal government and subnational levels of

government from a normative economic perspective. The chapter also explains the

purpose of fiscal transfers and evidence on their effectiveness at increasing a good's

output. The chapter concludes by discussing how lessons from the literature can be

applied to renewable energy provision.

---

[11] Renewable portfolio standards (RPS), a requirement for a percentage of energy to be produced from renewable sources, are the most common type of regulations adopted by states. As of February 2019, RPS were adopted by 29 U.S. states, D.C., and three U.S. territories ("State Renewable Portfolio Standards" 2019). An additional eight states and one territory adopted a voluntary renewable energy target.
[12] Net metering requires utilities to credit energy producers for energy contributed to the power grid (DSIRE 2019). Energy producers can use credits at a later date when the system does not produce energy. Interconnection standards determine how renewable energy suppliers connect to the power grid.

CHAPTER THREE: A LITERATURE REVIEW ON THE CENTRALIZATION-DECENTRALIZATION TRADEOFF

3.1 Introduction

Energy policy scholars argue for a prominent federal role in energy policymaking and investments. Margolis and Kammen (1999) argue that the federal government has underinvested in renewable energy research and development, limiting the federal government's ability to respond to global climate change. Laird and Stefes (2009) compare renewable energy production in the United States to the more developed renewable energy system in Denmark. They argue that Denmark's centralized policies have helped to support renewable energy development. By comparison, they credit the underdeveloped renewable energy market in the United States to weak federal policy support. Finally, Sovacool (2008; 2009) argues that federal comprehensive policy is necessary to overcome barriers to renewable energy development, including inconsistent political support, market failure, upfront costs of investments, and misinformation about the benefits of renewable energy investments.

While energy policy studies discuss issues with decentralized provision and how the federal government should address this policy issue, they do not directly consider the centralization-decentralization tradeoff of renewable energy provision. Instead, fiscal federalism studies provide the theoretical underpinnings of normative arguments concerning provision of goods, discussing the role of government, the centralization-decentralization tradeoff, and the purpose of fiscal transfers. This chapter reviews the literature and then applies lessons from the literature to renewable energy provision in the U.S.

3.2 History of Federalism in the United States

The U.S. has a federalist government—governed by both a central government and subnational governments, but sovereignty among the three levels of government has varied since the ratification of the U.S. Constitution. Peterson (2012) explains that the federal government and states had dual sovereignty before the Civil War, where each level had control over their own territory and military. The end of the Civil War dramatically changed federalism in the U.S., giving the federal government sovereignty and military capacity while allowing each level of government to elect political leaders and have independent taxing and spending authority. Subsequently, the New Deal in the 1930s expanded the federal government's spending power, but state and local governments have continued to raise a significant amount of taxes for domestic spending.

Authority over policymaking has also varied over time and by policy. Policies can be either centralized, giving the federal government primary authority of overseeing the policy, or decentralized, where primary authority to oversee the policy is delegated to state or local governments. The United States has embraced a "complicated" process of both types of policymaking (Oates, 1993). The United States has also experienced an increase in special districts that govern multiple local jurisdictions to provide public services, which has also contributed to the complexity of government in the United States (Oates, 1999).[13] This has marked a movement of joint decision-making among different levels of government and a move towards more intergovernmental decision-making.

---

[13] Many scholars write about the complexity of the U.S. government. Seminal examples include Ostrom, Tiebout, and Warren (1961) who describe the "polycentric governance" as independent, decision-making governments that govern within a system (instead of a three-tier hierarchy). Frey and Eichenberger's (1999) functional, overlapping and competing jurisdictions (FOCJ) describe special jurisdictions that form to provide a particular good or service but overlap across competing jurisdictions.

Intergovernmental transfers, a prominent fiscal policy tool, have added to the complexity of intergovernmental decision-making. Intergovernmental transfers primarily flow from the federal government to state and local governments to fund subnational policies or projects, creating policymaking interdependence between the separate levels of government. Figure 3.1 shows total federal outlays for grants to state and local governments as a percentage of total federal outlays from 1990 to 2018. The average relative size of fiscal transfers increased over this time period.[14] Total outlays to state and local governments as a percentage of total federal outlays increased from 11 percent in 1990 to 18 percent in 2018. There was a noticeable decline in fiscal transfers as a percentage of total federal outlays from 2003 to 2009. The increase from 2009 to 2010 corresponds with the implementation of ARRA.

Figure 3.1
Total Federal Outlays for Grants to State and Local Governments as a Percentage of Total Federal Outlays, 1990 to 2018
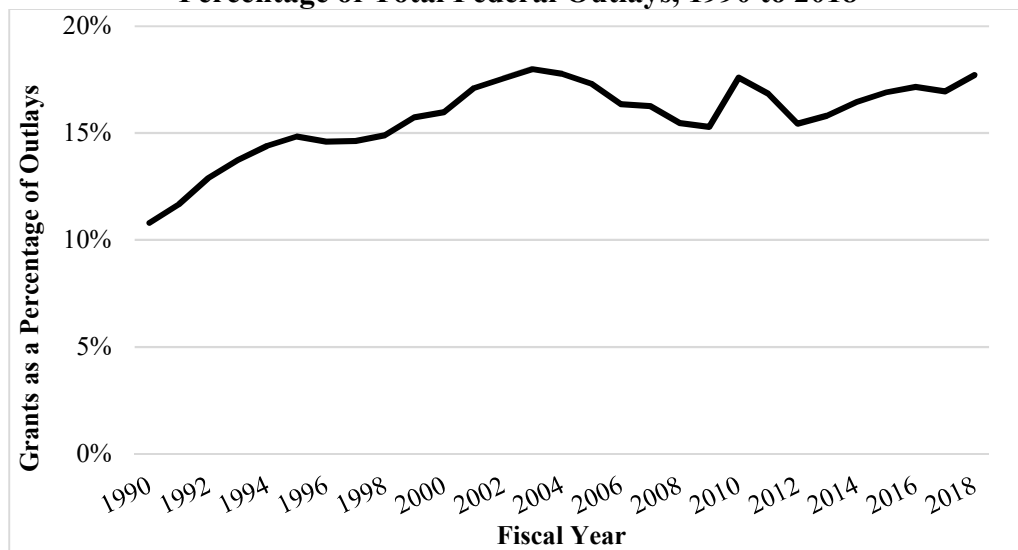
Notes: Data are adjusted for inflation. The amount for 2018 is estimated.
Source: Office of Management and Budget, "Table 12.2" and "Table 1.1"

---

[14] It is unclear what led to the increase in fiscal transfers over this time period. Baicker et al. (2011) discuss the positive relationship between fiscal transfers and the growth of state budgets as federal policies and legal constraints lead states to spend more on education, health, and public welfare.

Some scholars attempt to define the optimal federalist structure. Most notably, Oates (1972; 1999) claims that federalism promotes allocative efficiency by allowing goods to be provided by the level of government that is most suited to provide them. He argues that the central government should be responsible for macroeconomic stabilization, distribution of income, and providing goods that benefit society as a whole. He also argues that local governments should be responsible for providing goods that primarily benefit their respective residents. Inman and Rubinfeld (1997a) lay out three different types of federalism to discuss optimality: economic federalism, cooperative federalism, and democratic federalism. All three types focus on assigning responsibilities to the proper levels of government but differ in how to achieve the optimal provision of goods. Generally, economic federalism emphasizes the importance of economic efficiency where goods are provided at the most decentralized level of government capable of internalizing externalities. Cooperative federalism is similar except that it also considers the willingness of elected officials to unanimously agree to centralized policies. Democratic federalism is also similar to economic federalism except that it also places the most value on civil liberty, where the majority of elected officials agree to centralized policies. Therefore, the optimal structure of government depends on how federalism is defined, which may vary over time or by policy area.

3.3 Federal Intervention and Centralization

The literature explains the role and responsibilities of the federal government. Samuelson (1954; 1955) is one of the earliest scholars to demonstrate how the optimal provision of public goods is different from the optimal provision of private goods, arguing for federal

provision of public goods. Musgrave (1959) and Oates (1972) argue that the federal government is responsible for the three roles of budgetary policy: macroeconomic stabilization, redistribution, and allocation of resources. Musgrave argues that the federal government achieves macroeconomic stabilization by maintaining a steady currency, and the federal government redistributes wealth or income across individuals to pursue a more equitable distribution. Musgrave (1961) argues that the federal government has an obligation to respond to individuals regardless of state policies to maintain equity but is also responsible for respecting state policies and improving fiscal performance.

Scholars also explain the advantages of centralization. Oates (1972) explains that local governments are limited in their ability to regulate the economy, allocate income, or provide the efficient level of the public good due to the leakages that occur because of the mobility of residents and businesses. Centralized policies can eliminate the potential for leakages. Additionally, the central government may be better off providing the good because of economies of scale (Musgrave, 1961; Oates, 1972). The national government typically has more access to resources, which is ensured by the federal government's ability to run a deficit to meet obligations.

The disadvantages of centralization provide justification for decentralization. Uniformity in the level of public good provided is the most commonly discussed disadvantage of centralization. In Oates' (1972) discussion of impure public goods, he argues that if the efficient provision of public goods varies by jurisdiction, a uniform central policy will create a loss in welfare. The extent of the loss depends on the

magnitude of the differences in the efficient levels of provision across jurisdictions.[15]

Oates implies that decision makers should consider the potential welfare losses when deciding whether an impure public good should be centralized or decentralized. However, Besley and Coate (2003) show that centralized policies lead to greater surplus than decentralized policies when spillovers are large, even when local governments are not identical.

Furthermore, Inman and Rubinfeld (1997b) discuss a disadvantage of having too much centralization, arguing that heavy local representation in the central government will increase democratic representation but reduce economic efficiency. Conversely, if the central government has sole responsibility over policymaking with little local representation (too little centralization), democratic representation is completely diminished. Therefore, the optimal level of centralization involves a tradeoff between democracy and economic efficiency.

More recent literature discusses the disadvantages of centralization by considering institutional structure and politics. Tommasi and Weinschelbaum (2007) argue that the central government may be better able to internalize externalities but can create an "agency problem." When multiple principals make decisions at the federal level, efforts cannot be easily monitored, and coordination may be difficult. The common pool problem is related, occurring because taxpayers pay the same average cost when goods are centralized. Therefore, the marginal cost to each individual for using the good is much lower than it would be if that good was provided at the local level, creating an

---

[15] Although, Wrede (2006) takes a political economy approach to argue that uniform policy under centralization provides a better outcome than centralization without uniformity, because uniformity reduces the opportunities for exploitation by special interests.

incentive for rent-seeking (e.g. Weingast, 2009). Special interests may seek to maximize their own output when costs are shared by everyone (e.g. Persson and Tabellini, 1994; Weingast et al., 1981; Knight, 2004).

3.4 The Purpose of Decentralization

Musgrave's (1959) third objective of budgetary policy, allocation of resources, is the economic justification for federalism (Oates, 1991). Oates explains that the federal government's role is to oversee allocation of resources and provide the overall efficient level of the public good, and local governments are responsible for allocating it. Local governments can offer different levels of the public good, which increases efficiency by allowing individuals to sort into jurisdictions according to their preferences (Tiebout, 1956; Oates, 1972). Furthermore, efficiency gains through decentralization are increased by mobility of individuals but still exist without it (Oates, 1999). Decisions at the central level are removed from citizens, and decision-makers face both informational and political constraints that keep them from responding to individual jurisdictions (Oates, 1999). On the other hand, local governments know more about local preferences than the national government (e.g. Hayek, 1945; Oates, 1972; Brueckner, 1999). Oates' infamous *Decentralization Theorem* states,

> *"it will always be more efficient (or at least as efficient) for local governments to provide the Pareto-efficient levels of output for their respective jurisdictions than for the central government to provide any specified and uniform level of output across all jurisdictions"* (Oates, 1972, p. 35).

Enhanced accountability is another benefit of decentralization. Jurisdictions are better able to internalize the costs of their spending decisions when they are responsible for providing the public good (Oates, 1972). As previously mentioned, taxpayers pay the average cost of a centrally provided public goods, leading local taxpayers to have less information about costs of providing the public good in their own jurisdiction. With local provision, the costs of public goods are more closely tied to local taxes, giving taxpayers more information about the true costs of public provision. Furthermore, Weingast (2009) argues that localizing decisions increases accountability to make democracy more stable as constituents are better able to monitor spending decisions.

The potential for innovation is a benefit of decentralization is less emphasized in the literature.[16] Decentralization provides the opportunity for local governments to make their own spending decisions and create innovative policy solutions to address policy issues (Oates, 1972). The greatest potential for innovation is when local governments are relatively heterogeneous and can use different policy approaches (Strumpf, 2002). Finally, some scholars argue that efficiency gains from decentralization might lead to economic development (Oates, 1999). However, studies looking at the relationship find mixed results.[17]

---

[16] The potential for innovation as a result of decentralization has been acknowledged in other literature. For example, Galle and Leahy (2009) point out that numerous scholars discuss the potential for laboratories of innovation at the local level and note that this argument has been discussed in court cases starting as early as the 1930s. Furthermore, diffusion studies discuss how state and local governments overcome the collective action problem to adopt innovative climate change policies (e.g. Lutsy and Sperling, 2008; Rabe, 2008; 2011; Feiock et al., 2009; Carly, 2011).

[17] Xie et al. (1999) look at the United States and suggest that a relationship between decentralization and economic development might exist but add that further decentralization will not further increase economic growth. Studies on other countries have conflicting conclusions. Davoodi and Zou (1998) find no relationship; Iimi (2005) finds a positive relationship; and Bahl and Linn (1992) argue reverse causality, where economic development leads to decentralization, because decentralization becomes more beneficial as countries become more developed.

The literature also puts forth several disadvantages of decentralization. Externalities are the most commonly discussed. Local jurisdictions have no incentive to internalize externalities when choosing a level of public good. Ogawa and Wildasin (2009) argue that when externalities affect local jurisdictions *disproportionality*, the federal government is justified in providing the public good. Second, local governments often have scarce resources when compared to the federal government, because they are restricted by a balanced-budget requirement. This can become an issue for local governments that do not have sufficient resources for capital and research investments.

A second potential disadvantage of decentralization is soft budget constraints. They result from bailouts by the federal government, meaning that the federal government assumes control of financing local projects up to a point that maintains the level of goods or services demanded by "external constituents" (Wildasin, 2004). This phenomenon occurs when the federal government subsidizes spending of local governments who provide local goods beyond the levels attainable with their respective budgets. Wildasin (2004) argues that residents in one jurisdiction may benefit from a bailout if services benefit nonresidents, because it reduces the costs of the services that residents must pay for the services provided to the nonresidents. Therefore, soft budget constraints incentivize local governments to exceed their budgets (e.g., Inman, 2003; Oates, 2005). Weingast (2009) argues that local governments must face hard budget constraints for the federalist society to work. However, benefit taxation—where jurisdictions tax goods and services that are provided directly to the residents—has been proposed as a solution to soft budget constraints, because it allows residents to communicate preferences to local decision makers (Oates, 1999).

Other potential disadvantages of decentralization relate to taxation. First, is the "tax assignment problem," which refers to decisions about who should tax and how much should be taxed (McClure, 1999; 2001). McClure (2001) argues that the inability for local governments to control these decisions and to effectively implement local taxes can lead to vertical fiscal imbalance, an insufficient amount of tax revenue to provide local public goods. Local taxation issues can relate to the ability of local governments to tax economic activity and capture revenue from mobile capital and residents. For example, residents can shop across borders to escape taxes; capital owners may live out of state; or residents might commute across borders for employment. As methods to ease the tax assignment problem, he suggests that neighboring jurisdictions coordinate tax rates, tax policies, and which items are subject to taxation.

A final potential disadvantage is "race to the bottom." Although not clearly defined in the fiscal federalism literature, it generally refers to jurisdictions offering sub-optimal taxes or restrictions on capital to compete for capital investments. The competition creates allocative deficiencies, leading to a suboptimal level of the public good (Oates, 1999). Current empirical studies on labor markets and welfare reform find evidence of race to the bottom (e.g. Olney, 2013; Davies and Vadlamannati, 2013; Dahlberg and Edmark, 2008; Brueckner, 2000). In contrast, empirical studies on environmental policies do not find race to the bottom, as states and local governments do not relax environmental regulations in response to economic pressures (e.g. Potoski, 2001; Konisky, 2007).[18] Conversely, mobile capital can create revenue problems for local

---

[18] Alternatively, Oates (1999) claims that we need to mainly be concerned with the size of the distortions caused by competition instead of debating whether they exist.

jurisdictions, because they can move out of taxing jurisdiction. Thus, the marginal cost of raising revenue may be larger than anticipated, although these issues can be mitigated with careful tax design. Bird (1986) argues that local governments should coordinate local taxes to prevent unintended distortions in economic activity. Benefit taxation has also been proposed as a solution to both race to the bottom and the tax assignment problem (e.g. Oates, 1996, 1999; Schwab and Oates, 2010 1991; McClure, 1999).

Political economy literature incorporates rent-seeking and the effects of political institutions into the centralization-decentralization tradeoff. Besley and Coate (1997; 2003) and others use the citizen-candidate model to provide additional insight as to why the tradeoff between centralization and decentralization is not as simple as considering the implications for economic efficiency.[19] These models argue that policymakers represent citizens from their own districts who have preferences for favoring their respective jurisdictions in centralized decision making. Therefore, policymakers might be incentivized to misallocate public goods, depending on characteristics of the legislature. Epple and Nechyba (2004), who review the literature on decentralization, point out that politics adds a complex dimension to evaluating the effects of decentralized policy. One lesson is that political decisions are fundamentally different under decentralization because of local competition. Another lesson is that the effects of decentralization may be situational. As an example, Epple and Nechyba discuss how the economic effects of education are affected by the effects of education in neighboring jurisdictions. They also point out the rise of private options may also change the expected outcome of decentralized education. The implication is that politics, interjurisdictional competition,

---

[19] See Osborne and Slivinski (1996) for the original use of the citizen-candidate model.

and interjurisdictional collaboration all have the potential to affect the outcome of decentralized policymaking.

3.5 The Purpose of Intergovernmental Transfers

Intergovernmental transfers are a fiscal policy tool available to the central government to support decentralized policymaking. Oates (1972; 1991; 1999) discusses three purposes of grants. One purpose is to correct for positive externalities. Oates (1972) discusses using Pigovian grants to correct positive externalities.[20] Pigovian grants are designed to provide an amount to local governments equal to the marginal external benefit so that local governments are encouraged to provide the socially optimal level of the public good. Oates claims that Pigovian grants should be used in instances where the externalities are generated by several jurisdictions.[21] He describes a matching grant, which provides a fiscal transfer from the federal government to a local jurisdiction with a requirement that the local jurisdiction match a certain percentage of each dollar received. The grant changes the marginal price of an activity, causing governments to internalize the social marginal cost and produce the optimal outcome. It has a price effect in addition to an income effect. Since matching grants change the marginal price of output, Oates says that it should be used to correct distortions in the provision of public goods.

Federal grants are also used to ensure equity in fiscal capacities across jurisdictions (Oates 1972; 1991; 1999). This is accomplished by providing lump sum grants to poorer jurisdictions using income from richer jurisdictions so that all

---

[20] See Pigou (1920).

[21] In the cases where only a few jurisdictions are generating an externality, he claims that the federal government should intervene to oversee a negotiation between the party generating the externality and those affected by it.

jurisdictions are enabled to provide some level of public goods to their residents. However, he points out issues with using lump sum grants to address inequalities at the jurisdictional level. There will likely be a small population of rich individuals living in poor jurisdictions (and a small population of poor individuals living in rich jurisdictions) who will unfairly benefit (or be harmed). Therefore, Oates argues for redistribution across individuals instead of jurisdictions to address inequalities or for equalization at the regional level to reduce mobility if redistribution across individuals is not possible. Oates (1991) adds that there may also be an economic rationale for using lump sum grants, offering education as an example. We value the economic benefits of educated workers in our mobile society in addition to providing equal access to education. Finally, lump sum grants can be used to enhance efficiency by supporting different levels of the public good across jurisdictions in cases where centralization reduces heterogeneity (Schwab and Oates, 1990).

Oates (1972) distinguishes lump sum grants from matching grants by discussing the economic effects of each type of grant. Lump sum grants are unconditional, meaning that jurisdictions are free to allocate funds between the public good and private goods. In other words, lump sum grants do not distort the relative prices of each type of good. Instead, they have only an income effect, whereas matching grants have both an income and a price effect.[22] This is why Oates (1972) argues that lump sum grants should not be used as a corrective mechanism for public good provision.[23] However, in response to

---

[22] Also see Bradford and Oates (1971).
[23] Oates (1972) notes that the one exception to when a lump sum grant will not lead to the optimal outcome is the case where the local government spent nothing on the public good prior to receiving the grant.

Gramlich (1977) who suggests that lump sum grants change the price of local provision of public goods (thus changing the quantity demanded), Oates (1991) finds that lump sum grants have a price effect. Oates' model shows that the effect of a lump sum transfer will depend on the elasticities of demand, meaning that the change in quantity demanded could either increase, decrease, or stay the same.

The third role of federal grants is to improve the efficiency of the tax system (Oates 1991; 1999). This is accomplished by replacing local taxes with federal taxes and then redistributing the money back to local governments to reduce inefficiencies associated with local tax revenue. Wildasin (1991) explains how inefficiencies arise with local taxation by considering tax redistribution across jurisdictions that share a common labor market. Since redistribution takes from the richer residents and gives to the poorer residents, he argues that jurisdictions with higher levels of redistribution will attract poorer residents but deter taxpayers. Therefore, redistribution among local jurisdictions can cause distortions in the labor market and wealth across localities. In contrast, a centralized tax is uniform, providing no incentive for individuals to relocate across localities (Oates, 1999). Oates argues that the federal government will presumably redistribute using lump sum transfers to equalize disparities across localities to account for the inequalities of imposing a uniform tax.

Scholars who discuss the effectiveness of fiscal transfers in correcting inefficiencies and inequities in decentralized policymaking rely on strong assumptions about local governments. Oates (1972) acknowledges that fiscal transfers can achieve the optimal outcome in public good provision only if local governments act on behalf of their residents. Most first generation fiscal federalism models assume that the government will

act to maximize the welfare of individuals. However, the political process also affects

public good provision (Bradford and Oates, 1971a). Another assumption is that local

governments will willingly accept fiscal transfers to improve social welfare, which may

not be accurate. Wildasin (2004) points out that local governments might value local

provision and prefer to oversee all public good provision as opposed to accepting federal

fiscal transfers to achieve the socially optimal output.[24] Finally, Wildasin also argues that

spillovers can result from misallocated responsibilities across the separate levels of

government. In this case, institutional restructuring may be more appropriate than using

fiscal transfers (Buchanan, 1950; 1952; Buchanan and Tullock, 1962; Buchanan and

Wagner, 1970).

The literature also makes assumptions about the complexity of designing a grant

program. Most theoretical literature assumes that externalities can be measured. In some

cases, we can infer the size of the externality. For example, we may consider how

location affects housing prices by measuring an individual's willingness to pay to be

either near or far away from certain types of externalities. However, this is difficult to do

on a large scale, because there is not always a simple way to measure external costs and

benefits, especially when they are produced by several jurisdictions. Additionally, the

literature does not address the difficulty of justifying the use of a grant program. Bird et

al. (2002) calls for us to consider cost and allocative efficiency and equity when choosing

the appropriate grant. However, considering costs, allocative efficiency, and equity can

be inherently difficult. For example, the central government explain why local provision

is suboptimal and whether the suboptimal provision relates to allocative efficiency or

---

[24] Wildasin refers to cases in which local governments can provide the good relatively efficiently.

equity. These complexities might make it difficult for the central government to decide on matching rates for matching grants and the amount to be transferred to individual governments in the case of lump sum grants.

There has also been an ongoing debate in the literature regarding the effectiveness of fiscal transfers, which has led scholarships to evaluate the existence of the "flypaper effect" as described by Arthur Okun. The flypaper effects results when intergovernmental transfers lead a jurisdiction to spend more on the public good than they would have if there were to raise their own income, increasing local provision of the public good. Several empirical estimates find at least some evidence of the flypaper effect (e.g., Inman, 1971, Weicher, 1972; Gramlich et al., 1973; Bowman ,1974; Feldstein, 1975; Case et al., 1993; Olmsted et al., 1993; Brennan and Pincus, 1996; Rodden, 2003). On the other hand, few studies find little to no evidence of the flypaper effect (e.g., Zampelli, 1986; Megdal, 1987; Becker, 1996).

Scholars offer different theories to explain the flypaper effect. Hamilton (1983) differentiates between transfer income and own income to argue that the two have different effects on demand. In a subsequent article, he attributes the cause to the marginal deadweight loss due to taxation (Hamilton 1986). Loss aversion and fungibility are two interrelated concepts also used to explain the flypaper effect (Hines and Thaler, 1995; Kahneman et al., 1991; Thaler, 1990). Loss aversion refers to the concept that citizens are more opposed to a reduction in welfare than an increase in welfare. In other words, citizens are more accepting of a grant used to increase in public spending than a reduction in spending by substituting funds. Fungibility refers to the substitutability of funds. Completely fungibility occurs when a local government substitutes own public

spending in an amount equal to a federal grant award. These scholars argue that grant money and tax revenue are not completely fungible since they are different types of money.

Some scholars offer fiscal illusion as another explanation for the flypaper effect (e.g., Courant et al., 1978; Oates, 1979; Filimon et al., 1982; Winer, 1983; Turnbull, 1992; 1998). Generally, fiscal illusion refers to the idea that federal transfers change the perceived cost of local output. Federal transfers to local governments increase the amount of information asymmetry between local governments and residents, because they make it difficult for residents to understand the true marginal cost of producing the local good. Individuals vote for a level of public provision based on their average tax price instead of the true marginal cost of the good, leading to a level of provision greater than the desired level with full information (Courant et al.; Oates). Turnbull offers a different explanation of fiscal illusion, claiming that voters are aware of the true marginal price but have incomplete information about expenditures or services they receive (Turnbull, 1992; 1998). Winer argues that voters have the perception that other jurisdictions pay for some of the local output when grants are used. Fiscal illusion occurs with both the matching grant and the lump sum grant, but Bradford and Oates (1991) find that in most cases the matching grant induces more spending on the public good than a lump sum grant, because the matching grant has a price effect.[25]

More recent literature points to endogeneity to explain the flypaper effect. One argument is that grants are awarded to recipients who have a high demand for the public

---

[25] Bradford and Oates illustrate an exception to this finding, showing that if decisions are made by voters who demand less public goods than the level provided by the median voter under a matching grant, those voters will vote for a level of provision provided by a lump sum grant.

good, implying that grant recipients would have invested in the good even without the grant. After correcting for endogeneity, scholars find that grants have a smaller to no effect on the level of public good produced (e.g. Knight, 2000; Gordon, 2004). Although some studies find existence of the flypaper effect after controlling for endogeneity (e.g. Singhal, 2008; Dahlby, 2008). Lastly, Inman (2008) argues that politics is the best explanation for the flypaper effect as institutions create incentives for elected officials to spend differently with grant income.

A final explanation for the flypaper effect, crowding out, conjectures that public spending crowds out private spending, increasing the size of the public sector.[26] Most literature looks at the effects of intergovernmental transfers on voluntary contributions. Early theoretical work suggests that a federal grant to an organization completely offsets voluntary contributions to that organization (e.g. Warr, 1982; Roberts, 1984; 1987; Bergstrom et al., 1986). Empirical evidence on the effects of crowding out private donations finds incomplete to complete crowding out (e.g. Andreoni, 1993; Payne, 1998; Eckel et al., 2005; Heutel, 2014). However, following a subset of literature looking at the effects of fundraising and crowding out, Andreoni and Payne (2003; 2011) find that crowding out is primarily caused by reduced efforts to fundraise after receiving a grant. Literature on crowding out also considers effects of intergovernmental transfers on state spending. Bradford and Oates (1971a; 1971b) suggest that federal transfers will completely crowd out state spending. Knight (2002) controls for the endogeneity of local demand for intergovernmental transfers and finds that crowding out is statistically

---

[26]See Feldstein (1975) for one of the earliest explanations of crowding out.

significant. He argues that crowding out can help us to understand the flypaper effect, because these two effects work in the same way.

Most early scholars ignore the effects of politics and institutions on the distribution of fiscal transfers. The "second generation fiscal federalism" focuses on how incentives created by the institutional structure affect fiscal transfers (Qian and Weingast, 1997). Whereas the early fiscal federalism literature assumes that decision makers act on behalf of all the constituents, the second generation literature incorporates political behavior and information asymmetry (Oates, 2005). Qian and Weingast compare the government to firms to suggest the structure of government does not require that decision makers act on behalf of citizens. Weingast (2009) argues that the institutional structure incentivizes political officials to behave in ways that do not necessarily lead to social welfare maximization. Following Downs (1957) and others, he assumes that politicians are self-interested. The empirical literature supports this argument, finding that special interests and politics play a role in affecting fiscal transfers (e.g. Becker, 1983; Grossman, 1994; Inman, 1987; Knight, 2002; Bordignon et al., 2008; Inman, 2008).

Despite concerns with the implementation of fiscal transfers, scholars argue that they can be efficient and offer advice on how to minimize unintended incentives. First, local governments should generate their own revenue to ensure responsible decision-making at the local level (e.g., Bird, 1986; Oates, 1993; 1999; 2005). Local governments can become responsive to higher levels of government when they rely heavily on grant revenue. This can also lead local governments to have misinformation about the true cost of raising funds. Bird et al. (2002) discuss increasing accountability through benefit taxation at the local level, which also corrects other issues with decentralization as

discussed previously. They argue that local autonomy must be preserved to prevent the federal government from using fiscal transfers to control local decisions.

The second generation fiscal federalism literature further discusses how local revenue generation is important for local democracy, building on the first generation literature. Weingast (2009) discusses criteria for effective federalism. Like first generation scholars, he argues that local governments should raise their own revenue and face hard budget constraints, arguing that local governments become more responsive to their constituents and less corrupt as they finance more expenditures with locally-generated revenue. Local revenue generation conveys more information to residents about how much they pay for local services. He adds that the federal government should use grants and broad-based taxes to encourage local economic development.

3.6 Lessons for Renewable Energy Provision

Determining whether to centralize or decentralize policy provision involves consideration of the centralization-decentralization tradeoff and the role of fiscal transfers. Scholars outline a clear role for the federal government and advantages of decentralization. However, there are decisions to be made about how the subunits will govern together and what responsibilities will be assigned to each level of government (Inman and Rubinfeld, 1997a). Weingast's (2009) conditions for "market-preserving federalism" calls us to think about how to structure institutions so that local governments exist within a hierarchy and maintain some autonomy. Additionally, fiscal transfers exist to correct inefficiencies with local provision of the public good, but there is also complexity in using fiscal transfers given uncertainty, politics, and institutional structure.

We can use this framework to think about the role of government in renewable energy provision. The literature provides theoretical guidelines for how to assign responsibility for public good provision. Among other things, the role of the federal government is to provide goods with large spillovers, while responding to both states and individuals. The federal government has a substantial role in making regulatory decisions for and financing goods with large spillovers, such as environmental protection, education, healthcare, and food production, for example. Federal intervention can also be justified on grounds of economies of scale in acquiring the appropriate knowledge and physical and human capital needed to provide these goods. The same justifications could be used to argue for some centralized component of renewable energy, because it has large, positive spillovers and requires expensive investments in human capital and infrastructure for widespread development.

Current decentralized provision in the United States also indicates what type of provision is appropriate for renewable energy from a normative perspective. Scholars argue that decentralized provision can lead to race to the bottom or the tax assignment problem. Even though there is not clear evidence of race to the bottom, most studies looking at decentralized policymaking have mixed conclusions regarding effectiveness of subnational renewable energy policies (e.g. Carley, 2009; Menz and Vachon, 2006; Delmas and Montes-Sanchos, 2011). Concerning the tax assignment problem, Menanteau et al. (2003) argue that imposing an environmental tax is the most expeditiously method of encouraging renewable energy development, although they do not provide suggestions on how to design or implement an environmental tax. It is reasonable to think that an environmental tax could be implemented only at the central level given the difficulties of

designing and implementing a local tax as outlined by McClure (2001). Local benefit taxation as suggested in the literature does not seem like a viable option, giving the difficulties of measuring preferences and benefits of renewable energy production, such as cleaner air, water, and climate mitigation.

The advantages of decentralized renewable energy are observed but perhaps not sufficient to justify decentralization. We learn that decentralization allows local governments to cater to constituents' preferences. State and local governments have adopted heterogeneous renewable energy policies. While these policies may have been motivated by constituents' preferences, second generation fiscal federalism literature teaches us that policymakers do not always respond to constituents. The public has shown support for renewable energy since the 1970s (Laird and Stefes, 2009; Stoutenborough et al., 2014). Yet the market continues to be relatively underdeveloped. Finally, decentralization allows for policy innovation, which we observe with current subnational policies adopted since the 1970s. Since the renewable energy market is still underdeveloped in the United States, it is reasonable to consider if there will be additional innovations in years to come to further justify decentralization.

We can also apply the lessons from the literature to understand federal grants to state and local governments for decentralized renewable energy in the United States. Most energy grants are designed as Pigouvian grants. At the most basic level, the literature contends that Pigouvian grants can help to correct externalities associated with decentralized provision. In practice, Pigouvian grants are difficult to implement for renewable energy, because externalities from renewable energy production are difficult to measure. This is further complicated by the fact that different forms of energy technology

produce different levels of renewable energy. Even if grants could be designed to increase the optimal level of renewable energy, grant programs do not necessarily address informational asymmetry regarding the true costs of renewable energy development. For example, utility companies can have complicated pricing structures and difficult or nonexistent interconnection standards.

One could also argue for equalization grants on the premise that localities are not equally capable of investing in research or infrastructure for renewable energy. Equalization grants used without centralized policy could be difficult in practice as they would require extensive oversight from the federal government. Renewable energy resources and available infrastructure vary across jurisdictions. For example, some jurisdictions in the West are best able to develop geothermal energy whereas jurisdictions in the Midwest are more suited for wind or biomass energy. As a result, these jurisdictions face different costs for investments in infrastructure, information, and human capital, possibly making program implementation difficult.

Lessons from the fiscal federalism literature suggest that a centralized renewable energy policy might be more efficient than decentralized renewable energy provision. Centralized policies can also be implemented without preempting current state and local policies. This dissertation explores why federal policymakers choose to decentralize renewable energy by way of fiscal transfers. Chapter Four puts forth a theoretical model to explain the circumstances under which federal policymakers are incentivized to support funding for renewable energy grants to subnational governments.

CHAPTER FOUR: A CONCEPTUAL PERSPECTIVE ON CHOOSING DECENTRALIZED CLEAN ENERGY IN THE UNITED STATES

4.1 Introduction

Federal policymakers have at least some discretion over decisions regarding the centralization or decentralization of public goods. These policymakers can also distribute fiscal transfers to federal agencies to provide a centralized good, provide grants to subnational governments to support decentralized provision of goods, or some combination of both. In his review of the literature, Oates (2005) explains how the choice between centralization and decentralization involves more than a consideration of which level of government can provide a public good more efficiently. As discussed in the previous chapter, he points out that imperfect information and institutional incentives affect decision-making. This chapter builds on previous studies to consider the centralization-decentralization tradeoff of energy policy from this perspective.

U.S. Policymakers' choices for renewable energy provision can be generalized into two basic types of decisions. First, the majority of policymakers have decided not to support centralized provision of renewable energy policy and development, which has been evident in failed attempts to pass centralized clean energy policies. This decision has been discussed in the literature, mainly by studies looking at subnational policy efforts in response to a lack of federal response to renewable energy (e.g. Bromley-Trujillo et al., 2016; Aslani and Wong, 2014; Carley, 2011; Delmas and Montes-Sancho, 2011; Feiock et al., 2009; 2010, Rabe, 2008). Second, policymakers choose to provide annual appropriations for grant programs to support subnational renewable energy provision. The majority of grant programs are implemented by the U.S. Department of Energy, which awards money to state and local governments to partially cover costs of

clean energy investments. The decision to utilize grants for renewable energy has received less attention in the literature.

The broader political and institutional context in which these decisions are made can help us to understand the motivation for these two decisions. The public has shown support for renewable energy since the 1970s, but the federal government has not provided consistent federal policy support and funding for renewable energy development (Laird and Stefes, 2009; Stoutenborough et al., 2014). Scholars speculate as to why efforts to pass centralized renewable energy policies have failed. Bang (2010) argues that policymakers value clean energy as a solution to energy independence and climate change, but policymakers cannot agree on a policy approach to implement renewable energy at the federal level. Wüstenhagen et al. (2007) explains that policymakers might lack support from major stakeholders; fail to implement effective policies; and not understand public preferences for centralized energy implementation and location. Bang also argues that fossil fuels dominate the energy market in the United States, providing fossil fuel lobbying groups the political power to discourage federal action on renewable energy development and keep the status quo in energy policy. However, these studies have not empirically evaluated the decision-making relationship, which is the focus of this dissertation.

Furthermore, renewable energy is subject to the political discourse of climate change policy, because clean energy is regarded as a solution to help mitigate climate change (Brown, 2001; Menanteau et al., 2003; Longo et al., 2008; Roe et al., 2001; Wiser, 2007; Goett et al., 2000; Batley et al., 2001; Beck and Martinot, 2004). Climate change policy is salient and controversial in the United States. Despite hundreds of

congressional hearings on climate change, the federal government has failed to pass a comprehensive climate policy at the national level (Rabe, 2007). Instead, public preferences for climate change have become polarized across partisan or ideological lines (Egan and Mullin, 2017; Dunlap et al., 2016; Stoutenborough et al., 2014; Dunlap and McCright, 2008; Fiorina and Abrams, 2008; Krosnick and Holbrook, 2000). In general, the public is divided on whether they consider climate change to be a policy issue and whether the federal government should adopt policies to address climate change. Political leaders continue to debate if climate policies should be adopted and who should be responsible for addressing this policy issue. Most of the difficulty for policymakers has been balancing both economic and political concerns while responding to both industry and environmentalists (Hahn, 1990; Kolstad and Toman, 2005).

Controversy over energy policy exists primarily at the national level. Local renewable energy policies are potentially less controversial as they allow for innovation and costs savings (Feiock et al., 2009; 2010). Policies in individual jurisdictions can be tailored to suit local heterogeneous preferences to achieve clean energy and energy efficiency goals. Feiock et al. (2010) explains that energy development can sometimes be implemented using existing technologies in individual jurisdictions. For example, energy systems are often tied directly to governmental operations or buildings. Additionally, decentralized local energy policies allow local government to utilize existing energy resources. Feiock et al. also argue that clean energy technologies can result in energy costs savings for local governments by increasing energy efficiency.

The energy policy literature explains why the federal government has failed to pass a centralized renewable energy policy. This chapter takes a different perspective to

explain why legislators appear to choose decentralized renewable energy policy. I do so by exploring a policymaker's decision to federally fund centralized or decentralized renewable energy. Borrowing assumptions from legislative bargaining models, I put forth a conceptual model of legislative decision-making. This chapter contributes to existing work in two ways. First, I offer a perspective on the centralization-decentralization different from current legislative bargaining studies. Whereas other scholars conduct a comparison of a legislator's utility under centralization and decentralization, this model considers a legislator's decision to *choose* funding to support centralization or decentralization. Second, I discuss the political price of decision-making, which is related to proposing centralized or decentralized good provision for a specific good. I include political price directly into the constraint on a legislator's utility function to show how political price affects the optimal outcome.

The chapter proceeds as follows. I discuss studies on legislative behavior in the following section to explain how incentives and institutional structure affect public good provision. In the third section, I use the literature to inform a theoretical model to explain a legislator's decision to either centralize or decentralize a policy by way of utility maximization subject to institutional constraints. I do so by showing the relationship between political price and the type of a proposed good provision. I argue that legislators responsible for clean energy policy are incentivized to provide funding for decentralized renewable energy policy instead of centralized renewable energy policy despite large spillovers of clean energy. I conclude the chapter by discussing how this theoretical model explains decentralized clean energy policy in the United States and provide motivation for subsequent empirical chapters.

4.2 Legislative Behavior

The economic literature in the preceding chapter discusses normative arguments for choosing centralization or decentralization. However, studies on legislative behavior explain how self-interest can affect a legislator's decision to choose the optimal amount of public good provision. Some studies explain overprovision by focusing on a legislator's role in Congress. Most notably, Niskanen discusses a legislator's behavior while serving on a subcommittee to explain how the public good can be overprovided (Niskanen, 1971; 1975; 1991; 2008). Legislators oversee bureaus through their appointments on their legislative subcommittees, and subcommittee appointments are often tied to interests of their constituents. Niskanan argues that legislators typically demand a level of output from the bureau that is higher than the demand of the median voter. I borrow to from Niskanen by considering good provision within the context of self-interested legislators who serve on legislative subcommittees tied to their own interest. However, I use this assumption to explain under provision of goods.

The second generation fiscal federalism literature relates the work of Niskanan to public good provision. The literature incorporates the political process, political behavior and asymmetry of information to understand the behavior of legislators (e.g. Oates, 2005; Weingast, 2009). Oates explains that institutions of imperfect information encourage participants to seek their own objectives instead of a common good. Therefore, the decision to centralize or decentralize is influenced by legislators' own objectives subject to constraints on their behavior. For example, Weingast et al. (1981) assume legislators choose a level of spending for their constituents independently of decisions made by other legislators. They argue that this is inefficient and leads to overprovision of the

public good. Furthermore, the distribution of fiscal transfers—which are intended to aid decentralized provision—might be affected be self-interest. For example, scholars argue that politicians distribute grants to local governments in effort to maximize votes from their constituents (e.g. Grossman, 1994; Inman, 1987; Rodden, 2003; Gamkhar and Ali, 2008).

4.3 Legislative Bargaining Models

Scholars also model the legislative bargaining process to show how strategic behavior affects the provision of goods.[27] Some studies on legislative bargaining take a political economy approach and find that politics affect the level of spending on goods. For example, Baron and Ferejohn (1989) assume that the legislature is non-cooperative, leading to an overprovision of goods in jurisdictions with the highest levels of political power, underprovided in other jurisdictions, and overprovided overall. Knight finds that legislators with proposal power have the greatest amount of overspending (Knight, 2008; 2005). Rather than focusing on overall level, Leblanc et al. (2000) argues the existence of a systematic underinvestment in public goods caused by majority-rule governance. They argue that current majorities make decisions based on current consumption and underinvest in future consumption.

Legislative bargaining models also show how centralized spending relates to tax burden. Generally, these models argue that legislators will support centralized spending on a project if the benefits going to his or her constituents exceed the share of taxes those constituents will pay. For example, Knight (2004) finds that the probability of a legislator

---

[27] Legislative bargaining is a concept developed by Baron and Ferejohn (1989), which assumes that legislators strategize to reach a policy outcome.

supporting funding for a project increases as his or her district's share of the tax burden decreases. Lorz and Willman (2005) argue that representatives intentionally choose a suboptimal public spending to reduce their region's share of the tax burden. Although scholars also suggest that the level of spending depends on a legislator's preferences for spending on pork projects and spending on the common good (Volden and Wiseman, 2007; Christiansen, 2013).

Scholars also use legislative bargaining models to directly evaluate the centralization-decentralization tradeoff. Models in the literature typically build from the citizen-candidate model, where legislators are elected by voters who share the same preferences (e.g. Osborne and Slivinski, 1996; Lockwood, 2002; Besley and Coate, 1997; Besley and Coate, 2003). These studies reevaluate Oates' (1972) Decentralization Theorem to show the circumstances under which centralized output does not necessarily result in uniform provision and can lead to inefficiencies even with large spillovers. These models assume that legislative institutions create incentives to misallocate goods under centralization (Oates, 2005). Given these institutional assumptions, the choice between centralization and decentralization is a tradeoff between decentralized output that cannot internalize externalities and centralization output with misallocations.

Lockwood (2002) compares the relative efficiency of centralization and decentralization within the framework of legislative rules. He finds some support for Oates' decentralization theorem, arguing that uniform provision is relatively efficient with large, positive externalities, and decentralization is more efficient when externalities are small or localities are heterogeneous. Lockwood's contribution is in his argument that centralization does not necessarily lead to greater surplus with increasing externalities

49

and more homogeneous jurisdictions. Instead, a project's non-monotonic costs will also determine the optimal choice between centralization and decentralization. He discusses the case of logrolling where legislators vote for spending on projects that benefit their respective jurisdictions. To the extent that regional projects' positive externalities are increasingly smaller than the number of region-specific projects funded, centralization can become increasingly inefficient. Therefore, decentralization may become more efficient in cases where legislators are likely to vote for projects that provide increasingly disproportionate regional benefits.

Besley and Coate (2003) model the political process discussed in Inman and Rubinfeld (1997a; 1997b), who argue that politics is involved in the process of allocating funds. Besley and Coate argue that legislators' respective districts can receive disproportionate benefits from public spending under a centralized system funded by general taxation. They contend that the cooperativeness of the legislature determines the size of the spillovers needed for centralization to be the optimal output. They illustrate by comparing centralized provision to decentralized provision. In a decentralized system, the surplus-maximizing output is determined by each jurisdiction's median voter, who elects representatives who share the same preferences.

Besley and Coate (2003) argue that the efficiencies of output depend on the cooperativeness of the legislature under centralization. If the legislature is cooperative, legislators will bargain to maximize their joint utility. Under this scenario, legislators bargain for their respective constituents, not the median voter across all districts. Therefore, legislators overprovide the good when maximizing their joint utilities. Therefore, there is a certain threshold of spillovers, k^*, for choosing between

centralization and decentralization, where centralization is preferred when spillovers are above k^*. Besley and Coate add that the policy outcome is random under a centralized system with a non-cooperative legislature, where a winning coalition makes decisions, leading to uncertainty and misallocation of resources. In the case of a non-cooperative legislature, the threshold for k^* is higher.

Furthermore, Lockwood (2005) includes benefits and costs of centralized and decentralized projects in the legislator's utility function and shows that legislators can act like they are maximizing joint utilities in a centralized system if they are able to make side payments to one another. He argues that Besley and Coate's (2003) model holds if side payments are made through personal transfers. However, he argues that Besley and Coate's model does not apply if those side payments are made through differentiated taxes. If this is the case, there is an incentive for legislators to bargain and centralization is efficient. Following the second generation fiscal federalism literature, Lockwood (2008) argues that institutions and organized interests affect preferences. He uses this framework to evaluate how strategic delegation affects the centralization-decentralization tradeoff. He finds that strategic delegation does not necessarily invalidate Oates' classic theory of the tradeoff. Instead, the welfare-maximizing choice can depend on the preferences of voters. Centralization can be welfare-maximizing with no spillovers and heterogeneous jurisdictions if the preferences of the majority of voters outweigh the loss of efficiency. Conversely, decentralization may be preferred when there are large spillovers and relatively homogeneous jurisdictions.

Legislative bargaining models have been used to explain why normative economic rules regarding the centralization-decentralization tradeoff do not always

determine whether a legislator will support centralization or decentralization. Some legislative bargaining models show rules that determine whether a legislator will vote for centralized spending on a project. Other studies evaluate a legislator's utility under centralization and decentralization separately to show the circumstances under which decentralization is more efficient given the institutional incentives that affect legislators' behavior. In the following section, I build on these models to offer a different perspective on a legislator's decision-making process. I focus on a legislator's decision to choose whether to offer a good at the central level or support decentralized provision. Before a legislator proposes a distribution and level of spending, he or she must first consider the likelihood of the proposed centralized or decentralized policy passing the legislature, which is determined by the political price of each type of proposed policy provision. The theoretical model suggests that political price will determine whether a legislator choose to propose centralized or decentralized provision for a good.

4.4 Theoretical Model

Current legislative bargaining models analyze the decision to centralize or decentralize policy by comparing outcomes under both types of provision by showing which option maximizes own utility. These models generally explain overprovision of a good. However, the model I propose looks at the centralization-decentralization tradeoff from a different perspective to explain under provision of a good. Instead of comparing outcomes under the two different types of provision while assuming that the centralized or decentralized policy is exogenously given, I treat a legislator's choice to either centralize or decentralize policy as the variable. Therefore, I consider a different stage in

the decision-making process where a legislator determines which type of policy to propose. This perspective contributes to the literature by offering an explanation as to why we sometimes observe decentralized provision for goods that have a normative economic justification for centralization.

I begin with assumptions from the literature to put forth a conceptual model of legislative decision-making. I start with legislative bargaining models, which use citizen-candidate utility functions. In one of the most basic forms, the utility of legislator i from jurisdiction j and with preferences α can be described as a quasi-linear function: $U^{i,\alpha} = c^i + \alpha H(g^i)$, where c^i is private consumption and g^i is a level of the goods provided by the government (e.g. Persson and Tabellini, 2000). This utility model assumes that legislators are perfect representatives of their constituents. Other studies extend on this model to incorporate institutional factors that presumably affect decision making.

Instead, the political economy literature starting with Downs (1957) establishes that reelection is a primary concern for current legislators. For example, Fenno (1977; 1978) argues that incumbents seek to satisfy their constituents to win reelection. Ferejohn (1986) argues that legislators behave strategically to get reelected, contingent on their desire for reelection. Fenno (1973) states that legislators seek reelection and their own policy objectives. Subsequent studies linked reelection to policy objectives. The seminal work by Peltzman (1976) argues that reelection is a function of pleasing constituents. Peltzman's model considers the regulation of industry to argue that legislators can increase votes by offering benefits to their constituents. Becker (1976) argues that Peltzman's model also applies to federal policies that offer cash transfers. Alesina and Tabellini (2007; 2008) argue that legislators try to increase the probability of reelection

by maximizing the utility of their constituents. Although I do not formally define reelection, I assume that legislators can increase the likelihood of reelection by offering some benefits to constituents using some level of goods.[28] Therefore, I assume that legislators have a unique utility function as a legislator, and the legislator utility function includes reelection. Thus, I propose a simplified model of utility of each legislator i serving on subcommittee j.

$$U_i^j = U(r(g_i^j)_i, g_i^j, \theta_i) \tag{1}$$

Where utility is a function of r_i, the probability of getting reelected, g_i^j, the publicly provided good by subcommittee j, and θ_i, a legislator's preference parameter. The good, g_i^j, enters the utility function separately and as a function of r_i since positive values of g_i^j can increase utility independently and increase the probability of getting reelected by benefiting legislator i's constituents.

For simplicity, I focus only on a legislator's role as a subcommittee member since legislators allocate their time making decisions based on subcommittee assignments. This approach varies slightly from legislative bargaining models that express utility of a legislator who serves an individual jurisdiction. I assume legislators respond to constituents by serving on a subcommittee that oversees bureaus that benefit his or her constituents (Niskanen, 1971; 1975; 1991; 2008). I focus on the subcommittee, because subcommittees specialize in policies that impact a small number of goods. This leads to my next assumption about legislators. I assume that legislators have a high demand for the output of the bureaus their congressional subcommittee oversees and spend most of

---

[28] Reelection may also be a function of lobbyist support and other factors important to constituents.

their time making decisions about provision of the bureau's output. Therefore, I focus on how a legislator values the good produced by his or her bureau, and not public spending in general.

The assumptions about the role of a legislator serving on a subcommittee are critical to evaluate how legislators work together to decide on type of public provision. I assume that legislators serving on the same subcommittees all have a high demand for the good their subcommittee oversees, even if they disagree on how to provide the good. Therefore, they have an incentive to cooperate to achieve a policy outcome, even if they disagree on policy details, because cooperation allows for each legislator to get their preferred level of g subject to institutional constraints. Therefore, I assume that legislators serving on the same subcommittee have an incentive to cooperate to increase g_i^j. I revisit the cooperative legislature discussed in Besley and Coate (2003). They argue that cooperative legislators work together to provide a level of the public good that maximizes the sum of their utilities: $\Sigma U_{i=1,2} [\theta_i ((1-k)\ln g_i + kg_j)]$ subject to a budget constraint $p/2(g_i + g_j)$. The model assumes two legislators, denoted by i, for simplicity. In this model, θ_i is a preference parameter, k is the degree of spillovers associated with the good distributed in district i, g_i, and the good distributed in district j, g_j. Legislator *i*'s utility is a function of the amount of good retained in his or her own district i and the amount of spillovers that go to district j.

Although Besley and Coate's model applies to the whole legislature, I apply the model only to the subcommittee to explain decision-making. I assume that legislators who serve on the same subcommittee are cooperative and maximize the sum of their

utility functions.[29] Revisiting Model (1), I assume two legislators for simplicity, where $i = 1,2$. If two legislators cooperate to maximize their joint surplus, they work together to get their preferred levels of $g_1{}^j$. Therefore, the two legislators, 1 and 2, on subcommittee 1 will find the amount that satisfies $\text{Max}_{r,g} \sum_{i=1}^{2} (U_1{}^1(r(g_1{}^1)_1, g_1{}^1, \theta_1) + U_2{}^1(r(g_2{}^1)_2, g_2{}^1, \theta_2))$. With more than two legislators, the utility maximization of legislator i on subcommittee j is $\text{Max}_{r,g} \sum_{i=1}^{n} U_i{}^j(r(g_i{}^j)_i, g_i{}^j, \theta_i)$, where $i = 1, 2, \ldots, n$.

To find the utility-maximizing solution, I define the constraint. Current legislative bargaining models put forth rules under which legislators will agree to a policy. For example, Knight (2004) assumes that a legislator will vote for a policy proposal if the benefit to his or her constituents exceeds his or her jurisdiction's share of taxes for that good. He defines utility as having a functional form, h. The share a jurisdiction pays for the good, g, is total taxes, τ, divided by the number of people within that jurisdiction, N. Therefore, a legislator will support spending if utility is greater than or equal to share of taxes: $h(g) \geq \tau / N$. Furthermore, other legislative bargaining models show that a policy will pass if the majority of legislators $((i/2) + 1)$ agree to the policy. However, I reconsider the constraint to explain the decision to centralize or decentralize a good.

I focus on redefining the constraint a legislator faces during the decision-making process by proposing an alternative way to think about the institutions in which legislators make decisions. Legislators are responsible for introducing policy proposals before the proposals pass through the legislature to be voted upon by the legislative body. I consider the moment when a legislator considers a policy proposal, which will

---

[29] I do not assume that the legislature as a whole is necessarily cooperative. The legislature as a whole can be uncooperative at a moment in time without impacting the cooperativeness of a subcommittee.

inevitably passed through an official process replete with political and policy preferences. Therefore, a legislator will face some level of political costs associated with his or her effort to promote a policy proposal. Some models similar costs directly into legislator i's utility function, such as transaction costs: $u_i = \lambda r_i + p_i R$, where r is the rents of holding office, λ is the transaction cost associated with collecting rents to office, and $p_i R$ is the probability of getting reelected (e.g. Persson et al., 2000; Janeba and Schjelderup, 2009). However, these models do not include costs of vying for reelection and a legislator's limited resources utilized to advocate for their preferred policies.

Although not applied to the centralization-decentralization tradeoff, Woon (2009) argues that legislators have limited resources to perform legislative duties and achieve policy objectives. Therefore, legislators pursue activities that produce the largest benefits subject to a constraint. Following this logic, I include a constraint to account for a legislator's limited resources that affect decision making. The constraint function here is different from standard approaches to modeling a constraint. Instead of modeling income, prices, and quantity, I consider a legislator's political resources used to support a specific type of policy provision. These resources are monetary and nonmonetary resources that assist a legislator in advocating for a certain policy output. The costs in the constraint are the political price associated with producing a level of output, g_i^j, or competing for reelection, $r(g_i^j)_i^j$. I define the constraint for legislator i on subcommittee j as

$$Y_i^j = P_r r(g_i^j)_i^j + P_g g_i^j \qquad\qquad (2)$$

where Y is a legislator's total resources, P_r is the political price associated with increasing the probability of getting reelected, and P_g is the political price associated with implementing legislator *i*'s preferred level of g.

This newly defined constraint function warrants further description. Total resources, Y, include all monetary and nonmonetary political resources that help a legislator to perform his or her job, which may include time, effort, and political resources. These resources are used to create policy proposals to produce some level of the good and to compete for reelection. Policy proposals for the good and competition for reelection consume total resources as there are political costs associated with each one. The political price of reelection includes activities such as campaigning and rallying support from interest groups. The political price of the good, as described in further detail below, is the price associated with creating and garnering support for a policy proposal. I argue that this price is determined by the political platforms of legislators, which may be divided across party lines. It is specific to the good and type of provision proposed. Support for a specific good depends on legislators' political platforms. The type of provision (centralized or decentralized) determines how much of the good is produced. If a majority of legislators are willing to vote for centralized provision of a specific good, we should expect there to be a lower political price associated with a centralized policy proposal. Conversely, if support for centralized provision of a specific good is divided across party lines, we should expect a higher political price associated with a centralized policy proposal. This is the case because it will be more difficult for a legislator to garner votes for his or her policy proposal. The price will inevitably be lower for decentralized provision in the latter case as there will be less output with decentralized provision.

Using the constraint function, we can see how political price affects the optimal outcome. I apply the Besley and Coate (2003) model to subcommittees by assuming that legislators serving on the same subcommittee share the same preferences. In other words, each subcommittee member has a high demand for the output of the bureaucracy he or she oversees and reelection, making each subcommittee a cooperative subunit inside the legislature. Furthermore, legislators serving on the same subcommittee have an incentive to cooperate, because cooperation allows each legislator to receive his or her preferred level of g. Therefore, legislators have the incentive to maximize the sum of the utilities of all legislators serving on the same subcommittee. Then the utility-maximizing solution for legislators serving on subcommittee j is $Max_{r,g} \sum_{i=1}^{n} U_i^j(r(g_i^j)_i, g_i^j, \theta_i)$ subject to $Y_i = P_r r_i^j + P_g g_i^j$.

Therefore, the utility-maximizing solution is where the marginal rate of substitution of the sum of legislators' utilities is equal to the political price ratio.

$$\Sigma U_r^j / \Sigma U_g^j = P_r / P_g. \tag{3}$$

In other words, cooperative legislators choose an amount of the bureau's good and the likelihood of reelection that provide the highest amount of utility given the constraint.

The contribution of this model is P_g, the price of making a decision, which is specific to each good. It also has one of two values depending on the type of provision (centralized or decentralized) a legislator proposes for an individual good. The magnitude of the difference in the values of P_g under each type of proposed provision depends on the political climate surrounding that particular good at a given moment in time. For politically contentious policy issues, the difference in the political price of proposing a

centralized policy can be larger than the political price of proposing a decentralized

policy compared to policy issues that are not politically contentious as decentralized

output requires less federal funding and results in lower amount of the good produced.

Therefore, it is less costly for a legislator to garner support for decentralized provision

when a majority of legislators do not support centralized provision of a specific good.

When political prices of centralized policy proposals are higher than those of

decentralized policy proposals, the centralized policy proposal reduces legislators'

utilities compared to decentralized policy proposals.

I also argue that the level of spillovers should be directly incorporated into P_g

instead of the utility function. A consideration of spillovers and the appropriate level of

government undoubtedly implicitly or explicitly affects how easily a legislator can

advocate for each type of public provision. While the exact function of P_g can depend on

several factors, we can think of a simplistic function to show the relationship between the

political climate of a good, spillovers, and how they simultaneously affect P_g. For

example, consider a possible function of P_g with a centralized policy proposal:

$$P_g = h(c)/k_p \tag{4}$$

where h is a functional form, c the size of the controversy associated with a centralized

policy proposal, and k_p is the size of the spillover associated with the proposed level of

centralized provision. This simplistic model shows when centralized policy proposals

have the highest political prices: when controversy over preferences for a centralized

policy proposal is large and spillovers of an actual centralized policy are small. In this

example, decentralized provision may be preferred.

I use this conceptual model to explain why clean energy remains decentralized in the United States. Assuming a legislator values clean energy and wants to allocate funds to increase clean energy output, the legislator has two choices: (1) advocate for a centralized policy, or (2) advocate for a decentralized policy. The outcome, shown in equation (3), is affected by values of P_g. Using the simplistic formula in equation (4), we can compare P_g under both centralization and decentralization provision proposals. I consider how clean energy affects P_g. The literature argues that centralized clean energy policy is controversial among policymakers, on average. However, the value of P_g has a different value for a decentralized policy proposal. Although spillovers are large, the value level of controversy over the type of provision for the specific policy is smaller. Therefore, the total price of a decentralized policy proposal, P_g, is smaller for a decentralized energy policy proposal.

We can also consider the utility function in its entirety to understand why policymakers allocate funds to support decentralized provision of clean energy. Looking at equation (4), we can think about how political prices affect the attainable levels of r and g. First, we can assume that the probability of reelection is similar under both scenarios. If legislators and the public shares similar preferences for the good, the probability of reelection will increase with a large output under centralization and decentralization. This occurs because centralized output increases g for everyone, even if disproportionately across districts, and decentralized output will increase output for legislators' respective districts. However, the overall level of g will not be the same in both scenarios. Decentralized provision can increase g if the federal government utilizes grants to increase local spending or allows for policy provisions that encourage local

governments to spend on g. However, legislators must allocate a certain level of federal spending on g to provide a centralized output. If political prices associated with centralized provision due to controversy surrounding a specific good are high, decentralized provision is the likely outcome under this model. If controversy surrounding a policy issue is low, centralized provision is more likely if spillovers are large.

While I only consider a legislator's utility within his or her role on a subcommittee, we can also use this framework to think about the subcommittee's strategy to pass a policy proposal through the legislature. Individual legislators introduce policy proposals but must expend resources to gain votes for their proposals from other legislators. Legislators working together on a subcommittee have a high demand for the good's output and are incentivized to cooperate within the subcommittee. However, legislators not serving on that same subcommittee are less likely to have a high demand for the good's output. Therefore, there are naturally higher political prices when subcommittees need the whole legislature to agree to a policy proposal. It is plausible that subcommittees push forward the proposals that both maximize utility within the subcommittee and have the greatest chance of being approved by the legislature. In the case of a controversial policy like clean energy, the magnitude of political price associated with decentralized policies is small relative to a centralized clean energy policy. This could explain why decentralized policies have passed the legislature.

The focus of this paper is controversial policies, but a brief discussion of policies that are not highly controversial is relevant as well. Perhaps all policies can arguably be characterized as "controversial" to some extent as the court system is inundated with

cases concerning a variety of policies. However, the controversy of policy output is not always a factor that inhibits adoption of a solution. Political parties may disagree on how much they should respond to policy problem but generally agree on an approach. Therefore, if the policy issue or potential solutions are not controversial, legislators may base the decision on efficiency grounds, the lowest cost, or the best feasible policy solution to address the policy problem. Regardless of how legislators come to a decision, the key point is that successful policies are ones where the political price are relatively low. For example, opposing political parties may disagree on the amount of national defense that should be provided publicly, but this good is relatively noncontroversial as most legislators agree that the federal government should provide this good.

4.5 Implications for Policy

The conceptual analysis put forth in this chapter makes assumptions about legislators and their role as subcommittee members. I consider the stage in the decision-making process where legislators consider policy proposals. I assume that legislators have utility functions that are unique to their role on a legislative subcommittee: utility for a legislator is a function of reelection and the good produced by the committee's bureau. I also assume that legislators have a high demand for the output of the bureau they oversee. Given these assumptions, the utility-maximizing decision involves a tradeoff of the political price associated with passing a policy under each type of provision. In other words, the legislator might agree that centralized clean energy policy can be effective but vote for a decentralized clean energy policy because high political prices limit a legislator's ability to pass a centralized policy proposal. The key takeaway is that

decentralized policy leads to greater probability of a policy outcome for a certain level of controversy associated with the nature of the policy.

This model can help us think about decentralized clean energy policy in the United States. One bureau through which clean energy is passed is the U.S. Department of Energy. The subcommittees in both the U.S. Senate and House of Representatives responsible for overseeing the DOE have both conservative and liberal congressional members. One might argue that congressional members who have different ideologies would likely have different preferences, even if they serve on the same congressional subcommittee. However, I argue that they both still intrinsically value the output of the bureau and getting reelected. For example, some clean energy policy can encompass several benefits and appeal to both ideologies. Clean energy can produce local environmental benefits, reduce energy costs for businesses and residents, and improve energy security. While legislators may have different ideas about clean energy policy, preferences may converge if clean energy output is provided through the bureau their respective subcommittee oversees.

There might also be cases where legislators who value fossil fuel energy pursue subcommittee membership on the same subcommittee overseeing clean energy. The model is still beneficial in explaining legislative behavior in this case. The model requires legislators to cooperate to pass some level of the good. However, subcommittees only require a majority of legislators to agree to a policy proposal to pass it out of committee. If there are a subset of subcommittee members on the same subcommittee who share the same preferences, that subset of legislators is still incentivized to cooperate to pass some level of g.

Although this analysis of legislative behavior and utility maximization helps us to understand decentralization of clean energy policy, the conceptual model does not address how noncontroversial policies may be decentralized given normative economic arguments for centralization. According to this model, legislators will push for centralized policies when the political price is low, assuming the output should be centralized from a normative economic perspective. However, we can imagine a case where a legislator wants to allocate fiscal transfers to his or her constituents through decentralized policy even if it is not controversial. One example might be education policy in the United States. Until recent years, education policy in the United States was fairly decentralized (DeBoer, 2012). I argue that this policy issue is relatively uncontroversial, because most legislators would agree that there are benefits of having an educated workforce. Moreover, education policy at the local level undoubtedly has large, positive externalities, because educated persons are mobile. Therefore, from a normative economics perspective, education should be centralized, and perhaps this is why the United States has moved towards centralization of education policy.

Another limitation of this analysis is that it only considers a legislator's decision on policy provision. It does not consider other important actors in the policy process, such as the president and the courts. The president can be quite influential in intergovernmental transfers for decentralized policies (e.g. Hudak, 2014). Moreover, legislators work within the constraints of the law. Along these same lines, this analysis does not formally consider the role of legislators who do not serve on the subcommittee and bureaucrats who help to carry out these policies. This model only considers them in

relation to how they are involved in a legislator's decision-making process, i.e. the political price associated with reelection and bargaining for policy provision.

Lastly, this analysis does not take into consideration the current state of clean energy policy in the United States. National policy could preempt state and local clean energy policies if not designed by policymakers who consider the current state of subnational policies. Furthermore, if states do not want federal policy, it may be true that legislators hope to increase their probability of reelection by meeting states' demands. Any further analysis of the legislator's role in the decision to either decentralize or centralize clean energy policy could consider these factors.

The following chapters evaluate the theoretical argument put forth in this chapter. Chapter Five offers a direct empirical test of the conceptual model by examining how the political price associated with renewable energy impacts the probability of proposing decentralized funding for renewable energy provision.

CHAPTER FIVE: AN EMPIRICAL EVALUATION OF A LEGISLATOR'S CHOICE OF DECENTRALIZED FUNDING FOR RENEWABLE ENERGY

5.1 Introduction

The previous chapter put forth a theoretical framework to explain why legislators propose funding for decentralized provision of renewable energy. Chapter Four argues that when policy proposals for centralized renewable energy development have a high a political price, legislators are incentivized to propose funding for decentralized renewable energy output. The model seeks to explain why we observe decentralized renewable energy in the U.S. even though there are large spillovers associated with renewable energy production. This chapter empirically evaluates the theoretical argument of Chapter Four by asking if legislators are more likely to propose decentralized funding for renewable energy policies when the associated political price is lower than centralized policy proposals at the time of a policy proposal.

To evaluate legislators' initial funding decisions, I start by considering the first observable moment in the decision-making process. Legislators document their initial policy proposals by introducing new bills in the legislature. Thus each introduced bill represents an initial, strategic decision for a preferred policy output by the bill sponsor (Woon, 2008). The legislator introduces a new bill with the expectation that the whole legislature will vote upon that proposal later in the legislative process. Relating this to the theoretical model in the previous chapter, we should expect a legislator to strategically choose either decentralized or centralized funding for renewable energy output subject to institutional constraints at the time of the policy proposal. Therefore, this chapter analyzes renewable energy bills to observe whether the political price of renewable

energy policymaking at the time of the bill's introduction affected a legislator's choice of funding for either centralized or decentralized renewable energy provision.

I also consider the main institutions in which legislators make decisions, legislative committees, as considered in the theoretical model in Chapter Four. Legislators serve on one or more congressional committees that have jurisdiction over a limited number of policy issues and are responsible for considering legislation introduced on those policy issues. Congressional committees can facilitate legislative participation in information gathering, discussion, proposing ideas, and drafting or amending proposed bills. Congressional committees also play a vital role in helping bills move through Congress (Krehbiel et al., 1987). Shepsle and Weingast (1987) argue that the ability for committees to be involved in the process at multiple points makes them a powerful part of the legislative process. Congressional committees also serve as intermediaries between principals and agents (Kiewiet and McCubbins, 1991). Therefore, the congressional committee can be directly tied to all legislative decisions, including funding decisions. This chapter proceeds by looking at the specific congressional committees responsible for overseeing renewable energy policy.

Two congressional committees within the U.S. Congress have primary jurisdiction over energy policy, although other congressional committees can make decisions on energy-related bills when the bill also involves the policy jurisdiction of more than one congressional committee. The U.S. House Energy and Commerce Committee and the U.S. Senate Committee on Energy and Natural Resources have primary jurisdiction over national energy policy and other policy issues.[30] Both have

---

[30] In other words, these committees are designed to receive any energy-related bill introduced by a legislator.

subcommittees that concentrate on energy infrastructure and conservation.[31] The House

Energy subcommittee focuses on energy policies, regulations, utilities, and agencies and

commissions responsible for overseeing energy programs, which are the U.S. Department

of Energy, the Nuclear Regulatory Commission, and the Federal Energy Regulatory

Commission ("Energy Jurisdiction," 2017). The committee's jurisdiction includes fossil

fuel, renewable, and nuclear energy. The Senate Energy subcommittee has jurisdiction

over specific energy projects, research, and development and jurisdiction over agencies

overseeing these projects, such as the U.S. Department of Energy's National Laboratories

("Jurisdiction," n.d.). The jurisdiction of this subcommittee includes oil and gas and

nuclear, coal, solar, and synthetic fuel energy.

This chapter explores legislative decisions by analyzing the content of energy

bills introduced, by any U.S. legislator, that were assigned to the U.S. House of

Representatives' Energy and Commerce Committee from 1993 to 2014, which includes

the 103rd to the 113th Congresses.[32] I focus on bills that are assigned to this specific

committee, because this committee is designed to receive bills primarily related to

energy. Although I am unable to search for bills related to renewable energy specifically,

I use the subset of energy bills to manually search each bill for renewable energy

provisions. This process allows me to observe bills that are the product of legislative

decisions related to renewable energy provision.

---

[31] The information regarding policy jurisdiction of the U.S. Senate and U.S. House Energy Committees and subcommittees is based on the committee descriptions provided as of March 2018. The description of and the actual policy jurisdiction is subject to change over time.
[32] The bills introduced in this committee during this time were introduced by both committee and non-committee members.

Each bill represents a set of choices made by a legislator (or a set of legislators) who introduced that particular policy proposal at that moment in time. I look at introduced bills to observe a legislator's initial decision on renewable energy funding and provision. I hypothesize that legislators are less likely to propose decentralized funding for renewable energy (as observed by the content in the bill) at the moment in time when the political price of passing a renewable energy policy is low. Since political price is unobservable, I propose a binary proxy variable to measure whether the political price of renewable energy policymaking was low at the time a legislator introduces a renewable energy bill, equal to 1 if both the bill sponsor and the majority of the U.S. Congress are Democrat at the time of a bill's proposal.[33] I run a linear probability model to estimate a legislator's likelihood of including funding for decentralized renewable energy in a renewable energy bill. The findings suggest that legislators are less likely to propose a bill that includes funding for decentralized renewable energy development when the political price is low. I include alternative models as robustness checks to support this finding.

To my knowledge, no study asks how the political climate of a specific policy issue affects funding decisions in the way I propose in this chapter. Instead, the literature discusses legislative preferences and legislative characteristics that might have an effect on all legislative decisions. The following section discusses these studies to inform the empirical model put forth in this chapter. I first consider legislators' preferences that could directly influence funding decisions. Legislative preferences are at least partially

---

[33] I measure the political ideology of the whole U.S. Congress instead of just the subcommittee since legislators make strategic decisions regarding legislation knowing that the bill, if passed through committee, will only be passed subject to the majority of Congress agreeing to the bill.

revealed by their choice of congressional committees on which they serve. Therefore, I review studies pertaining to a legislator's decision to join a congressional committee, which signals legislative preferences that can also affect decisions. This literature serves as the foundation for the legislative bargaining literature, also discussed in the proceeding sections, which directly considers legislative decision making.

5.2 Preferences Revealed by Committee Choice and Proposed Legislation

As discussed in Chapter Four, legislators have preferences that are expected to impact their decisions, including the congressional committee(s) on which they choose to serve. Therefore, studies on congressional committee formation can help motivate the empirical model as they reveal legislative preferences.[34] The literature argues that the committee on which a legislator serves is tied to issues legislators most value, because legislators vie over seats on their most preferred committees and essentially give up the right over policy issues of other committees (Weingast and Marshall, 1988). The committee can serve as a means for legislators to achieve policy goals related to the committee's policy jurisdiction, specifically influencing the policy output of the bureaus they oversee (Weingast and Moran, 1983). However, Kellerman and Shepsle (2009) suggest that committee seniority might play a role in a legislator's ability to influence policy output, as suggested by the positive association between committee seniority and the likelihood of a committee member's bill being adopted.

---

[34] Since legislators self-select into committees, there is likely endogeneity in the effect of committee membership on legislative decision making. Therefore, I do not imply that causality exists between committee membership and the dependent variable.

Studies also focus on the strength of legislators' policy preferences while serving on congressional committees. Weingast and Marshall (1988) and Woon (2009) argue that congressional committees represent preference outliers for policy issues with the committee's jurisdiction since legislators self-select into congressional committees. Kreibel (2004; 1990) disagrees, arguing that most congressional committees are representative of the legislature at large and fit no specific type of preferences. Instead, only a subset of congressional committees represents those described by Weingast and Marshall. Epstein and O'Halloran (2001) argue that the strength of preferences vary by type of committee, observing that committees over more information-driven issues are more representative of the legislature at large. They find bias only in committees that cover broad policies issues and those responsible for policies targeting specific groups.

It is conceptually unclear how the literature translates to preferences within the U.S. House Energy committee. The potential for strong energy preferences could depend on whether this committee is more information-driven or focused on energy projects that benefit a subset of the population. Preferences can also depend on the level of benefits provided to committee members' constituents, as different groups of constituents would benefit differently. Therefore, the literature does not suggest whether bills proposed by members of the U.S. House Energy committee will be significantly different from bills proposed by non-committee members.

The literature also examines the relationship between committee choice and constituents' preferences (Adler and Lapinski, 1997; Weingast and Marshall, 1988). Congressional committees that provide benefits to all districts are desirable by more legislators. Examples include committees with jurisdiction over spending and taxes.

Since the pool of legislators who desire these committees is larger, we should expect the committee composition to be more representative of the legislature at large when compared to committees that are desired by a smaller number of legislators. Conversely, legislators will choose a committee with a more specialized policy jurisdiction only if the benefits provided by the committee to his or her constituents are greater than the benefits provided by committees with broader jurisdictions. Energy committees are cited as examples in the literature as having a specialized jurisdiction. Therefore, we might expect legislators who serve on energy committees to be from districts that have the greatest interests in energy, which could lead to a difference in funding proposals between committee members and non-members.

This chapter builds on the assumption that legislators reveal policy preferences through the legislation they introduce. Consistent with the theoretical model proposed in the previous chapter, studies argue that the content of the bill is a result of strategic behavior by sponsors. The decision to sponsor a bill can depend on the perception of the sponsor's constituency (Mayhew, 1974). Woon (2008) claims that the bill's content is included based on a legislator's knowledge that the outcome of the legislation will be subject to other legislators. Woon (2009) explains that legislators have limited resources and focus on issues with the perceived highest benefits subject to constraints. Since this is one of the first stages where legislators reveal their preferences, the decision to sponsor a bill might be a better indicator of policy objectives than bill votes (Talbert and Potoski, 2002; Desposato et al., 2011). Although, the preferences as revealed in the bill might be an imperfect measure as institutional factors also affect policy preferences (Mouw and Mackuen, 1992).

5.3 Legislative Bargaining and Outcomes

Studies in legislative bargaining discuss how institutional factors affect legislative decision making. To my knowledge, no study considers the choice to use decentralized funding in the same context as this study. However, legislative bargaining models do consider the tradeoff between centralized and decentralized provision and preferences for public spending. Therefore, I revisit the legislative bargaining models as discussed in the previous chapter and include additional studies in legislative bargaining further inform the empirical model that follows. These studies point to the significance of preferences, benefits to constituents, and institutional incentives in legislative decision-making.

Studies in legislative bargaining discuss how legislators' preferences for public spending affect their decisions, arguing that legislators seek to minimize their own district's spending on the good. The Baron and Ferejohn model hypothesizes that legislators focus on minimizing overall costs of the public output but also vote for projects when benefits to their district exceed their district's share of the total cost (Baron and Ferejohn, 1987; 1989; Baron, 1991). According to the model, politically powerful legislators are able to secure spending, causing the good to be overprovided in their respective districts and underprovided in others. Besley and Coate (2003) show the misallocation of public spending when a legislature is cooperative. In their model, cooperative legislators work together to increase their shared utility, resulting in overspending in their respective jurisdictions. Knight (2004) studies spending decisions by analyzing Congressional votes in support of spending on transportation projects and concludes that legislators attempt to reduce overall spending to reduce their district's share of the tax burden. Instead, legislators seek to increase own-district benefits while

considering their district's share of the costs. Lorz and Willmann (2005) study factors that affect the amount of centralization of goods and argue that elected leaders tend to focus on reducing local tax burdens of their constituents. We can infer from these studies that legislators from districts that benefit the most from renewable energy might be more likely to propose all types of funding for renewable energy.

Legislative bargaining models also point out the significance of proposal power in legislative decision making. The legislature consists of committee members who have agenda-setting power over policy issues that fall within their respective jurisdictions (Persson and Tabellini, 2002; Krehbiel, 1990). Persson and Tabellini argue that committee structure provides legislators with power that affects their decisions on spending. Knight (2005) finds that legislative committee members have a greater likelihood of getting projects funded. In the context of this study, committee members might be more likely to propose funding if they know that they have a greater likelihood of getting funding for the projects they propose. However, Persson and Tabellini argue that institutional factors limit proposal power by providing the ability for other legislators to amend proposed policies and limiting the jurisdiction of each congressional committee.

The significance of constituents is one of the most consistently considered factors in legislative bargaining models. Baron and Ferejohn (1989) argue that legislators are uncooperative and make strategic decisions to serve their respective constituents after considering decisions that other legislators will make during the policy process. The most notable legislative bargaining models assume that legislators are direct representatives of their constituents (e.g. Lockwood, 2002; Besley and Coate, 2003). The implication is that legislators make choices on behalf of the local jurisdictions they represent, ignoring

regional or national preferences (Lockwood 2005). This assumption implies that a legislator's willingness to cooperate depends on his or her perception of whether their jurisdiction will benefit. Some scholars describe this behavior as pork-barreling, meaning that spending decisions can directly and disproportionately benefit a legislator's constituents (e.g. Alesina and Tabellini, 1990; Volden and Wiseman, 2007; Battaglini and Coate, 2008).

Finally, studies in legislative bargaining discuss how strategic behavior can influence legislators' decisions. Besley and Coate (2003) show how legislators' willingness to cooperate affects the level and allocation of public spending by showing overspending in some districts when legislators seek to maximize the sum of their utilities. Other models discuss the importance of side payments between legislators to support each other's policies (e.g. Segendor, 1998; Lockwood, 2005). Lockwood argues that legislators make personal transfers to other legislators when the legislature is cooperative, which makes it appear that legislators maximize the sum of their utilities. Persson and Tabellini (2002) explain that legislators might also spend money to benefit other legislators to get them to agree to their decisions. These models help us to understand that some decisions legislators make, especially concerning policy specifics such as funding, could be motivated by interpersonal agreements between legislators.

5.4 Data and Methods

Scholars utilize voting data on congressional bills to study legislative decisions on public spending (e.g. Knight, 2005). However, voting data on renewable energy bills cannot feasibly be separated from voting data on bills regarding all other types of energy.

Therefore, I utilize the content in congressional bills to study legislative decisions. Each bill represents a set of choices made by a legislator at a specific moment in time. Utilizing the content in proposed bills is the most feasible method to fully observe legislators' initial decisions regarding renewable energy funding. This allows me to directly observe a legislator's initial choice of funding mechanism for renewable energy he or she proposes for renewable energy provision. I use introduced legislative bills assigned to the U.S. House Energy Committee, which is the House committee with primary jurisdiction over renewable energy.

I collect data from the U.S. Library of Congress on all introduced energy bills that were assigned to the House Energy Committee during the 103rd to 113th Congresses, which includes years 1993 to 2014. I look only at bills assigned to this committee, because bills directly related to energy development are likely assigned to this committee as it has the primary jurisdiction over energy policy. There were 1,010 bills in the U.S. House Energy Committee that directly pertained to energy during the period in this analysis.[35]

In order to empirically examine legislators' decisions to utilize grants, I create a list of variables based on the content of each bill introduced in this committee over this period. I first coded each bill based on type of energy and funding mechanism, if any, proposed in the bill. The House Energy Committee oversees all types of energy-related legislation, including bills related to renewable and non-renewable energy. I coded each bill for the type(s) of energy mentioned using a binary variable based on the following

---

[35] The U.S. Library of Congress allows congressional bills to be searched by committee and subject area.

categories: renewable energy, fossil fuel energy, and nuclear energy. This allowed me to differentiate between bills that were introduced with the main purpose to develop renewable energy from bills that were not introduced mainly to develop renewable energy.[36] For example, a bill that includes provisions for both solar panels and coal would be coded with a 1 for renewable energy and a 1 for fossil fuel.[37] Coding as such allows me to differentiate bills that include a provision for renewable energy bills along with provisions for other types of energy from bills that solely focus on renewable energy.

A portion of the energy bills introduced in the US House Energy Committee had provisions for centralized funding, decentralized funding, or both. In other words, some bills focused narrowly on funding energy development either at the federal or subnational level, and other bills provided a comprehensive funding package to include both federal and subnational funding for renewable energy development. Therefore, I created four additional binary coding variables based on funding mechanisms included in the bill, which I used to create the dependent variable and subset the data for robustness checks. I coded bills for decentralized funding if the bill included proposals for intergovernmental fiscal transfers to support subnational energy development. I coded bills for centralized funding if the bill included any provision that appropriates money or requires a federal agency to allocate funding towards centralized energy development. I also made note of whether the proposal for funding was targeted towards renewable energy specifically.

---

[36] For example, a bill that includes various types of energy is not designed specifically to develop renewable energy. Instead, the purpose of the bill might be to develop a research program but mentions each type of energy for which the funding can be used.

[37] Only bills that directly mentioned a type of energy were coded with a 1 to denote that the energy is included in the bill. For example, bills relating to regulations for car manufacturers were included in the 1,010 energy bills from the U.S. Library of Congress. In this specific example, I would code these bill as "0" for all types of energy unless the bill specifically mentioned a renewable or fossil fuel source.

Table 5.1 lists the four binary coding variables and a description of each one. The criteria are based on whether a bill included funding for 1) decentralized energy output for any type of energy, 2) centralized energy output for any type of energy, 3) decentralized renewable energy output, and 4) centralized renewable energy output. The four variables are not mutually exclusive. For example, a bill that proposes centralized and decentralized funding for renewable energy received a "1" for all four criteria. Bills that do not include any funding mechanism received a "0" for all four criteria. The primary dependent variable is equal to 1 if the introduced bill contains a provision for funding to support decentralized renewable energy, 0 otherwise.

Table 5.1
Descriptions of the Types of Funding Mechanism Included in Energy Bills Introduced in the U.S. House Energy Committee

Categorical Variable	Description
Proposes Funding for Decentralization	Bills that propose decentralized funding for any type of energy, including renewable energy.
Proposes Funding for Centralization	Bills that propose centralized funding for any type of energy, including renewable energy.
Proposes Funding for Decentralized RE	Bills that propose decentralized funding for renewable energy.
Proposes Funding for Centralized RE	Bills that propose decentralized funding for renewable energy.

Source: U.S. Library of Congress

Legislators proposed centralized and decentralized funding mechanisms for several types of renewable energy development. The majority of bills with a funding mechanism for centralized renewable energy output directed funding to a federal agency, giving that agency direct oversight of renewable energy development. The majority of bills with a funding mechanism for decentralized renewable energy output included a grant program or similar type of financial assistance to encourage local development of

renewable energy. These are generally targeted towards local governments, or, in some cases, nonprofits. Some bills targeted renewable energy generally while others specified types of renewable energy. Bills that included both centralized and decentralized provision generally directed a federal agency to produce renewable output but also included assistance to local governments for renewable energy output.

Table 5.2 provides summary statistics for the 1,010 energy bills. Looking at both renewable energy and nonrenewable energy bills, 235 bills include a funding to support decentralized energy output, and 250 bills include funding to support centralized energy output. Furthermore, 385 of all energy bills mention renewable energy. Of all bills that include renewable energy, 113 bills propose funding for decentralized renewable energy output, and 82 bills propose funding for centralized renewable energy output.

Table 5.2
Summary Statistics, All Energy Bills

n = 1,010				
Variable	Count	Mean	Min	Max
Proposes Funding for Decentralization	235	0.23	0	1
Proposes Funding for Centralization	250	0.25	0	1
Mention Renewable Energy	385	0.38	0	1
Proposes Funding for Decentralized RE	113	0.12	0	1
Proposes Funding for Centralized RE	82	0.8	0	1

Source: U.S. Library of Congress

Table 5.3 includes only the 385 introduced bills that include renewable energy. The table includes the percentage of renewable energy bills that include funding for centralized and decentralized renewable energy output. Of the 385 renewable energy bills proposed over this period, 29 percent include funding for decentralized renewable energy, and 21 percent include funding for centralized renewable energy. Furthermore, 17 percent of bills include funding for only decentralized renewable energy, meaning that

the proposed bill includes decentralized funding for renewable energy projects and no other forms of energy. For example, this would not include a bill that proposes a grant for all types of energy.

Table 5.3
Summary Statistics, All Renewable Energy Bills

n = 385				
Variable	**Count**	**Mean**	**Min**	**Max**
Proposes Funding for Decentralized RE	113	0.29	0	1
Proposes Funding for Decentralized RE Only	65	0.17	0	1
Proposes Funding for Centralized RE	80	0.21	0	1

Source: U.S. Library of Congress

As shown in Figure 5.1, renewable energy bills were proposed in the U.S. House Energy Committee during all Congresses in this analysis. Over the span from the 103rd to the 113th Congresses, the fewest number of renewable energy bills, 10, were introduced during the 103rd Congress, and the most, 78, were introduced during the 110th Congress. Bills with at least one provision for renewable energy accounted for 26 to 52 percent of all energy-related bills introduced in the U.S. House of Representatives Energy Committee during this period. The figure also shows the number of bills during each Congress that contained at least one provision for funding decentralized renewable energy, which also varied by Congress. There was only one bill containing a provision for funding decentralized renewable energy introduced during the 103rd Congress, which was the fewest number introduced during this period. The largest number of bills containing a provision for decentralized renewable energy funding, 31, was introduced during the 110th Congress.[38]

---

[38] The final model includes both fixed effects and a dummy variable equal to 1 in years after 2008 to account for the increasing propensity to introduce a bill with a provision for renewable energy.

Figure 5.1
Frequency of Introduction of Renewable Energy Bills
103rd to 113th Congresses
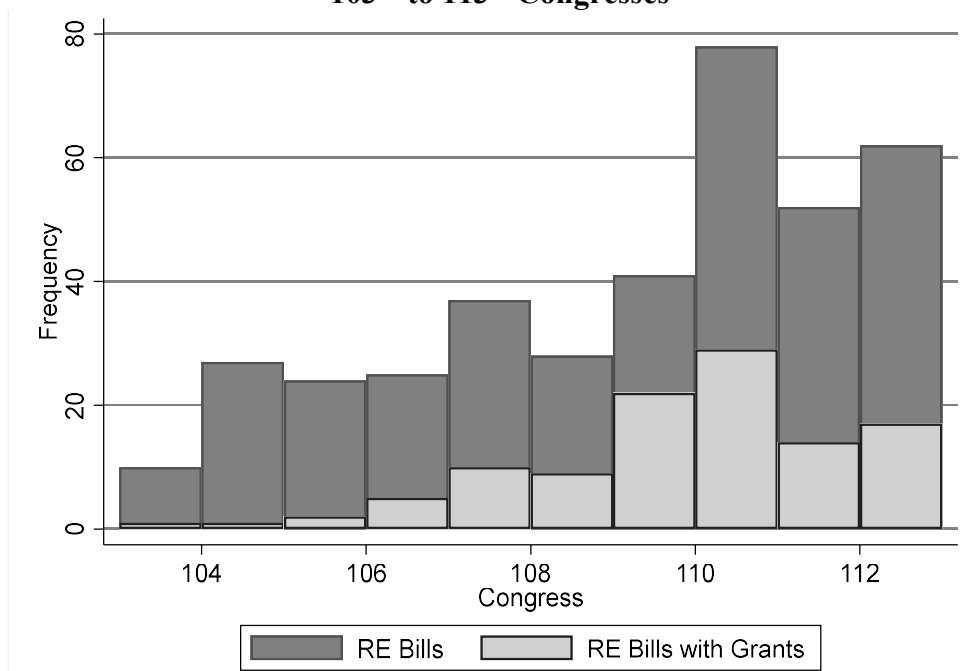
Source: U.S. Library of Congress

The variable of interest in this analysis is political price. I hypothesize that when the political price of renewable energy policymaking is high, legislators are more likely to use fiscal transfers to support decentralized renewable energy output. Since there is no direct measure available for whether renewable energy is a controversial policy issue in time t, I create a measure based on the energy literature. As discussed in Chapter One, renewable energy became a polarized policy issue between Republicans and Democrats after the 1980s with Democrats more favorable towards renewable energy policies (e.g. Krosnick and Holbrook, 2000; Fiorina and Abrams, 2008; Dunlap and McCright, 2008). Therefore, we should expect Democrats to be more likely to support centralized renewable energy policy during the period analyzed in this chapter and for the Democratic sponsors to be more likely to propose legislation when there is a majority of Democratic legislators who are willing to vote favorably on the proposed bill.

I exploit the expected correlation with political party to create a proxy variable, which I label as "low political price". In order for a legislator's proposed bill to pass through Congress, the bill must pass the congressional committee and then the legislature. Therefore, I consider the party affiliation of the sponsor, the congressional committee, and Congress to create the proxy measure for political price. The House Energy Committee and Congress were both majority Democrat in the same years. Low political price is equal to 1 if both the bill sponsor and Congress and the House Energy Committee are majority Democrat at the time of a bill's proposal.[39]

Consistent with the hypothesis, I expect low political price to be negatively associated with the likelihood of proposing funding for decentralized renewable energy development. In other words, the theory predicts that legislators will rely more heavily on funding for decentralized renewable energy provision when the political price of renewable energy policy is high. As shown in Table 5.4, the average value for the binary variable measuring whether the political price is low or high is 0.24, meaning that 91 of 385 bills that contain a provision for renewable energy were introduced during a year in which the political price of renewable energy policymaking was low. The variable of interest is equal to 1 in years 1993, 1994, and 2007 to 2010, which is during the 103rd, 110th, and 111th Congresses.

---

[39] Low political price is equal to 1 only if both the sponsor and the majority Congress are Democrat at the time of the bill's proposal. Although Republicans proposed funding for renewable energy during this same period, I would argue that a Republican sponsor naturally creates a higher political price regardless if Congress is majority Democrat or majority Republican at the time of the bill's proposal. In the first case, the higher political price would result from the sponsor and majority of Congress belonging to opposite political parties. In the second case, Republicans have historically been less favorable of renewable energy policies, regardless of the bill sponsor's political party.

Table 5.4
Summary Statistics for the Variable of Interest
for Renewable Energy Bills

n = 385				
Variable	Count	Mean	Min	Max
Low Political Price	385	0.24	0	1

I include a secondary variable of interest, centralized funding for RE. This variable is equal to 1 if the bill also has a provision for centralized funding for renewable energy. The relevance of this variable relates to the theoretical model proposed in Chapter Four. In the previous chapter, I proposed that legislators choose between funding centralized renewable energy and decentralized renewable energy, given that a legislator chooses to provide funding for renewable energy. Therefore, I include this variable to test whether the choice to offer centralized funding for renewable energy decreases the likelihood of introducing a provision for decentralized funding for renewable energy. This variable is included to test whether a significant relationship between the two variables exists.

Since the model specifically analyzes legislators' decisions as observed in introduced bills, I include explanatory variables that measure characteristics of legislators who primarily sponsored each bill. The literature finds that legislators serve on committees pertaining to issues they value most and that committee members have a greater likelihood of getting projects funded as opposed to legislators who are not on that same committee.[40] Therefore, I expect that committee members are more likely to propose all funding for all issues pertaining to the committee's jurisdiction. I include

---

[40] A legislator has the ability to propose bills regarding the jurisdiction of any congressional committee, including the jurisdiction of congressional committees on which they do not serve. In the context of this analysis, any legislator in Congress can propose a bill related to renewable energy.

three measures of legislative experience from Stewart and Woon (2017). Committee member is equal to 1 if a bill's primary sponsor is a member of the U.S. House Energy and Commerce Committee in the current year, 0 otherwise. Forty percent of bills that contained a provision for a grant for only renewable energy (and no other forms of energy) were sponsored by a member on the energy committee. Forty-two percent of bills that contained a provision for centralized funding for only renewable energy (and no other forms of energy) were sponsored by a member on the energy committee. Sponsors of the other bills with a provision for funding for either centralized or decentralized renewable energy funding were not on the energy committee.

Following Stewart and Woon (2017), I also include committee seniority, which is the number of consecutive terms a legislator has served on the U.S. House Energy and Commerce Committee as of the year in which the bill was introduced. The third measure, chamber seniority, is included to take into account a legislator's experience in the legislature. This is the total number of terms a legislator has served in Congress as of the year in which a bill was introduced. I also expect seniority to increase the likelihood of proposing any type of funding since seniority can represent bargaining power.

There is a consensus in the literature that legislators prefer to minimize their district's cost while providing benefits to their constituents. Since decentralized funding is generally a less costly option compared to centralized funding, legislators whose districts benefit (or are perceived to benefit) from renewable energy grants are expected to be more willing to propose funding for decentralized renewable energy. Therefore, I hypothesize that legislators with constituents who benefit disproportionally from local renewable energy projects might be more likely to propose decentralized funding. I use

controls for preferences for renewable energy based on data from the U.S. Energy

Information Administration's State Energy Data System. All energy measures are based

on the primary sponsor's home state and are lagged to test whether energy usage

influences funding decisions.[41] First, I include renewable energy production in a

sponsor's state, which is the total renewable energy (in billions of BTUs) per capita

produced is legislator i's state in year t-1. Furthermore, legislators from more energy-

intensive states might be more motivated to find cleaner, alternative energy. Total Energy

Consumption is the total amount of all energy consumed (in billions of BTUs) per capita

in legislator i's state in year t-1. Finally, I include fossil fuel energy consumption to

measure preferences that might be opposed to providing funding for renewable energy.

Fossil fuel energy production is the total amount of all energy produced excluding

renewable energy (in billions of BTUs) per capita in legislator i's state in year t-1.[42]

Additionally, I consider other details included in each proposed bill to control for

the sponsor's preferences. I created two binary variables based on the proposal. Fossil

fuel is a binary variable equal to 1 if the bill also mentions any type of fossil fuel energy,

0 otherwise. Since renewable energy is often expressed as a substitute for fossil fuel

energy, legislators who propose a bill that contains a provision for fossil fuel might be

less likely to propose any type of funding for renewable energy.

I also address the theoretical arguments by Segendor (1998) and Lockwood

(2005) who discuss the use of side payments between legislators that decision making,

---

[41] None of the three energy measures are highly correlated with being on the U.S. House Energy and Commerce Committee. On the energy committee has a correlation coefficient of -0.01 with renewable energy production per capita, 0.04 with fossil fuel energy production per capita, and 0.06 with total energy consumption.

[42] It should be noted that renewable energy production per capita and fossil fuel energy production per capita have a correlation coefficient of -0.03, indicating that collinearity is not a concern.

although it is not clear how they are to be measured in practice. The number of cosponsors could serve as a proxy for agreements made between legislators to support each other's bills. Cosponsors is included in the model and is measured as the number of cosponsors listed on each bill in the analysis. I include a second variable, bipartisan support, to capture efforts made by legislators to get members of the opposite party to support the proposed bill. This is measured as the proportion of cosponsors listed on the bill who are of the opposite political party as the sponsor.

Finally, I include a series of control variables that are expected to be correlated with the probability of proposing any type of funding. As discussed in Chapter One, Democrats are more likely to support renewable energy policies. I control for political party using a dummy variable equal to 1 if the legislative sponsor is a Democrat, 0 otherwise. Data on Congressional members are from the Brooking's Institute's Vital Statistics on Congress. I also include a few variables to control for preferences for renewable energy that occurred at the federal level with passage of the American Recovery and Reinvestment Act as discussed in Chapter Two. Post 2008 is a binary variable equal to 1 if the year in which the legislation was proposed was after year 2008. Since Democrats led the efforts of the ARRA, I also include an interaction variable to test the effects of Democratic support after 2008. This variable is equal to 1 for years 2009 to 2013, 0 otherwise. Finally, I include dummy variables for each year of Congress to control for the unobserved, fixed factors of each two-year period of Congress that could affect legislative decision making, such as the increasing propensity to propose funding for renewable energy. Appendix B provides summary statistics for all control variables.

5.5 Statistical Model

The main analysis uses data on all renewable energy bills introduced in the U.S. House Committee on Energy from the 103rd to the 113th Congresses. I include decisions made by legislators regarding type of funding mechanism used to fund renewable energy as revealed in the proposed bill. I observe different bills introduced by different member and non-member legislators during this period.

The hypothesis in this chapter argues that when the political price of renewable energy policymaking is low, policymakers are less likely to propose funding for decentralized renewable energy output. Although the previous chapter assumes that legislators choose between decentralized or centralized funding, the decision to use a funding mechanism can be more complicated in practice. Legislators can choose no funding, decentralized funding, centralized funding, or a combination of both centralized and decentralized funding. However, I narrow the focus of the theory proposed in Chapter Four to factors affecting the decision to use decentralized funding for renewable energy development. Since this is a binary decision, I employ a linear probability model with robust standard errors. Additionally, I include dummy variables to control for the unobserved effects of each two-year Congress. Model (1) demonstrates the standard linear probability model.

$$P(Y_{ij} = 1 | X_{jt}) = X'_{jt}\beta \qquad (1)$$

where Y_{ij} is a binary variable equal to 1 if a legislator i proposes funding for decentralized renewable energy during Congress j and 0 otherwise, and X'_{ij} is matrix of continuous and binary variables that are expected to be correlated with the dependent variable.

5.6 Results

I run linear probability models to test the hypothesis that low political price has a negative and significant relationship with the likelihood of proposing funding for decentralized renewable energy. The results in Table 5.5 use the same sample of the 383 renewable energy bills introduced in the U.S. House Energy and Commerce Committee during the 103rd to 113th Congresses.[43] The control variables are identical in each model, but the dependent variables are coded differently. The dependent variable in Model 1 is equal to 1 if the introduced bill contains a provision for funding to support decentralized renewable energy. Thus, it includes all bills that propose funding for decentralized renewable energy, but these bills may also include provisions for decentralized funding for other types of energy too. Model 2 applies stricter criteria as to whether the dependent variable is coded as 1. In Model 2, the dependent variable is equal to 1 if the bill proposes decentralized funding only for renewable energy. In other words, bills that contain a provision for decentralized funding for renewable energy and another form of energy, such as fossil fuel or nuclear energy, are coded as 0. Model 2 is more focused on a subset of bills that are narrowly designed to develop renewable energy.

---

[43] Two bills were dropped in the final models due to missing data for one or more of the control variables.

Table 5.5
Linear Probability Model Results for Proposals for Funding for Decentralized Renewable Energy

	(1) RE	(2) Only RE
Low Political Price	-0.195*	-0.168**
	(0.099)	(0.085)
Centralized Funding for RE	0.289***	-0.269***
	(0.064)	(0.036)
Mentions Fossil Fuel Energy	0.077	0.033
	(0.054)	(0.046)
Cosponsors	0.002**	0.002*
	(0.001)	(0.001)
Bipartisan Support	0.035	0.049
	(0.074)	(0.068)
Post 2008	0.152*	0.180**
	(0.081)	(0.075)
Democrat	0.134**	0.131**
	(0.067)	(0.060)
Post 2008 x Democrat	0.304***	0.271***
	(0.104)	(0.090)
Chamber Seniority	0.014**	0.012**
	(0.006)	(0.005)
Committee Seniority	-0.033***	-0.030***
	(0.009)	(0.008)
Energy Committee Member	0.146**	0.149***
	(0.062)	(0.055)
RE Production per Cap	-0.098**	-0.088**
	(0.043)	(0.037)
FF Energy Production per Cap	-0.002	-0.005
	(0.005)	(0.004)
Energy Consumption per Cap	0.023	0.023
	(0.022)	(0.019)
Congress 104	-0.214*	-0.115
	(0.128)	(0.116)
Congress 105	-0.086	-0.061
	(0.134)	(0.121)
Congress 106	-0.089	-0.064
	(0.140)	(0.127)
Congress 107	-0.036	-0.004
	(0.139)	(0.129)
Congress 108	0.012	0.027
	(0.147)	(0.133)
Congress 109	0.169	0.124
	(0.146)	(0.132)
Congress 110	0.060	0.090
	(0.119)	(0.112)
Congress 111	-0.312*	-0.252*
	(0.159)	(0.146)
Congress 112	-0.320**	-0.270**
	(0.133)	(0.119)
Congress 113	-0.326*	-0.303**
	(0.168)	(0.147)
Constant	0.035	0.023
	(0.150)	(0.136)
Observations	383	383

Standard errors in parentheses
* p<0.10, ** p<0.05, *** p<0.01

The results are consistent with the hypothesis put forth in this chapter. The variable of interest is negative and significant at the 10 percent level in Model 1. The variable indicates that when the political price of renewable energy policymaking is low, the sponsor is less likely to propose a bill that includes funding for decentralized renewable energy provision. Specifically, having both a Democratic sponsor and majority Democratic legislature decreases the probability of proposing funding for decentralized renewable energy by about 20 percent, all else equal. The variable of interest is significant at the five percent level in Model 2, which restricts the dependent variable to count only those bills that have decentralized funding for renewable energy and no other form of energy. In Model 2, low political price of renewable energy policymaking decreases the probably of proposing funding for decentralized renewable energy by about 17 percent, all else equal.

Models 1 and 2 also suggest that other explanatory variables are significantly correlated with the likelihood of proposing decentralized funding for renewable energy. The results for centralized funding also offer support for the hypothesis. Centralized funding, a dummy variable equal to 1 if the proposed bill includes funding for centralized provision of renewable energy, is statistically significant in both models. However, the direction of the impact is different between the two models. In Model 1, centralized funding increases the probability of including a provision for funding for decentralized provision of renewable energy. This could indicate that broader energy packages to fund multiple forms of energy likely start with a comprehensive approach to funding renewable energy development by also funding centralized renewable energy output. Conversely, centralized funding is negative and significant in Model 2, which counts bills

that propose funding only for renewable energy. This model offers further support for the theory proposed in Chapter Four, suggesting that centralized funding and decentralized funding for renewable energy could be substitutes. However, further investigation of the causality between these two variables is warranted.

The three variables measuring legislators' characteristics are significant in both models. Chamber seniority is positive and significant at the five percent level in both models. The coefficients are approximately one percent in both models, implying that each additional term in the Chamber increases the likelihood of proposing decentralized funding by one percent, all else qual. This result is consistent with expectations. However, the result for committee seniority is not consistent with my initial expectations. Committee seniority is significant at the one percent level and negative in both models. The results suggest that each additional consecutive term on the House Energy Committee reduces the likelihood of introducing a bill with funding for decentralized renewable energy, all else equal. This could imply that more senior committee members are more likely to propose centralized funding for renewable energy, although this result also warrants further exploration.

Energy committee member is significant at and positive in both models. In both models, being on the energy committee increases the probability of including a provision for funding decentralized renewable energy provision by approximately 15 percent, all else equal. This coefficient is significant at the five percent level in Model 1 and at the one percent level in Model 2. This result could suggest that committee members are more likely to include a provision for funding in general, regardless of whether the funding supports centralized or decentralized provision of renewable energy. However, this result

does not imply causation as there is likely endogeneity since legislators self-select into committees.

Furthermore, the results in Table 5.5 show the statistical significance of Democrats and the passage of the American Recovery and Reinvestment Act of 2009 in the likelihood of including a provision for funding. Post 2008 and Democrats are significant and positive in Models 1 and 2, suggesting that both are positively associated with the probability of proposing funding for decentralized provision of renewable energy. Furthermore, the interaction between these two variables is positive and significant at the one percent level in both models. In Model 1, the probability of including a provision for funding decentralized renewable energy increases by 30 percent for Democratic sponsors who introduced a renewable energy bill after 2008, all else equal.

Only one of the three state-level energy variables included in the models is significant. The amount of renewable energy production per capita in legislator i's state in the previous year is significant at the 5 percent level in both models. Looking at Model 1, a one billion BTU increase in renewable energy production per capita in legislator i's state decreases the likelihood of proposing decentralized funding for renewable energy by approximately 10 percent. However, the magnitude of this result indicates that state-level renewable energy production does not have a substantive impact on the dependent variable. To put this result in perspective, South Dakota, which has the highest renewable energy production per capita, produced 0.26 billion BTUs per capita in 2016 ("Table P5B" 2019).[44] The amount of fossil fuel energy produced per capita in the sponsor's state

---

[44] This calculation is based on population estimates from the U.S. Census Bureau's 2016 Population and Housing Estimates.

in the previous year and the amount of energy consumed per capita in the sponsor's state in the previous year are not significantly associated with the likelihood of including a provision for funding decentralized renewable energy.

The two additional measures used to capture legislators' preferences do not significantly affect the probability of proposing funding for decentralized renewable energy. Whether the proposed bill includes a provision for fossil fuel energy and the proportion of bipartisan support are not statistically significant. The number of cosponsors on the proposed bill was used as a proxy to capture potential agreements between legislators to support projects. The coefficient is statistically significant, but the effect size is essentially zero. This result indicates that it does not impact the probability of the proposed bill including funding for decentralized renewable energy.

5.7 Robustness Checks

I refer to the theoretical model in Chapter Four to consider the robustness of the results in Table 5.5. The model argues that political price varies by good. The chapter argues that a high political price associated with centralized renewable energy provision explains why legislators support decentralized renewable energy. I also argue that the price differences between centralized and decentralized renewable energy provision, as defined in this chapter, are unique to renewable energy. Therefore, I also consider the counterfactual as a robustness check. If the variable of interest is key to understanding why renewable energy remains decentralized, we should expect that the variable of interest does not significantly explain funding proposals for the decentralization of other types of energy.

I run two additional linear probability models. Models 3 and 4 test the variable of interest on the likelihood of including a provision for funding decentralized energy development for all types of energy other than renewable energy. The dependent variable in both models is equal to 1 if bill contains a provision for decentralized funding for any type of energy other than renewable energy, 0 otherwise. For example, the dependent variable would be coded as 1 for a grant program for fossil fuel energy and coded as 0 for a grant program for solar panels. Models 3 and 4 are identical except for the sample of bills. The sample in Model 3 considers all energy bills including bills that discuss renewable energy but do not provide decentralized funding for renewable energy. The sample in Model 4 includes only bills that do not mention renewable energy.[45] Figure 5.2 shows the coefficients for low political price for both models.

---

[45] There are 1,007 observations in Model 3 and 624 observations in Model 4.

Figure 5.2
Robustness Check
The Effect of Low Political Price on the Likelihood of Proposing Funding for
Decentralized Provision of Non-Renewable Energy Sources
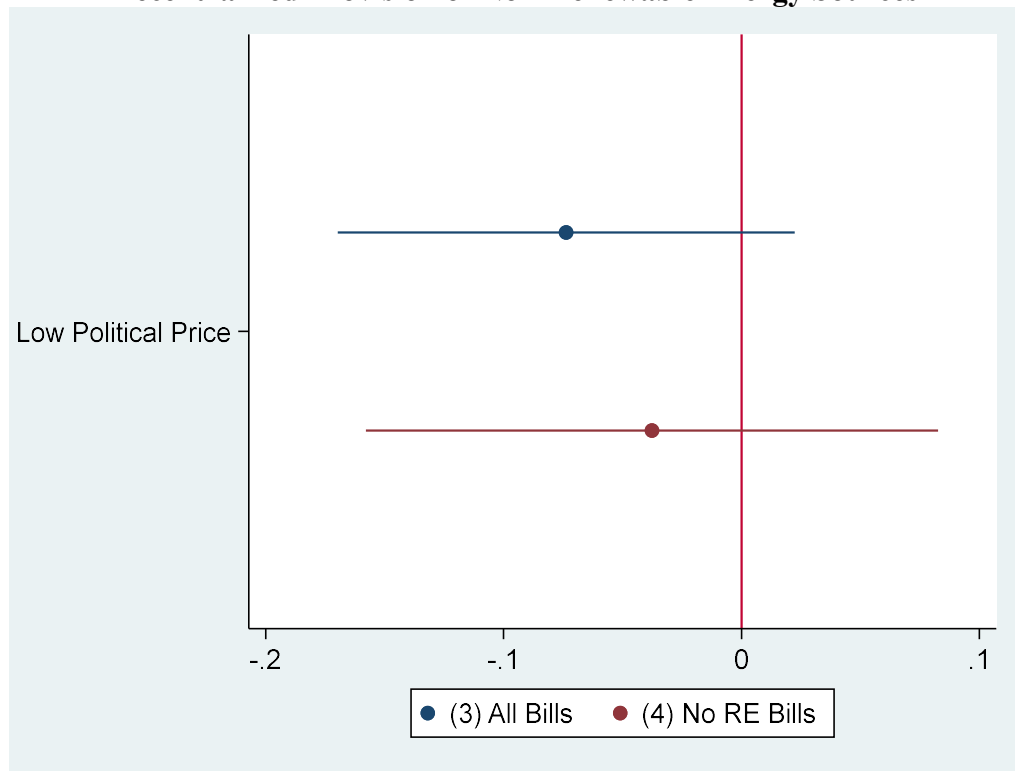
The variable of interest is negative but not statistically significant in Models 3 or

4. This implies that a low political price associated with renewable energy policymaking

do not significantly impact the decision to propose decentralized funding for non-

renewable energy sources. This robustness check further validates the findings in Models

1 and 2 by showing that the variable of interest does not explain decentralized funding for

other forms of energy. Instead, it suggests that renewable energy is a unique case of a

good with large spillovers that remains decentralized due to the policy climate

surrounding this issue.

Although the focus of this chapter is the decision to use decentralized funding, the

theoretical model in Chapter Four posits that legislators will choose centralized funding

for renewable energy when the political price of renewable energy policymaking is high.

Therefore, I focus on centralized funding to further evaluate the robustness of the results in Table 5.5. I consider the decision to propose funding for the centralized provision of renewable energy compared to the decision to propose funding for the centralized provision of other forms of energy.

I run another two linear probability models as robustness checks to evaluate the effect of low political price on centralized funding decisions. The explanatory variables in both models are identical, but the dependent variables and samples are different. Model 5 looks at the decision to propose centralized funding for renewable energy, and Model 6 looks at the decision to propose centralized funding for any form of energy other than renewable energy. Therefore, the sample of bills used for Model 5 includes only bills that contain a provision for renewable energy. The dependent variable in this model is equal to 1 if the bill proposes centralized funding for renewable energy. For comparison, the sample of bills used for Model 6 includes bills that contain no provision for renewable energy.[46] The dependent variable in this model is equal to 1 if the bill includes a provision for centralizing funding for any type of energy other than renewable energy.

---

[46] There are 383 observations in Model 5 and 624 observations in Model 6.

Figure 5.3
Robustness Check
The Effect of Low Political Price on the Likelihood of Proposing Funding for
Centralized Renewable Energy and Non-Renewable Energy
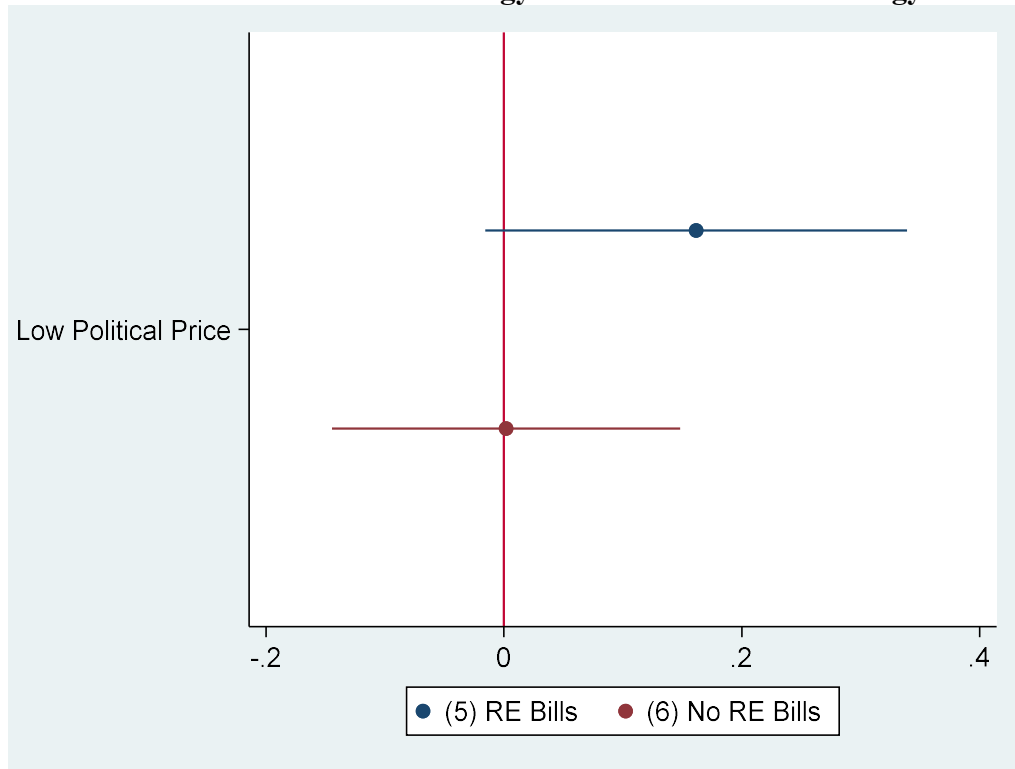
The variable of interest is significant and positive in Model 5, which is consistent

with the hypothesis. The result suggests that when the political price of renewable energy

policymaking is low, legislators are 17 percent more likely to introduce a bill with

funding for centralized renewable energy, all else equal. However, this finding is

significant only at the 10 percent level and warrants further investigation. Furthermore,

the variable of interest in Model 6, which considers non-renewable energy bills, is not

significant. This is also consistent with the hypothesis and the results, suggesting that the

relationship between policy climate and funding mechanism is unique to renewable

energy in the ways discussed through the chapters.

5.8 Conclusions

This chapter seeks to empirically evaluate the theoretical model put forth in Chapter Four. I estimate the likelihood of a legislator proposing funding for decentralized renewable energy when the political price of renewable energy policymaking is low. The results from the linear probability model support the hypothesis: when the political price of renewable energy policymaking is low, a policy maker is less likely to use grants to support decentralized renewable energy. The robustness checks offer additional support for this hypothesis, suggesting that these results are specific to the unique case of renewable energy output as we observe in the United States. Additionally, the robustness checks offer weak support for the counterfactual: legislators are more likely to propose funding for centralized renewable energy when the political price of centralized renewable energy provision is low.

This chapter offers two main contributions to the existing literature. First, the results offer another explanation as to why the decision to use grants for good provision deviate from normative economic theory. Other scholars discuss the importance of politics and institutional incentives in affecting whether a good will be centralized or decentralized. I contribute to these studies by directly evaluating the role of political price in affecting the decision to use grants for decentralized good provision. Second, the results contribute to studies in energy policy. Whereas other energy studies focus on subnational efforts to adopt renewable energy policies in response to a lack of federal action, this study considers federal policymakers' actions to support decentralized renewable energy provision with grants.

While the results offer support for the hypothesis in this chapter, the findings are limited by the data. This chapter takes a very direct approach to evaluate a legislator's initial decision by looking at renewable energy bills introduced in Congress. The analysis uses the bills to infer legislators' preferences. However, the analysis would benefit from actual data on individual legislators, such as aggregated data on voting or survey data, which does not currently exist. Additionally, the analysis could be further enhanced by considering other actors involved in the policymaking process, including interest groups, other legislators, and legislative staff. To the extent that these individuals impact policy proposals put forth by individual legislators, the bills analyzed in this chapter might not be an accurate representation of bill sponsors' initial decisions.

The next chapter further investigates the theoretical model in Chapter Four by evaluating the underlying assumptions of the hypotheses. I argue that funding for decentralized renewable energy is the utility-maximizing choice when the political price associated with centralized renewable energy policymaking is high. The model implies that renewable energy output will increase in decentralized provision, even if this is not the optimal type of provision according to normative economic theory. Chapter Six evaluates this assumption by analyzing the effectiveness of renewable energy grants, offering additional support for the theoretical model in Chapter Four and a deeper understanding of the motivation to utilize renewable energy grants.

CHAPTER SIX: AN EMPIRICAL EVALUATION OF ENERGY GRANTS EFFECTIVENESS ON RENEWABLE ENERGY OUTPUT

6.1 Introduction

Like the previous chapter, this chapter empirically evaluates the theoretical model proposed in Chapter Four to explain why legislators use renewable energy grants to increase renewable energy output. The theoretical model is built on the assumption that a legislator's utility increases with either choice of funding mechanism, centralized or decentralized, as he or she expects any amount of funding to increase output and the probability of reelection. This chapter empirically examines whether decentralized funding leads to an increase in goods with a normative argument for centralization. I focus on the effect of energy grants on renewable energy production. Consistent with the theoretical model in Chapter Four, I hypothesize that energy grants are associated with an increase in renewable energy output at the local level.

As discussed in previous chapters, the literature does not provide unequivocal support that grants increase output. Crowding out is one explanation, which occurs when local governments substitute own spending for federal grant dollars. The fungibility of funds can result in a small to no net effect on public investment. When funds are completely fungible, own spending is completely substituted for federal grants. Studies also find incomplete crowding out where every dollar in federal grant money leads to a decrease in own spending of less than one dollar. Another explanation is directly linked to energy grants. Scholars argue that renewable energy projects are associated with large, positive externalities relating to air quality, reduced greenhouse gas emissions, energy conservation, innovation, and public health. Therefore, normative arguments make the

case for centralized renewable energy, leading to the question as to whether renewable energy grants are effective at increasing renewable energy output.

This chapter contributes to an understudied area of research. Generally, studies on the effectiveness of renewable energy grants are not feasible as spending on renewable energy grants is either not reported or not consistently reported. This study uses a unique public dataset on one-time energy project grants awarded through the American Recovery and Reinvestment Act of 2009 (ARRA). The §1603 energy grant program was one component of a total energy package focusing expanding clean energy, offering cash payments for wind, residential and nonresidential solar, biomass, geothermal, and other types of renewable energy ("Overview and Status Update," 2017). The program sought to increase renewable energy generation in addition to increase energy efficiency and improve transportation ("American Recovery and Reinvestment Act Program Plan," 2009). The U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy was responsible for the funding announcement and reviewing project applications. With the implementation of ARRA, the Office expanded its current formula grant program and distributed additional competitive awards.

The U.S. Department of the Treasury had primary responsibility of administering the §1603 grant program, including administering funds to subnational governments and entities, such as states, counties, cities, public nonprofits, small businesses. The Treasury department was also responsible for reporting requirements for selected projects. This program is conducive to empirical evaluation as it required reporting on ARRA award recipients, including whether each grant was awarded for renewable energy or other types of energy projects, the amount awarded, the amount distributed, and where the project

was located. Furthermore, the program required recipients to have a detailed project plan and to periodically report on the project's status to ensure that funds were spent to increase the amount of installed renewable energy capacity.

As of March 2017, the grant program awarded $25.7 billion to fund 105,972 renewable energy projects, which accounted for about 22% of total project investments. Table 6.1 compares the total amount of §1603 grants awarded for renewable energy by energy type as of March 2017. The table also shows the total number of projects and expected generation capacity. Approximately $13 billion was awarded to 1,026 wind projects, which received the most total funding and had the highest expected generation capacity of 21,633 megawatts. Residential and nonresidential solar accounted for the largest number of projects with a combined total award amount of approximately $9.8 billion. All solar investments were expected to have 9,428 megawatts in generation capacity.

Table 6.1
Total Awards by Renewable Energy Type

Renewable Energy Type	Total Awards (*millions*)	Number of Projects	Generation Capacity (*megawatts*)
Wind	$12,995	1,026	21,633
Non-Residential Solar	$8,928	19,889	8,976
Residential Solar	$890	84,162	462
Biomass	$1,053	168	1,334
Geothermal	$764	163	758
Other	$1,091	564	1,314

Source: U.S. Department of the Treasury, ("Overview and Status Update," 2017)

Most studies evaluate grant effectiveness by estimating the impact of grants on public spending. Although ARRA required reporting on the grant amount awarded, it is not clear how much entities spent on renewable energy prior to receiving an ARRA grant. Additionally, ARRA awards were awarded to several types of entities, making it difficult

to track spending on renewable energy. Therefore, I evaluate the effectiveness of renewable energy grants by directly measuring renewable energy output, net renewable energy generation. Energy scholars who study policy effectiveness utilize net renewable energy generation as a measure of policy effectiveness (e.g. Carley, 2009). However, to my knowledge, no studies focus on renewable energy grant effectiveness at the local level in the U.S.

The following section reviews the literature on grant effectiveness, focusing on issues of crowding out and endogeneity. I hypothesize that receiving a grant leads to an increase in renewable energy production at the local level. To test the effects of energy grants on energy production, I utilize data on ARRA §1603 grants awarded in 2009 and 2010 from the U.S. Department of Energy. I match this data with energy production data from the U.S. Energy Information Administration from 2005 to 2014 for counties that had an operational power plant over this period. I consider the impact on all types of renewable energy but focus on solar energy as the majority of ARRA awards in the dataset were awarded for solar energy projects.[47] I aggregate all ARRA award and energy production measures at the county-level to create consistent measures. I run a fixed effects model, accounting for changes in economic activity during the recession of 2007 to 2009 on the estimated impacts of energy grants. I find that counties with an ARRA grant recipient had a significant and positive increase in solar energy production. I also include robustness checks to consider unobserved preferences and regional initiatives.

---

[47] The data include only awards that were recorded for 2009 or 2010 at the time of data collection. The data do not include awards distributed after the data were collected.

The additional empirical evaluation suggests that ARRA grants are most effective in warmer climate regions but are not affected by regional initiatives.

The research question put forth in this chapter is relevant for several reasons. This approach offers a different perspective on understanding grant effectiveness, because it considers how dollars are spent instead of the amount spent. In other words, I measure the actual good produced instead of the change in local spending on the good. This is an interesting perspective as the amount of dollars spent on renewable energy may not be perfectly correlated with the actual amount of renewable energy produced from grant-funded projects. Additionally, the analysis helps further our understanding of a legislator's motivation to support renewable energy grants. If renewable energy grants increase renewable energy output, we can be more confident that the model proposed in Chapter Four describes a legislator's utility function since it implies that renewable energy output increases regardless of funding mechanism.

6.2 Effectiveness of Fiscal Transfers

Grants are commonly designed to correct inefficiencies in decentralized policymaking by increasing spending on the local public good (e.g. Oates, 1972; 1991; 1999). However, intergovernmental transfers are fungible (Bradford and Oates 1971a, b). Fungibility refers to the ability of grant recipients to substitute state and local funds for federal funds, such as reducing taxes or own spending in response to receiving a federal grant. In other words, federal grants can crowd out local spending, resulting in no net or diminished effect on public spending. For example, complete crowding out would result in a dollar-for-dollar crowd out, resulting in no net effect on public spending. Partial crowd out

occurs when one dollar in federal grant results in a reduction of local spending of less than one dollar.

Some of the first studies on grant effectiveness find that fiscal transfers increase public spending (Gramlich, 1977; Inman, 1979; Fisher, 1982; Hines and Thaler, 1995).[48] As explained in previous chapters, this effect, referred to as the flypaper effect, occurs when grants lead to a greater level of spending on the public good than an equivalent increase in citizen income. Chubb (1985) argues that economic models could not provide a complete explanation of the subnational fiscal decisions using federal grant money, because politics, including ideological and constituency-oriented demands, also play a role. In fact, Inman (2008) argues that the political process is the best explanation for the flypaper effect. Mainly, legislators desire to send funds to their constituents for benefits such as reelection and political gains (e.g. Weingast, 2009; Inman, 1989; Grossman, 1994; Rodden, 2003; Gamkhar and Ali, 2008). However, Allers and Vermeulen (2016) argue that rent-seeking did not explain the flypaper effect in their study of local spending in the Netherlands, because grants were fully capitalized in housing prices. Instead, they offer government corruption as an explanation for the flypaper effect.

Empirical analyses on grant effectiveness test whether the flypaper effect is due to the endogenous nature of grants since unobserved preferences are not included in the model. Knight (2002) explains that preferences can influence grant distribution and spending on public output. Therefore, grants are likely awarded to localities that have stronger preferences for the public good. Some studies use political factors as instruments

---

[48] Some early studies find no effect on public spending (Hamilton, 1983; Hamilton, 1986).

to control for endogeneity. Gamkhar and Oates (1996) instrument grants using the proportion of Democrats in Congress and find evidence of crowding in, although results from specification tests are mixed. In other words, they find that federal grants increase subnational public investments. Knight (2002) controls for endogeneity by using legislative committee representation as instruments to control for unobserved preferences and finds evidence that federal highway grants crowd out state spending.

Other studies exploit the grant formula to control for endogeneity. Gordon (2004) uses an unanticipated change in the Title I grant formula to address endogeneity and finds a delayed effect of Title I grants on state and local education spending, but the effect diminishes over time. Dahlby and Ferede (2016) test Hamilton's (1986) theory that the flypaper effect arises from distortionary taxes imposed by subnational governments. They exploit the discontinuity of a grant formula used to distribute fiscal transfers to Canadian provinces and find support for this theory, attributing the flypaper effect to the deadweight loss of distortionary taxes. They argue that federal grants stimulate marginal expenditures by subnational governments, increasing the marginal costs of spending. Moreover, Dahlberg and Edmark (2008) use a discontinuity in a Swedish grant system where only municipalities above a certain migration rate receive extra grants, finding an increase in local spending and no reduction in local taxes.

Scholars also use unanticipated court decisions to control for endogeneity in studies on grant effectiveness. Lutz (2010) studies the effects of a court decision to change how lump sum education grants were awarded from the state to municipalities, finding that grants crowd out local spending. Card and Payne (2002) study school finance reform by looking at looking at changes in funding decisions required by the Supreme

Court. They find evidence of the flypaper effect, where state grant aid increases spending by local school districts.

Leduc and Wilson (2017) suggest that studying the effectiveness of ARRA highway grants might address issues of endogeneity and crowding out that arise with other studies on grant effectiveness. They instrument highway grants using proposed highway miles and find an increase in state spending. However, they argue for the exogenous treatment of ARRA grants since they were an unanticipated increase in spending. Furthermore, they explain that ARRA included a "maintenance-of-effort" requirement for highway grants to prevent crowding out state spending. The requirement directed states to maintain their planned level of transportation spending while receiving additional ARRA grant money for transportation. However, it is not clear if states complied with the requirement.

6.3 ARRA Grants

The Federal Recovery and Reinvestment Act of 2009 was a federal stimulus bill in response to the economic downtown of 2007 to 2009. The stimulus package contained provisions for several grant programs, including energy grants. Aldy (2013) argues that the stimulus bill, which contained funding for both federal and decentralized funding for renewable energy, was a means by which the Obama administration carried out its clean energy policy goals. Aldy explains that the Office of Energy and Climate Change was charged with drafting the clean energy package and told Congress to prioritize promoting renewable energy power, among other things.[49] U.S. Senator Harry Reid introduced S.1

---

[49] The Office of Energy and Climate Change, a temporary office, is currently closed.

on January 6, 2009, and H.R.1 (the House-amended version) was introduced shortly after President Obama's inauguration on January 26, 2009. Both bills contained a clean energy package, allocating most clean energy expenditures to renewable energy. The final draft, adopted on February 17, 2009, included many initial recommendations.

ARRA's §1603 grant program required expeditious installation of energy projects. The U.S. Department of the Treasury, who was responsible for administering the program, required applicants to submit a detailed project plan that included a construction permit and proof that projected costs matched the amount requested in the grant application ("§1603 Program," n.d.). The program also required ongoing progress reports to ensure that recipients continued to meet program deadlines. ARRA-funded projects were to start construction by the end of 2010 and become operational no later than 2012 for wind farms; 2013 for biomass, landfill gas, and marine energy projects; and 2016 for solar, geothermal and fuel cell projects (Martin et al., 2009). However, scholars report that ARRA-funded projects in general were associated with up to one-year delays in implementation (Callahan et al., 2012; Terman et al., 2012; Terman and Feiock, 2012).

Scholars exploit ARRA's reporting requirements to study the effectiveness of other ARRA grant programs on public spending. Studies find evidence of crowding-out of state borrowing for infrastructure (Cogan and Taylor, 2011; Inman, 2010). However, Leduc and Wilson (2017) study highway grants during the 2009 Recovery Act to ask how states responded to sudden, large changes in federal funding. After controlling for endogeneity, they conclude that grants were exogenous, finding that federal grants increase own spending. Studies also find evidence of rent-seeking. Leduc and Wilson find that states with higher political contributions from the public-works sector spent

more ARRA funds. Furthermore, Young and Sobel (2013) look at ARRA spending in general and find that states previously capturing large amounts of federal funds continue to do so under ARRA stimulus. However, these studies consider the impact on spending but not the good itself, as considered in this analysis.

Although no study to my knowledge empirically evaluates ARRA energy grants at the local level, few studies offer insights on ARRA energy grants. Bollinger et al. (2010) suggest that ARRA grants might have motivated wind investment but discuss concerns of possible endogeneity as wind grants were awarded to developers who had a history of wind purchases. However, Terman and Feiock (2014) argue that selection bias might not be an issue because very few grants applications were rejected, suggesting that grants were not just awarded to applicants with the highest preferences for renewable energy. Part of the difficultly in considering the role of preferences is that there is no consistent measure across types of entities who received an ARRA energy grants. ARRA energy grants were awarded to local governments and various forms of entities within these governments, making it difficult to find a single measure of preferences to control for potential endogeneity.

Finally, some scholars discuss implementation issues associated with ARRA that might impact how grant effectiveness is measured. For example, Terman and Feiock (2014) look at the implementation timeline of energy projects funded by ARRA energy grants and find that the level of direct involvement from city officials affects whether a project would be implemented on time. Other studies consider other types of ARRA grants. Leduc and Wilson (2013) explain that highway projects could be delayed due to timing of outlays to grant recipients as some outlays occur after project completion.

Gamkhar (2000) studies effectiveness of highway grants and finds no immediate effect but does find a delayed increase in state and local spending in response to federal highway grants.

6.4 Data

I compile data from several sources to test whether renewable energy grants increase renewable energy production at the local level. The dependent variables are net renewable energy generation in megawatt hours (MWH) by energy type. Data are from the U.S. Energy Information Administration's EIA 923 (previously the EIA-906/920) form, which provides the amount of energy produced by individual power plants across the U.S. ("Electricity," 2017). Net generation is the amount of energy produced in megawatt hours by a power plant minus the amount of energy consumed in megawatt hours by the power plant during the energy production process.[50] I use four measures of net renewable energy generation: total renewable energy, solar, wind, and biomass. Total renewable energy net generation includes renewable energy from all renewable energy sources. Solar energy includes photovoltaics and thermal solar energy. I aggregate power plant data at the county level for years 2005 to 2014, which includes years before and after the distribution of ARRA grants.

Some counties have multiple power plants, most of which produce more than one type of energy.[51] I calculated the total amount of energy produced by power plants by

---

[50] While the grants were designed to increase generation capacity, net generation more accurately measures an increase in renewable energy production.
[51] While I cannot match each power plant with the project funded by an ARRA energy grant, I assume that grant recipients produce renewable energy through existing renewable energy power plants within the

each type of energy for each county in the dataset. For example, the total net generation

of solar energy produced for each year in each county is the total amount of solar energy

produced by all power plants within that county in that same year. Data on power plant

energy production are included for 7,768 power plants in 2,117 counties, although not all

2,117 counties produced power or for each type of energy in each year in the analysis.

Table 6.2 shows the number of power plants and counties in the dataset that produced

each type of energy in any year from 2005 to 2014. Hydroelectric and biomass energy are

produced in a larger number of counties compared to other types of renewable energy.

Wind and solar energy are produced by a larger number of plants other than

hydroelectricity compared to other forms of renewable energy.

Table 6.2
Number of Power Plants and Energy-Producing Counties by Fuel Type

Fuel Type	Number of Power Plants	Number of Counties
Solar PV and thermal	992	270
Geothermal	67	19
Hydroelectric Pumped Storage or Conventional	1,493	595
Wind	895	346
Biogenic Municipal Solid Waste and Landfill Gas and Wood and Wood Waste	847	567
Other Renewables	262	202
Nonrenewable Sources	3,962	1,683

Source: U.S. Energy Information Administration EIA 923 form
Note: Although biogenic municipal solid waste and wood and wood waste are listed as separate categories, both are biomass energy.

Table 6.3 shows summary statistics for dependent variables used in the analysis.

The table includes the average values for the beginning and ending years in the dataset,

which include years before and after the distribution of ARRA energy grants. The table

---

same county. Renewable energy is localized since energy production efficiency is diminished with distance.

shows the average values for total net generation aggregated at the county level.[52] The

average amount of net generation for all forms of renewable energy increased from 2006

to 2014, while the average amount of nonrenewable net energy production decreased. Net

renewable energy generation increased by 28.8 percent, on average. The largest

percentage increase was for net solar energy generation, which increased by 3,081

percent. Energy from nonrenewable sources declined by 11.3 percent from 2006 to 2014,

on average.

Table 6.3
Summary Statistics
Net Energy Generation in Megawatt Hours Aggregated by County
2006 and 2014

Variable	2006 Mean	2014 Mean	% Change
Renewable Energy Net Generation	222,132	286,141	28.8%
Solar Net Generation	297	9,449	3,081%
Wind Net Generation	15,577	97,526	526.1%
Biomass Net Generation	30,984	32,656	5.4%
Nonrenewable Energy Net Generation	2,158,903	1,914,315	-11.3%

Source: U.S. Energy Information Administration EIA 923 form

The variable of interest in this analysis is ARRA energy grants. I use data on

Section §1603 ARRA grants awarded in years 2009 and 2010 downloaded from the U.S.

Department of Energy's website ("Recovery Act Recipient Data," 2017). I include

awards only for renewable energy projects. Each observation in the dataset lists the

recipient, the city in which the project was located, the amount awarded, and the date

awarded. Award recipients included counties, cities, universities, tribes, nonprofits,

schools, companies, and states. To design a feasible study, I use the project's location, the

county in which the project was located, as the unit of analysis. In some cases, the county

---

[52] Negative net energy generation occurs when the energy consumed in the energy production process
exceeds the amount of energy produced.

of the project's location was evident by the name of the recipient. In other cases, I conducted a Google search to determine in which county the project was located.

I use the data to create two measures of ARRA grants. The first is designed as a treatment variable, equal to 1 if a county had an ARRA grant recipient in year t and every subsequent year. Therefore, this variable is equal to 1 starting in 2009 or in 2010 for each county in the sample that had an ARRA grant recipient.[53] I also include a secondary measure to account for the magnitude of ARRA energy grants. Since renewable energy project costs can vary considerably, I count the number of ARRA energy grants received in a county instead of the total dollar amount of ARRA energy awards. This variable is the cumulative number of ARRA awards received by recipients in a county in the current and previous years. Therefore, this variable is equal to 0 for all counties until year 2009.

Table 6.4 shows the aggregated amount of ARRA renewable energy grant awards by county. Approximately nine percent of counties had an ARRA renewable energy grant recipient. Counties in the dataset had anywhere from one to 49 ARRA renewable energy grant recipients over years 2009 and 2010, although most counties had only one ARRA grant recipient. Of counties that had an ARRA recipient, 230 counties had only one recipient, and two counties had the maximum number of recipients. Two counties had the second highest number of recipients at 10 ARRA grant recipients for each county. Counties received an average of $547,617 in ARRA grant awards, which includes counties that did not receive an ARRA award for renewable energy. Of counties that

---

[53] For a county that had an ARRA grant recipient in 2009 and 2010, this variable is coded as 1 in 2009 and every subsequent year. There is no change to account for the 2010 recipient(s) in this case.

received an award, the average amount awarded to recipients was $8,088,057, and the

minimum was $4,941.

Table 6.4
Summary Statistics
ARRA Renewable Energy Grants Awarded to Recipients Aggregated by County
2009 and 2010

Variable	Mean	Min	Max
County with an ARRA Award Recipient	0.09	0	1
ARRA Award Count by County	0.18	0	49
Total ARRA Award Amount by County	$547,617	$0	$1,980,000

Source: U.S. Department of Energy

Figure 6.1 shows the geographic distribution of ARRA renewable energy grant

recipients in the dataset. The graph shows counties that had a renewable energy project

funded by ARRA §1603 grants in 2009 or 2010 and had at least one power plant

producing renewable energy by the end of 2014. There are 161 counties included in the

dataset that received an ARRA grant and had at least one renewable energy power plant

during this period. As the figure shows, counties meeting these criteria are dispersed

throughout the United States.

Figure 6.1
ARRA Renewable Energy Grant Recipients
in Counties with Renewable Energy Production
2005 to 2014

(0,1)
[0,0]
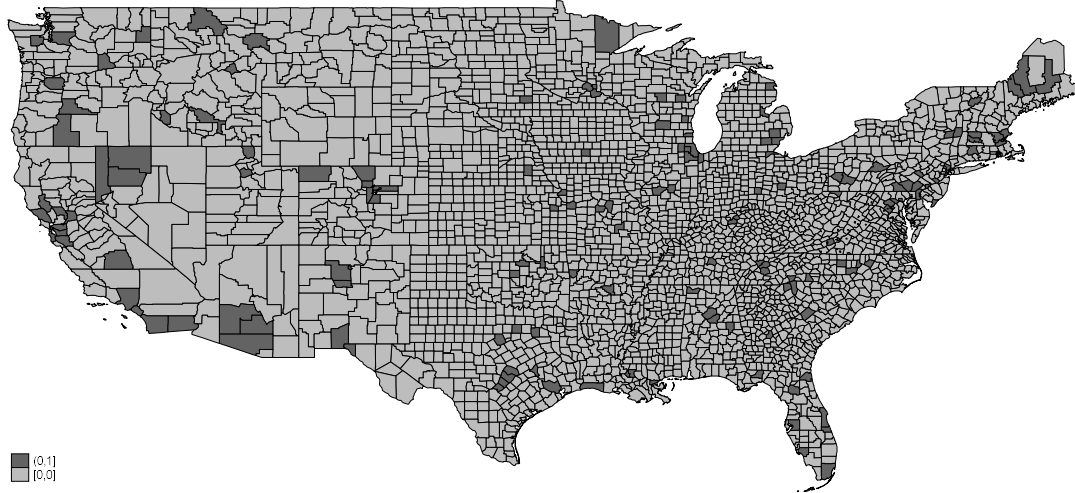
Sources: U.S. Department of Energy; U.S. Energy Information Administration

The largest proportion of ARRA grants in the dataset were awarded for residential and nonresidential solar energy projects. Figure 6.2 shows the 260 counties in the United States that had a solar power plant over the time period observed in this analysis. Figure 6.3 shows which of these counties also had a renewable energy project funded by an ARRA energy grant. The figures show that ARRA awards were distributed throughout the regions across the United States with solar-producing counties. All solar-producing regions across the United States have both counties that received an ARRA grant and counties that did not receive an ARRA grant.

Figure 6.2
Counties with a Solar Power Plant
2005 to 2014

[0,1]
[0,0]
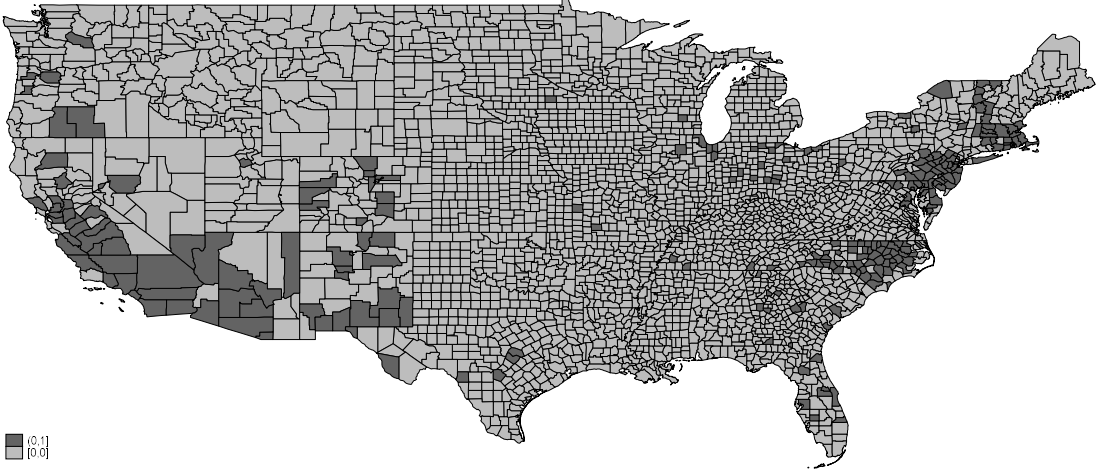
Source: U.S. Energy Information Administration

Figure 6.3
Counties with a Solar Power Plant and
a Renewable Energy ARRA Grant Recipient
2009 or 2010

[0,1]
[0,0]
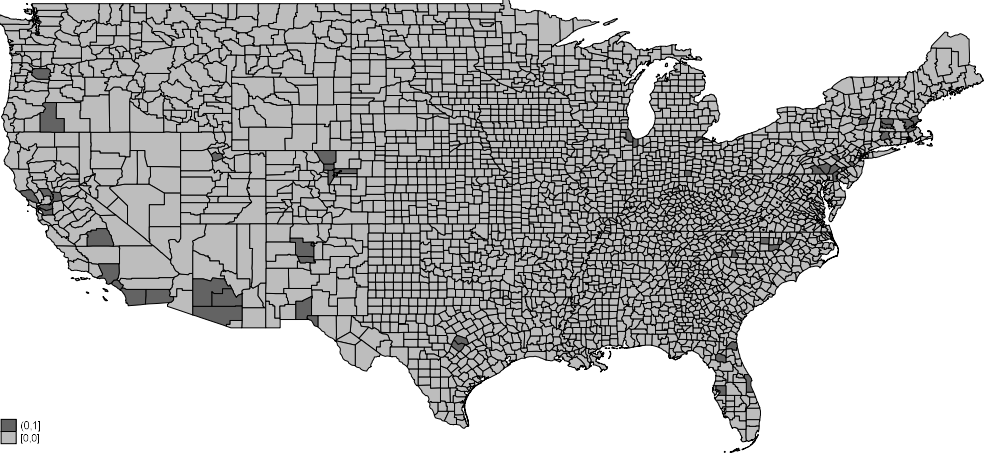
Sources: U.S. Department of Energy; U.S. Energy Information Administration

Wind and biomass were the next common types of ARRA energy grants awarded.

Although not shown here, the dataset has 337 counties that produced wind energy over

the observed time period, and 20 of those counties received an ARRA energy grant. The

sample includes 481 counties that produced biomass energy, and 73 of those counties received an ARRA grant.

I also include county-level controls from the literature that are expected to impact investments in renewable energy production. The literature includes economic controls, which can influence a locality's ability to make public investments (Winer, 1983; Ghamkar and Oates, 1996; Dahlby and Ferede, 2016; Leduc and Wilson, 2017). I assume that these same economic factors affect an area's likelihood of investing in renewable energy infrastructure. I include income and unemployment in the model. Personal income per capita data are from the U.S. Bureau of Economic Analysis' Regional Economic Accounts and are adjusted for inflation using 2014 dollars. The unemployment rate is from U.S. Bureau of Labor Statistic's Local Area Unemployment Statistics. I expect income to be positively related to renewable energy production, as higher income might signal greater ability to make public investments. Additionally, income could indicate preferences for intergovernmental grants as counties with less income might be more likely to apply for grant programs. I expect unemployment to be negatively associated with renewable energy development if unemployment is a signal of a restricted ability to make public investments.

I also include variables that are expected to impact demand for renewable energy investments and production. I include a measure of population density to control for amount of renewable energy used. I use population data from the U.S. Bureau of Economic Analysis' Regional Economic Accounts and land area data from the US Census Bureau's TIGER files and Census of Population and Housing. Geographic factors are also expected to affect the amount and types of renewable energy investments since

renewable energy resources are directly tied to location. I include the maximum

temperature in July to control for disproportionate changes in temperature changes across

the United States (Egan and Mullins, 2017). This could affect both renewable energy

resources and renewable energy consumption. The values are based on average

temperatures across weather stations within each county.

I also control for state-level policy actions that could affect the implementation of

local energy projects. There are two state-level controls in the model. The first is the

amount of renewable energy production produced in the state in which the county is

located, which was collected from the U.S. Energy Information Administration's State

Energy Data System. I expect this variable to be positively associated with local

renewable energy production, since higher levels of state renewable energy production

likely indicate more developed energy infrastructure. The second is a dummy variable

equal to 1 if a state has adopted a Renewable Portfolio Standard or goal to produce a

certain level of renewable energy collected from the National Conference of State

Legislatures ("State Renewable Portfolio Standards," 2019). Renewable portfolio

standards have been found to increase total state renewable energy generation (Carley,

2009; Kydes, 2007). I expect this variable to be positively associated with local

renewable energy production as this variable indicates efforts to develop renewable

energy within each state.

Finally, I include controls to measure preferences for renewable energy

production. Fossil fuel energy net generation, collected from the U.S. Energy Information

Administration 923 form, is included to account for energy preferences that might be

opposed to expanding renewable energy. Since fossil fuel energy is often viewed as a

substitute to renewable energy, I expect fossil fuel production to be negatively associated

with renewable energy production. I also include county fixed effects to control for

unobserved preferences that are not captured by the control variables in the model. Year

dummy variables are included to control for additional macroeconomic factors that are

not addressed by the local economic variables included in the model. Table 6.3 provides a

description of how each variable is measured. Summary statistics are reported in

Appendix C.

Table 6.5
Variable Descriptions

Variable	Description
Solar Energy Production	Total net generation in hundreds of megawatt hours from solar energy sources produced from power plants within county i in year t.
Wind Energy Production	Total net generation in hundreds of megawatt hours from wind energy sources produced from power plants within county i in year t.
Biomass Energy Production	Total net generation in hundreds of megawatt hours from biomass energy sources produced from power plants within county i in year t.
RE Production	Total net generation in hundreds of megawatt hours from all renewable energy sources produced from power plants within county i in year t.
FF Energy Production	Total net generation in hundreds of megawatt hours from all nonrenewable energy sources produced from power plants within county i in year t.
ARRA Grant	Equal to 1 if a recipient within a county received an ARRA grant for renewable energy in county i, 0 otherwise. This variable is equal to 1 the year the award was received and each subsequent year.
ARRA Grants Number	The cumulative number of total amount of ARRA grant awarded for a renewable energy project to all recipients in county i in 2009 to 2010.
Unemployment	The percentage of persons in the labor force who are unemployed in county i in year t.
Income Per Cap	The natural log of inflation-adjusted personal income per capita in county i in year t.
July Max Temp	The maximum temperature recorded in January in county i in year t.
Population	Total persons per square mile of land area in county i in year t.
RPS or RPS goal	Equal to 1 if county i's state had a renewable portfolio standard or a renewable energy goal in year t.
State RE Production	Total renewable energy production, measured in 10 billion BTUs, in county i's state in year t.

6.5 Statistical Model and Methods

I observe a sample of energy-producing counties from 2005 to 2014, although some variables are not observed across all years. I run a panel data model with county fixed and year effects. A portion of the counties in the sample received an ARRA Section §1603 grant in either 2009 or 2010. Since I have a portion of counties who received a one-time ARRA grant and a control group of counties that did not receive a one-time ARRA grant, the variable of interest is designed as a treatment variable. ARRA grant is equal to 1 in the year in which a recipient in a county received an ARRA renewable energy grant and 1 for all subsequent years. The variable measures the potential intercept shift in renewable energy production for counties receiving a grant. Additionally, ARRA grants number measures the cumulative number of grants received by a recipient in a county as of time t.

The standard panel data model with fixed and year effects is shown in Model (1).

$$Y_{it} = X'_{it}\beta + \alpha_i + \delta_t + \varepsilon_{it} \tag{1}$$

where Y_{it} is the dependent variable for county i in time t, X_{it} is a matrix of control variables for county i in time t, α_i denotes the fixed effects for county i, δ_t is a vector of year effects in time t, and ε_{it} is the error term. The fixed effects control for unobserved, time-invariant effects that are unique to individual counties. The year effects control for macroeconomic effects that are expected to have an impact on all counties across time t.

I consider potential endogeneity. Research in grant effectiveness warrants concern for endogeneity due to unobserved preferences. Scholars argue on whether endogeneity is a concern for ARRA grants. Leduc and Wilson (2017) find evidence in support of their

hypothesis that grants were an exogenous shock in their analysis of state highway grants. Terman and Feiock (2014) argue that selection bias might not be a problem because few applications were rejected. However, other aspects of the program warrant concern for endogeneity. Applications were reviewed by third parties, but most applicants were aware of the application process before applying (Bollinger et al., 2010). Therefore, it is plausible that grant recipients were those who had the strongest preferences for renewable energy and the most skilled, which causes concern for biased results.

Methods used in the literature to control for endogeneity are not applicable in this analysis due to the design of ARRA energy grants. One common method to control for endogeneity is to utilize the grant distribution formula as an instrument (e.g. Gordon, 2004; Dahlberg et al., 2008; Leduc and Wilson, 2017). However, ARRA grants for renewable energy investments were project grants that were awarded by a competitive application process, not by a formula. Other scholars use political variables as instruments. Gamkhar and Oates (1996) use the percentage of Democrats in Congress along with population and unemployment to control for endogeneity associated with state and local grants, and Knight (2002) uses the proportion of state representatives on committees as instruments as he argues that congressional power influences grant distribution. However, I am unable to find an appropriate political measure for the different types of governmental entities and organizations in the analysis, especially since all data are aggregated at the county level across time.

Instead, I argue that the county-level fixed effects to control for at least some unobserved preferences that could affect grant distribution and the amount of renewable energy produced in an area. The fixed effects are expected to capture at least some

political preferences associated with renewable energy development. The fixed effects will also likely control for some preferences associated with preferences for renewable energy grants. While fixed effects are not the preferred approach to address unobserved preferences, this is the only feasible way to address this concern given the nature of the data. Additionally, the nature of this program mitigates some potential for bias as the program was unanticipated and led to a sudden increase in spending. Furthermore, Terman and Feiock's (2014) argument that very few projects were rejected suggests that project grants were not awarded to recipients who had the highest preferences for renewable energy.

I consider two modifications to the model. First, I consider the economic conditions during the time of ARRA. Whereas other studies look at the effectiveness of ARRA grants from the period directly preceding the recession to the period directly following the distribution of ARRA grants (e.g. Leduc and Wilson, 2017), I start with years before the economic recession of 2007 to 2009 as I assume that renewable energy production and investments could have decreased during the recession (e.g. Card and Krueger, 2000). This concept, known as the Ashenfelter Dip, recognizes that there is typically a dip in a program's output right before a new program is implemented (Ashenfelter, 1978; Ashenfelter and Card, 1985; Card and Krueger). In other words, we should expect an increase in renewable energy production immediately following an economic recession if energy production decreased during the economic recession. In this case, the estimated impact of grants would be biased as it would measure a return to steady-state energy production. Figure 6.4 shows the sum of total net generation of renewable energy for counties across time. The figure shows a dip right before the

economic recession. I assume that the dip at the start of the economic recession does not reflect steady-state energy production. To account for the dip, I replace data values for all energy and economic variables in years 2007 and 2008 with values from 2005 and 2006 in some of the following models.

Figure 6.4
Total Net Generation of Renewable Energy for All Energy Producing Counties
2005 to 2014
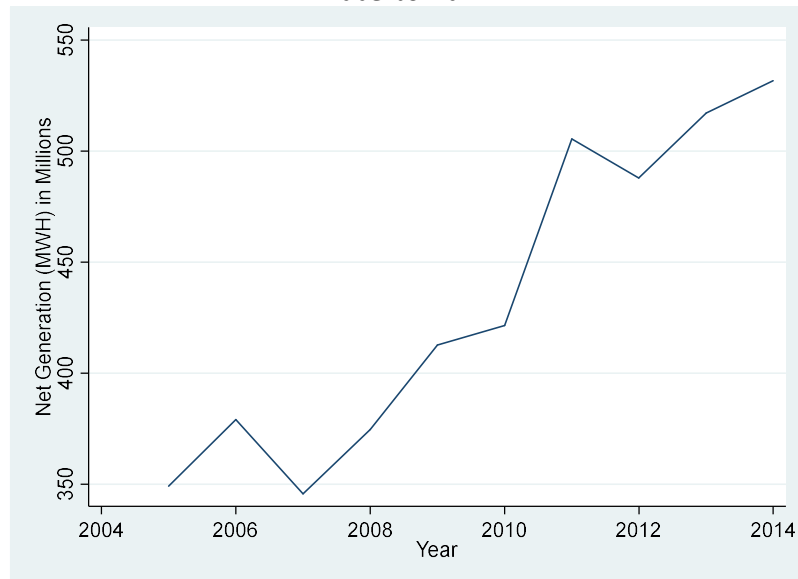
Second, I consider the differences in the time of award announcements and the time it took for project implementation and completion. Although grants can have an immediate effect on local spending, it is less likely that grants have an immediate effect on renewable energy production since projects require time for completion. I assume a delay in time from grant receipt to the time it takes for new energy projects to be constructed. Figure 2 shows project completion deadlines as required by the §1603 grant program. All renewable energy grants were awarded in years 2009 and 2010, although not all were necessarily paid in those two years. Project deadlines ranged from 2012 to 2016, depending on energy type. For example, a recipient could have received a grant for

a wind energy project in 2009 and have completed the project anywhere from 2009 to 2012. Even with reported one-year delays, all projects should have been completed by the end of 2016 for grants awarded in 2009 or 2010. I run additional models to include a series of lags for both ARRA grant variables, which also addresses the concerns for project delays as discussed in the literature.

Figure 6.5
Timeline of Award Receipt and Deadline for Project Completion

Type of Energy Project	Award	Project Completion							
Wind									
Biomass									
Landfill gas									
Marine									
Fuel Cells									
Geothermal									
Solar									
	2008	2009	2010	2011	2012	2013	2014	2015	2016
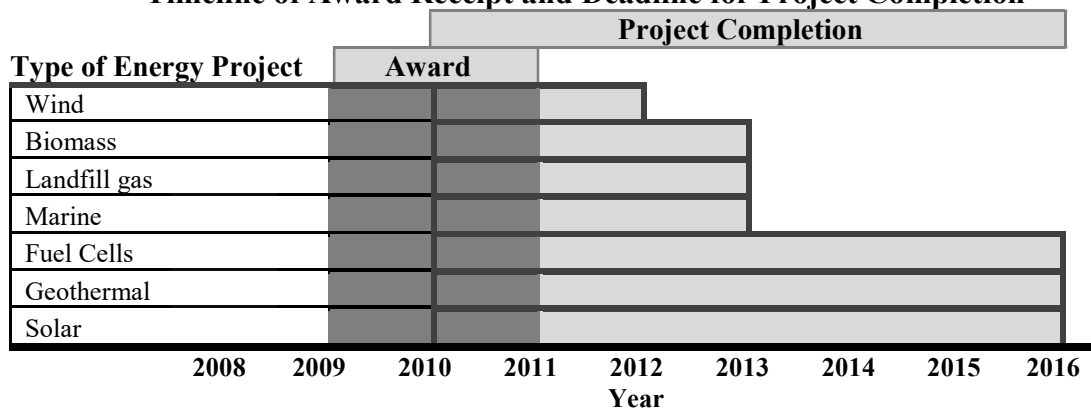
Year

Source: Martin et al. (2009)

I run four preliminary models without controlling for the potential pre-recession dip or including any lags for ARRA grants. The variable of interest in each model is ARRA grant, equal to 1 in the year in which a county had a recipient who received an ARRA grant and for all subsequent years, 0 otherwise. The dependent variable in the first model is total renewable energy net generation (MWH) at the county level. This dependent variable includes renewable energy from all renewable sources, including renewable energy sources not considered in this chapter. The dependent variables in the second through fourth models include renewable energy net generation separately for solar, wind, and biomass energy. Figure 6.6 shows the coefficients for ARRA grant for each of the four preliminary models.

125

Figure 6.6
Preliminary Fixed Effects Estimator for the Effect of ARRA Grants on
Renewable Energy Net Generation by Type of Energy
2007 to 2014
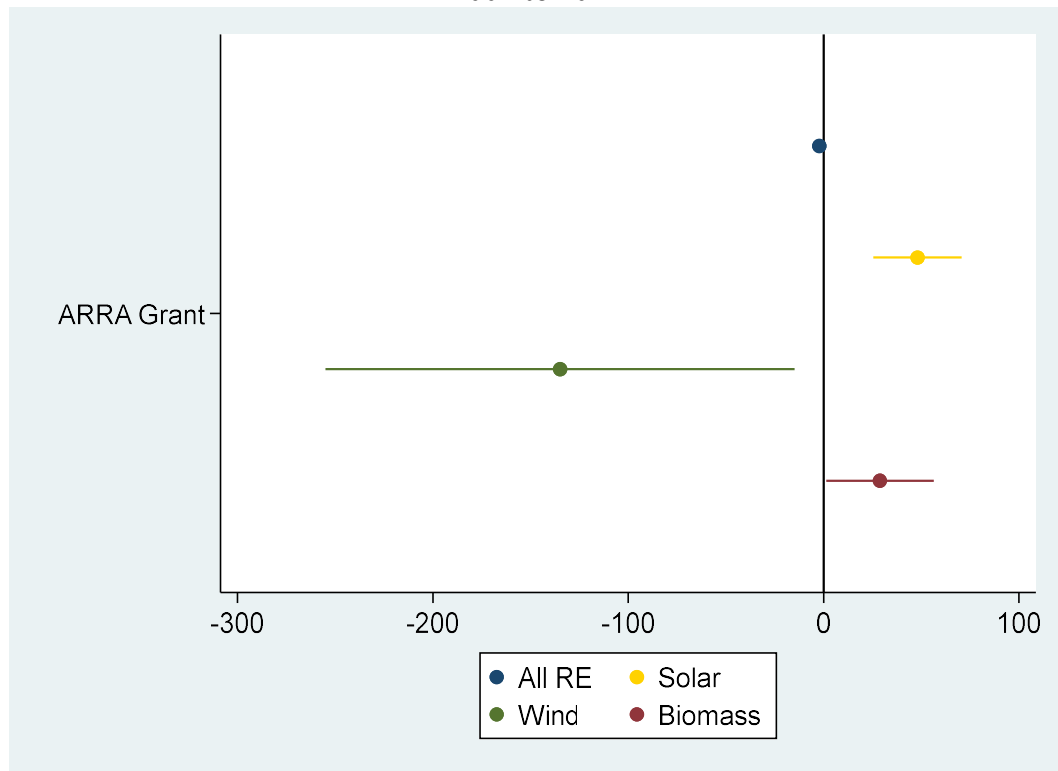
The preliminary coefficients for ARRA grants show different relationships between ARRA grants and renewable energy production across the four models, which measure renewable energy differently. The model for all renewable energy shows that ARRA renewable energy grants are negatively and significantly related to total renewable energy net generation. This effect could be at least partially driven by the association between wind energy and ARRA grants as by the negative coefficient in the wind energy model. The coefficients are significant and positive in the models for solar energy and biomass energy. Before proceeding to the final models, I further investigate the positive impacts relationship between ARRA grants and these two types of energy by considering the potential for overstated energy production following the economic

recession. I run the same four preliminary models with years 2008 and 2009 replaced

with values from 2005 and 2006 for all energy and economic variables. The coefficients

are in Figure 6.7.

Figure 6.7
Preliminary Fixed Effects Estimator for the Effect of ARRA Grants on
Renewable Energy Net Generation by Type of Energy
Controlling for Economic Impacts
2007 to 2014
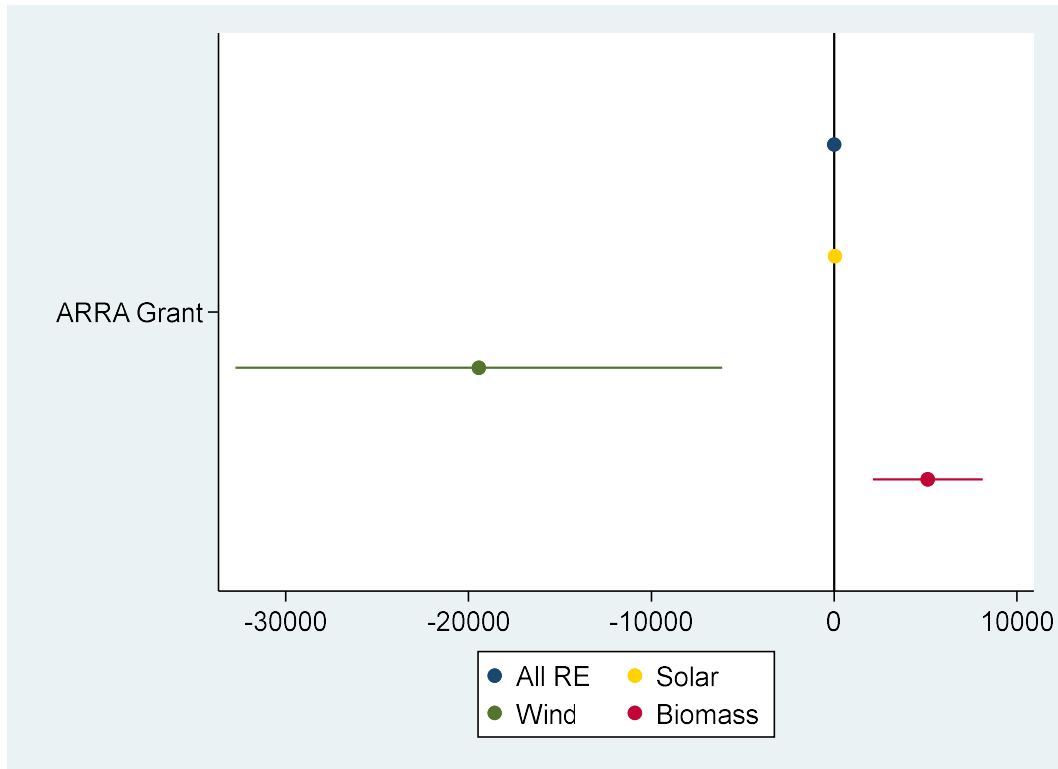
The figure above shows that solar energy production became less positive and

biomass energy became more positive after accounting for the possible dip in energy

production during the economic recession. Based on the preliminary results, I account for

the economic dip in the solar energy production models in the following section.

I also consider the negative effect for wind energy by comparing the counties that

received an ARRA grant to those that did not receive an ARRA grant. The following

three figures show these differences for solar, wind, and biomass energy separately.

Figure 6.8 shows total solar energy net generation for grant recipients compared to counties that did not receive a grant. The figure compares total net generation for the two groups. The figure shows a greater level of total solar energy production for counties that did not receive an ARRA grant since the majority of solar producing counties did not have an ARRA grant recipient. The figure also shows that total solar energy production increased for counties with recipients in almost all years except from 2005 to 2006 and again from 2008 to 2009, on average. Total solar energy production increased for both groups in 2009, which is the first year of the ARRA awards.

Figure 6.8
Total Solar Energy Net Generation
2005 to 2010
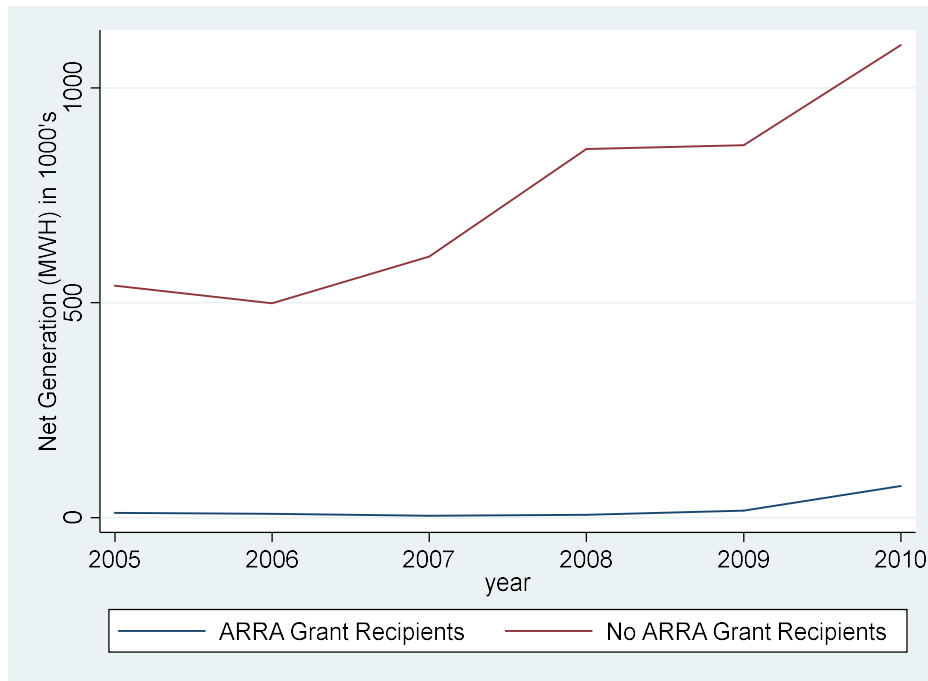
Figure 6.9 compares wind net generation in counties receiving an ARRA renewable energy grant to counties not receiving an ARRA renewable energy grant over the time period in the analysis. The two groups have different levels of total renewable

energy production and vary differently across time leading up to ARRA awards. Total

wind net generation for the group not receiving ARRA grants increased from

approximately 20 million MWH to over 170 million MWH from 2005 to 2014 at a

relatively steady rate. A closer look at the group receiving ARRA grants shows that wind

energy generation increased over time, but there was more variation in yearly changes in

wind energy production for this group. Figure 6.10 compares the two groups for counties

producing biomass energy and shows a similar pattern. The group not receiving an

ARRA renewable energy grant produced over 40 million MWH of biomass energy

during this period, and the group receiving ARRA renewable energy grants remained

under 10 million MWH.

Figure 6.9
Wind Energy Net Generation
2005 to 2010
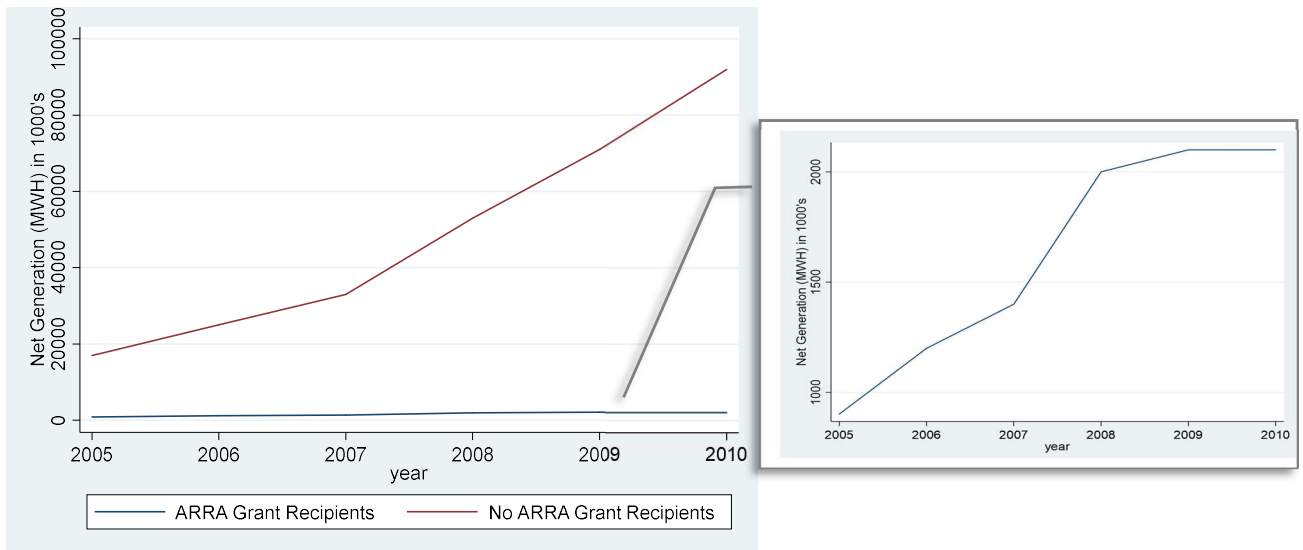
Figure 6.10
Biomass Net Generation
2005 to 2010
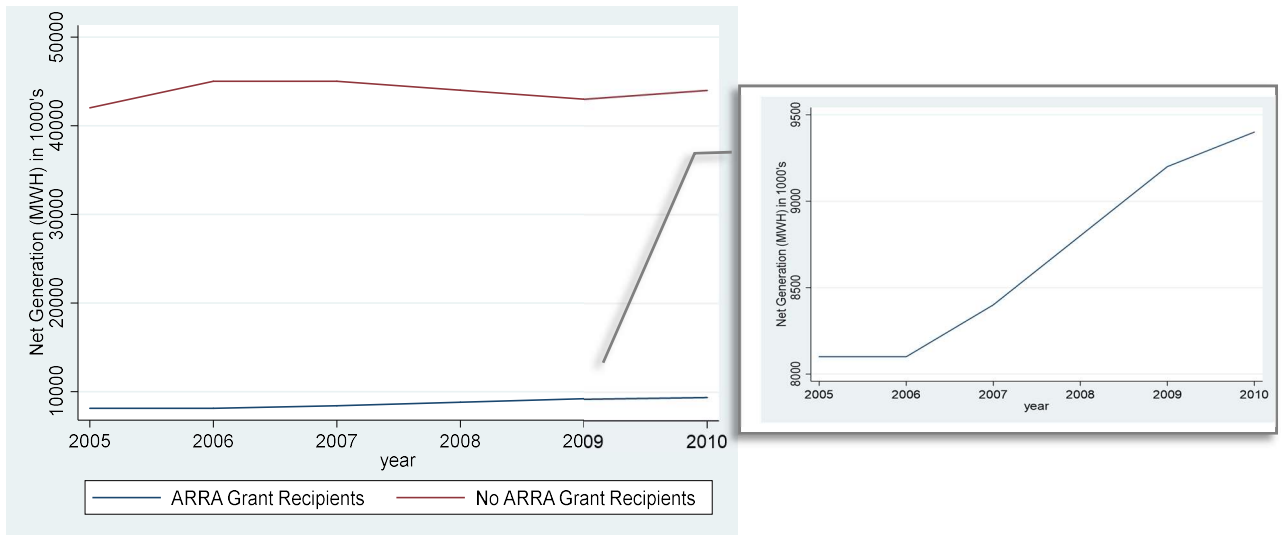
The graphs show differences between counties receiving ARRA renewable energy grants and counties not receiving ARRA renewable energy grants across counties producing these three types of renewable energy. One plausible explanation as is that the two groups in each graph are fundamentally different. It appears that ARRA grants were targeted towards counties with underdeveloped renewable energy systems since growth in renewable energy is different across time for the two groups. This provides further justification for running a panel data model to test the change in energy production using the ARRA grant variable as defined. I continue with using only solar energy production in subsequent models for two reasons. First, ARRA grants for biomass and wind energy were awarded less frequently than awards for solar energy. Second, I further investigate the positive and significant finding of ARRA grants for solar energy production in the preliminary model to check the validity of this finding.

6.6 Results

I run four panel data models with years 2007 and 2008 replaced with values from 2005 and 2006 for all energy and economic variables. Therefore, the sample now includes years 2007 to 2014 with the modified values for years 2007 and 2008. The results are reported in Table 6.6. The dependent variable in each model is total solar energy net generation (MWH) by county.[54] In Model 1, the variable of interest, ARRA grant, is equal to 1 for the year in which a county had an ARRA grant recipient and for all subsequent years. It is equal to 0 in all years for counties that did have an ARRA grant recipient over the time period in the analysis. ARRA grant is lagged by one year in Model 2, by two years in Model 3, and by three years in Model 4. The lags are included to test for any delays in project implementation or project completion following receipt of an ARRA renewable energy grant. All models include fixed and year effects.

---

[54] I also used the amount of the ARRA grant as the variable of interest, but the results are not included in this dissertation. The amount of the ARRA grant was not significantly correlated with solar energy production in any model. This result is likely best explained by the cost differences across projects, especially since costs for renewable energy projects can vary considerably. Put differently, ARRA energy grants were awarded based on percentage of cost. Therefore, a dollar spent on one project likely had a different impact than a dollar spent on another project

Table 6.6
Fixed Effects Estimator for the Effect of Receiving an ARRA Grants on Renewable Energy Net Generation

	(1)	(2)	(3)	(4)
ARRA Grant	44.553***			
	(11.88)			
ARRA Grant L1		59.332***		
		(11.26)		
ARRA Grant L2			81.512***	
			(11.65)	
ARRA Grant L3				118.769***
				(13.45)
RE Production	0.789***	0.795***	0.797***	0.795***
	(0.09)	(0.09)	(0.09)	(0.09)
FF Energy Production	-0.003	-0.001	0.000	-0.000
	(0.02)	(0.02)	(0.02)	(0.02)
Income Per Capita	-0.002***	-0.002***	-0.002***	-0.002***
	(0.00)	(0.00)	(0.00)	(0.00)
Population	0.026	0.014	0.003	-0.002
	(0.05)	(0.05)	(0.05)	(0.05)
Unemployment	6.457***	6.486***	6.567***	6.636***
	(1.57)	(1.56)	(1.56)	(1.56)
July Max Temp	-24.594***	-23.983***	-23.611***	-22.299***
	(8.50)	(8.48)	(8.47)	(8.46)
RPS or RE Goal	-14.295	-13.602	-13.042	-13.233
	(10.19)	(10.19)	(10.18)	(10.16)
State RE Production	-0.002***	-0.002***	-0.002***	-0.002***
	(0.00)	(0.00)	(0.00)	(0.00)
Constant	863.687***	796.110***	784.843***	744.939***
	(269.90)	(267.39)	(267.08)	(266.72)
Year Effects	Y	Y	Y	Y
Fixed Effects	Y	Y	Y	Y
Observations	12171	12171	12171	12171
R-squared	0.025	0.026	0.028	0.031
Adjusted R-squared	-0.169	-0.168	-0.165	-0.162

Standard errors in parentheses
* p<0.10, ** p<0.05, *** p<0.01

ARRA grant and the lagged ARRA grant variables are positive and significant at the one percent level in each model. However, the magnitude of the coefficient on ARRA grant increases with each lagged variable. The results in Table 6.6 suggest that counties with an ARRA grant recipient significantly increased solar energy production after receiving an ARRA renewable energy grant, all else equal, but the impact became greater over time. This finding could suggest that counties were quickly able to implement some solar energy projects but continued to develop solar energy over time. Looking at Model (4), receiving an ARRA energy grant is associated with an increase in 118,000 net

megawatt hours from solar energy at the county-level, all else equal. According to the U.S. Energy Information Administration, the average household consumed 10.4 MWH in 2017 ("How much electricity," 2019). Therefore, an increase at an estimated 118,000 MWH could potentially power approximately 11,346 homes per year at this usage rate.

Some control variables in the models are significant too. The total amount of renewable energy production in a county is significant at the one percent level and positive across all four models.[55] Since solar energy production is included in total renewable energy production, the result implies that counties do not substitute away from other forms of renewable energy when solar energy production increases, all else equal. The total amount of fossil fuel energy produced in a county is not significant and has a coefficient close to 0 across all four models, suggesting that counties do not substitute away from fossil fuel energy when solar energy production increases. However, it could mean that counties producing solar energy do not produce a significant amount of fossil fuel energy.

Population density and the average July maximum temperature for counties were included to control for energy demand. Population is not significant, suggesting that solar energy does not change in response to changes in the number of people in an area. This result could be expected if the majority of counties are not solely dependent on solar energy as a primary source of energy given that the renewable energy market is not fully developed. July max temp is significant at the one percent level and negative. This suggests that solar energy production decreases as a county experiences higher

---

[55] County-level total renewable energy production and solar energy production have a correlation coefficient of nine percent.

temperature in the summer. This result is unexpected but could suggest that counties rely on other forms of developed energy as weather becomes more extreme. It is unclear if this finding is caused by spurious correlation; this variable is not a sufficient measure of weather; or if counties tend to rely on other forms of energy when experiencing increasing temperatures.

The two county-level economic variables are significant at the one percent level. Income per capita is negative, suggesting that counties with less income are less likely to produce solar energy. This result could indicate that counties with more limited income are less able to afford the upfront costs associated with renewable energy development. The unemployment rate is positively associated with solar energy production, possibly implying that counties utilize solar energy projects as a means for economic development. However, both findings warrant additional research to imply causality.

Only one of the two state-level variables are significant. State energy production is significantly and negatively related to solar energy production. This finding is inconsistent with expectations and could imply that counties in areas, including states, with underdeveloped renewable energy markets were targeted with ARRA energy grants, which was the way the program was designed. Whether the state in which the county is located has a renewable portfolio standard or goal is not significantly associated with solar energy production. The fixed effects are informative too as they explain 68 to 71 percent of the variance in each model, suggesting that unobserved characteristics specific to each county explain the majority of solar energy production.

I also consider the impact of counties receiving multiple ARRA awards. ARRA grants measures the cumulative number of ARRA renewable energy grants received by a county as of time *t*. As with the previous models, I lag the cumulative number of awards by one year in Model 2, two years in Model 3, and three years in Model 4. The results are in Table 6.7. Each model includes both fixed and year effects.

Table 6.7
Fixed Effects Estimator for the Effect of the Number of ARRA Grants on Renewable Energy Net Generation

	(1)	(2)	(3)	(4)
ARRA Grants	4.726*			
	(2.49)			
ARRA Grants L1		5.573**		
		(2.31)		
ARRA Grants L2			7.146***	
			(2.35)	
ARRA Grants L3				8.128***
				(2.66)
RE Production	0.787***	0.788***	0.789***	0.788***
	(0.09)	(0.09)	(0.09)	(0.09)
FF Energy Production	-0.004	-0.004	-0.004	-0.004
	(0.02)	(0.02)	(0.02)	(0.02)
Income Per Capita	-0.002***	-0.002***	-0.002***	-0.002***
	(0.00)	(0.00)	(0.00)	(0.00)
Population	0.044	0.042	0.041	0.042
	(0.05)	(0.05)	(0.05)	(0.05)
Unemployment	6.443***	6.424***	6.430***	6.435***
	(1.57)	(1.57)	(1.57)	(1.57)
July Max Temp	-23.376***	-23.058***	-23.014***	-22.964***
	(8.49)	(8.49)	(8.49)	(8.49)
RPS or RE Goal	-14.076	-13.942	-13.858	-13.961
	(10.20)	(10.20)	(10.20)	(10.20)
State RE Production	-0.002***	-0.002***	-0.002***	-0.002***
	(0.00)	(0.00)	(0.00)	(0.00)
Constant	830.498***	820.909***	819.717***	818.383***
	(269.86)	(269.83)	(269.78)	(269.79)
Year Effects	Y	Y	Y	Y
Fixed Effects	Y	Y	Y	Y
Observations	12171	12171	12171	12171
R-squared	0.024	0.024	0.024	0.024
Adjusted R-squared	-0.170	-0.170	-0.170	-0.170

Standard errors in parentheses
* p<0.10, ** p<0.05, *** p<0.01

The results show that both the time required for implementation and the magnitude of ARRA renewable energy grants might be relevant for solar energy production. Each grant represents a new project funded within a county. The cumulative

number of ARRA renewable energy grants is positive and significant in all four models, but the significance increases with the lagged variables. The coefficient on ARRA Grants is significant at the 10 percent level in Model 1; at the five percent level in Model 2; and at the one percent level in the other two models. We can infer from the results that the number of projects funded within a county could have had a greater positive impact on solar energy production after the first two years of receiving a grant, all else equal. This result suggests that there could be delays in project implementation. The coefficient also increases with each subsequent lag. By the fourth year (Model 4), each additional ARRA grant is associated with an increase in 8,128 MWH of net solar energy production, all else equal. Using the calculation above, this amount of solar energy could potentially power 782 homes at the average household usage rate.

6.7 Robustness Checks

As discussed in Chapter Two, all states have potential for some at least solar photovoltaic (PV) power energy, although the potential for solar PV varies by region. I consider this variation to test the validity of the results in Table 6.6. I consider whether the effectiveness of ARRA energy grants on solar energy production is driven by solar energy-producing counties that are more able to develop solar energy. Solar potential varies greatly by region. The previous model controls for county fixed effects but does not provide information about the effectiveness of ARRA energy grants in different climate regions. I evaluate the effectiveness of energy grants by climate region using data from the U.S. Department of Energy's Building Technologies Office (Baechler et al.,

2015).[56] The office groups counties into one of eight climate regions based on heating

degree days, average temperatures, and precipitation. Due to data limitations with the

frequency of ARRA awards, I put counties into one of two groups based on climate

region. The first group includes counties in hot climate regions, which are the hot-dry,

mixed-dry, hot-humid, and mixed-humid climate regions. The second group includes

counties in cold climate regions, which are the cold, very cold, marine, and subarctic

climate regions. Each group includes both counties that received an ARRA renewable

energy grant and counties that did not receive an ARRA energy grant.

I run the model on the two groups of counties separately using solar energy net

generation (MWH) as the dependent variable. I use the first ARRA grants measure equal

to 1 in the year in which a county received an ARRA grant and subsequent years, lagged

by one year. Therefore, both models are the same except for the sample of counties in

each model. Figure 6.11 shows the differences in the estimated impacts of receiving an

ARRA energy grant on solar energy production for counties in hot climate regions

compared to counties in cold climate regions.

---

[56] The Building Technologies Office publishes this guide for home builders through the U.S. Department of
Energy's Building America Program. There are other programs and data sources for climate regions that
are defined differently.

Figure 6.11
The Effect of Receiving an ARRA Renewable Energy Grant on
Hot Climate Zones Versus Cold Climate Zones
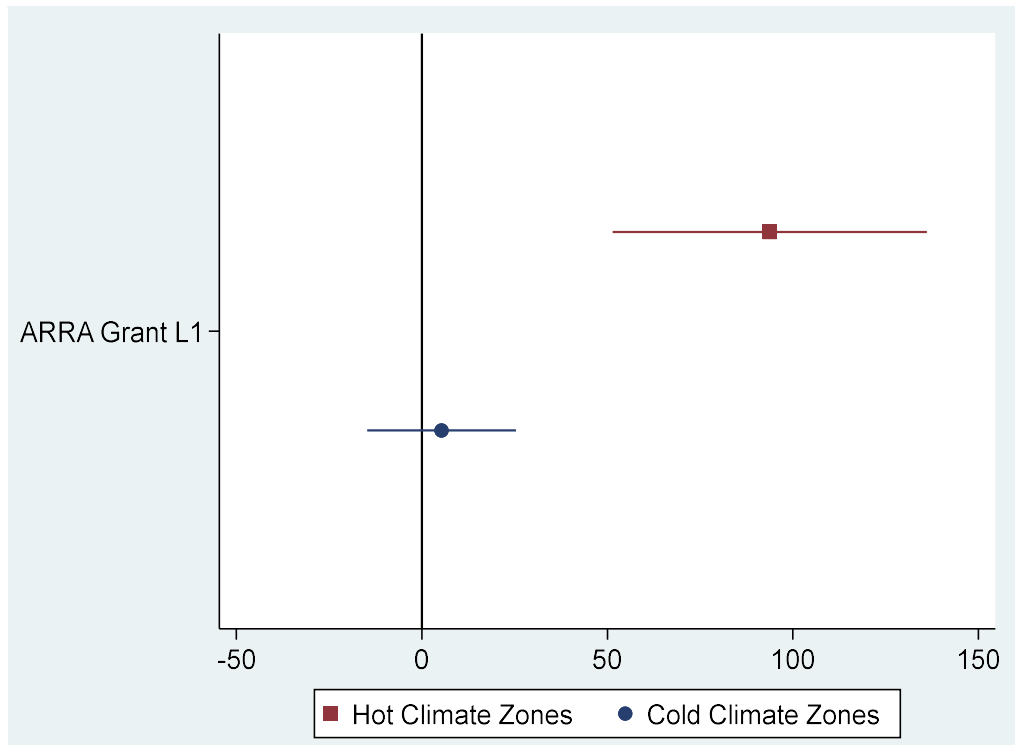
Dividing the data by climate region shows differences for the impact of ARRA

grants on solar energy production. Receiving an ARRA grant is not significantly related

to solar energy production in counties located in cold climate zones, but it is significantly

related to solar energy production in counties in hot climate zones. Counties in hot

climate zones likely have more natural resources to develop solar energy. This could

imply that those counties are better able to utilize ARRA grants to produce solar energy

relative to producers in colder climate areas. However, this could also suggest that these

counties also had stronger preferences for ARRA energy grants, although these

preferences do not necessarily reduce the effectiveness of ARRA energy grants.

However, the binary measure of climate region does not completely capture the nuances

of different climate conditions. Future analyses could more fully explore the impact of energy grants by region and the role of preferences as data become available.

I also consider regional climate policy efforts that could have impacted energy production. There were regional efforts by groups of states to develop renewable energy before the distribution of ARRA grants. Three notable regional efforts include the Regional Greenhouse Gas Initiative (RGGI) of 2009 by nine states to cap carbon dioxide emissions; the Western Climate Initiative (WCI) of 2007 by California and Canadian provinces to implement a cap and trade program; and the Pacific Coast Collaborative (PCC) of 2008 by four states to develop renewable energy ("Multi-State Initiatives," 2019). I test the effect of the lagged ARRA grant variable on solar energy production for counties in states that are members of each climate initiative. I also compare counties in states that were involved in any of the three climate initiatives to counties in states that were not involved in any of the three initiatives. Figure 6.12 shows the differences in the estimated impacts of receiving an ARRA energy grant on solar energy production for counties located in states involved in one of the three climate initiatives and non-member states.

Figure 6.12
The Effect of Receiving an ARRA Renewable Energy Grant
in States with a Regional Climate Initiative and Non-Member States
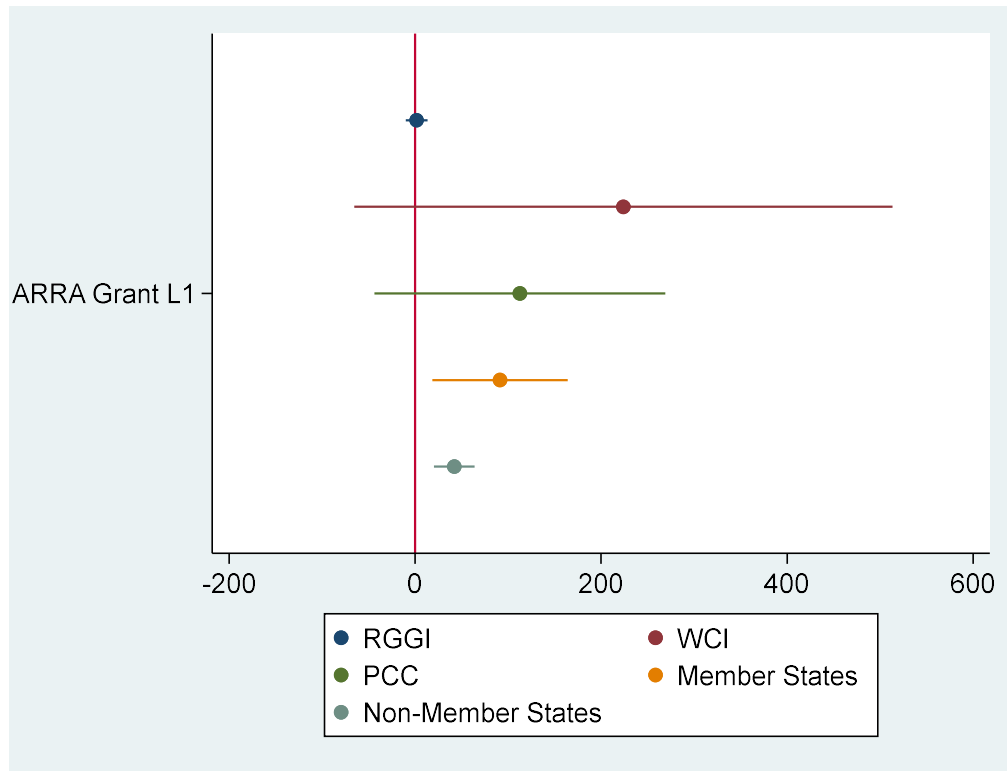
The coefficient plot above shows that ARRA grants do not have a statistically significant impact on solar energy production in counties located in member states of any of the three individual climate initiatives. However, the results may be restricted by the sample size.[57] The figure also shows the results for counties located within any member state compared to counties not located within a member state. The coefficient on ARRA grants is positively related to solar energy production in both models.[58] The result is

---

[57] The model for RGI has 910 observations, and the models for WCI and PCC have 378 and 778 observations, respectively.

[58] The member states model has 1,688 observations, and the non-member states model has 10,483 observations. Approximately seven percent of counties in the member states model had an ARRA grant recipient, and approximately 15 percent of counties in the non-member states model had an ARRA grant recipient.

significant at the five percent level in the member states model and one percent level in the non-member states model, although this could also be caused by the increased sample size in the non-member states model. Therefore, the results do not suggest that regional climate efforts to increase renewable energy production impacted the effectiveness of ARRA grants. This result, along with the results for state energy policies in the previous section, suggest that solar energy production continues to be highly decentralized in the U.S.

6.8 Conclusions

This chapter studies the effectiveness of one-time Section §1603 ARRA grants for renewable energy on solar energy net generation in counties. I hypothesized that renewable energy grants would have a positive and significant impact on solar energy production at the local level, which is supported by the findings and robustness checks. The results from a panel data model using power-producing counties from 2005 to 2014 suggest that receiving an ARRA grant increases solar energy net generation. The results also suggest that the magnitude increases over time and with the number of energy grants received. The robustness checks also suggest that grants may be more effective in hotter climate regions, which are expected to have more natural resources for solar energy but may also have recipients with stronger preferences for solar energy grants. The findings also suggest that local energy development is not tied to state or regional initiatives, implying that the effectiveness is tied to local implementation.

This chapter contributes to literature on grant effectiveness by using physical output as the dependent variable instead of local spending on energy. This is perhaps a

more precise measure to analyze the effectiveness of renewable energy grants, because the amount spent on renewable energy might not be strongly correlated with energy output. Both the amount spent on renewable energy and renewable energy capacity can vary by region, source, and technology. This chapter also contributes to the energy literature by utilizing a unique dataset to overcome an area of limited research. Data on renewable energy grants and spending are not typically reported or centrally collected.[59]

The findings in this chapter raise warrant considerations for future research on renewable energy grants. First, there are factors specific to ARRA's Section §1603 grants that might affect the generalizability of the results in this chapter. This program was implemented one time as part of a stimulus package following the economic recession of 2007 to 2009. While I control for economic conditions, there might be other economic factors or factors specific to the ARRA energy grant program that could impact the results. In this case, the results might not be generalizable to other types of energy grant programs, especially grants distributed annually through existing programs.

The findings also raise questions about how implementation of ARRA's energy grant program impacted grant effectiveness. ARRA required the DOE's Office of Energy Efficiency and Renewable Energy to "actively monitor" the progress of each grant-funded project ("American Recovery and Reinvestment Act Program Plan," 2009). We should expect the effectiveness of the program to be positively associated with the extent to which the Department of Energy monitored each project's progress. However,

---

[59] Data on grants through the Department of Energy's State Energy Program are reported annually. However, these data are combined with grants for energy efficiency and are available only at the state-level. These data also do not include other grants for renewable energy through the Department of Energy or other federal agencies.

monitoring requirements likely vary by program and the type of grant, suggesting that effectiveness might depend on implementation and metrics used to evaluate effectiveness.

Finally, some measures used in this study limited the ability to evaluate grant effectiveness. Although studying direct output is one contribution of this chapter, using renewable energy production as the dependent variable also limits the analysis. First, I am unable to determine whether federal funds crowded out local spending on renewable energy projects, even though the fixed effects likely capture some local preferences that lead to crowding out. Second, I use only one measure of energy production, net generation in megawatt hours. This measure takes into account the losses in energy production that occur from producing energy. Other measures exist, although some are not available for power plants. For example, total generation in megawatt hours and total energy production in BTUs are two alternative measures of energy production. Therefore, findings on grant effectiveness might vary based on the measure of renewable energy output.

The analysis in this chapter also raises additional research questions not specific to ARRA energy grants. This study considers the effect of renewable energy grants primarily for only one type of renewable energy, solar energy. This area of research is rich with additional questions that relate to decentralization and grant effectiveness. Future studies could explore the role of positive externalities from renewable energy production on the net aggregate effect of renewable energy production. Although renewable energy appeared to increase at the local level in counties with a grant recipient, did neighboring counties reduce energy production in response to positive spillovers?

What aggregate impact did the observed increase in renewable energy production have on aggregate renewable energy production? Future studies could also consider how grants interact with other local renewable energy policies and efforts, such as tax incentives and regulations.

The following concluding chapter provides an overview of the dissertation and briefly discusses contributions from each chapter. The chapter concludes with suggestions for future research.

CHAPTER SEVEN: CONCLUSIONS

7.1 Overview

This dissertation sought to explain why renewable energy provision remains decentralized in the United States despite large spillovers associated with renewable energy output. The focus on how institutional incentives affect funding choices offers an explanation as to why good provision may deviate from the optimal outcome suggested by normative economic theory. The approach builds on current literature by considering a legislator's initial choice of funding mechanism for good provision instead of evaluating the optimal outcome. This perspective helps to us to further understand the nuances in public funding decisions. This dissertation also contributes to energy policy studies by focusing on federal involvement in the decentralization of renewable energy in the United States, a perspective not currently considered in the literature. This approach connects the federal government's actions to support decentralized development to subnational efforts to adopt renewable energy in the United States.

Chapter Four constructs a theoretical model to explain how institutional incentives affect legislators' decisions on whether to support decentralized or centralized funding for goods. The model builds on current literature to include political price in the constraint on legislators' choices. Political price is loosely defined as the costs associated with passing a certain level of public good provision. The model treats the funding decision as the variable to show how the magnitude of the political price associated with decision making can affect a legislator's choice of decentralized or centralized good provision. The model shows that legislators can maximize their utility by choosing fiscal

transfers to fund decentralized renewable energy output when the political price of centralized renewable energy policymaking is high.

The simple theoretical model proposed in Chapter Four contributes to current literature by putting forth a different perspective to explain how institutional factors can lead legislators make decisions that deviate from normative economic theory. The perspective in this chapter is used to explain the unique case of renewable energy. However, the findings should not be limited to renewable energy, as suggested by the reference to previously decentralized education policy provision. A key component of the model is the consideration of political price, which extends beyond the monetary price typically used in constraint functions.

Chapter Five offers a direct empirical evaluation of the theoretical model proposed in Chapter Four by asking whether low political price of renewable energy policymaking decreases the probability that a legislator proposes a bill for decentralized funding for renewable energy. I created a proxy for low political price: whether Congress and the bill sponsor were majority Democrat at the time a legislator makes a funding decision. The findings show support for the hypothesis that legislators are less likely to propose funding for decentralized renewable energy when the political price is low. A robustness check finds weak support that legislators are more likely to propose funding for centralized renewable energy when political price is low.

Chapter Five explores the direct link between political price and funding decisions by analyzing data on decisions that have not been previously explored by the literature in this context. It considers the initial decision to choose a funding mechanism subject to the institutional constraints inherent in the policymaking process. This

perspective furthers our understanding of how the political price of a specific policy issue can affect legislative decisions on type of good provision. Additionally, it contributes to energy policy studies by explaining renewable energy grant distribution, which has been understudied in the literature. Future studies can enhance the discussion on political price by pondering a more specific definition.

Chapter Six provides a follow-up empirical analysis to further understand motivation to use renewable energy grants by evaluating renewable energy grant effectiveness. The empirical evaluation is based on the hypothesis that renewable energy grants increase renewable energy output at the local level and utilizes data on solar energy production aggregated at the county level. Findings suggest that localities with a renewable energy grant have significant increases in solar energy production, all else equal. This implies that renewable energy grants can be effective at the local level at generating small amounts of renewable energy, although the results are based on one-time, large sums of money relative to other renewable energy grant programs.

Chapter six offers additional support why legislators support decentralized renewable energy output even if it is not the most efficient way to increase renewable energy output by showing a positive association between grants and output at the local level. This analysis further contributes to grant effectiveness studies in energy policy by connecting grants to county-level energy production, an approach not currently explored in renewable energy studies.

7.2 Considerations for Future Research

The findings in this dissertation also raise several questions for future research. First, this dissertation focuses on legislators as the key actors in the policymaking process. The perspective considered here was necessary to explore decentralized funding for renewable energy but does not discount the significance of other actors in the policymaking process. Other actors could include the President, interest groups, other legislators, and legislative staff. For example, Hudak (2014) discusses the President's role in influencing the grant distribution process through bureaucratic control. Bordignon et al. (2008) evaluates social welfare under centralization and decentralization after accounting for lobbying interests. Future analyses could consider how the President or lobbyists influences legislators' initial decisions to propose a grant program or by clearly incorporating these actors into the political price variable.

The research in this dissertation also raises questions about what type of centralized renewable energy would be optimal. This dissertation focuses on decentralized renewable energy policy given the assumption that centralized renewable energy policy could more efficiently account for large, positive externalities resulting from renewable energy production. Even though normative theory makes a case for federal action, it is not necessarily clear that standard approaches to centralized policy in other countries would be optimal solutions for the U.S. As stated in Chapter Two, the predominant type of renewable energy resource varies by region, and different types of renewable energy resources are developed differently. Furthermore, the costs of renewable energy development vary by source, technology, and region ("Updated Capital Cost Estimate," 2016). Therefore, the efficiency of any centralized renewable energy

policy in the United States would be jointly determined by the degree to which heterogeneous jurisdictions were considered and the effectiveness of equalizing spillovers from local renewable energy production.

Similar to Wallis and Oates (1988), who measure the overall optimal degree of centralized spending, future analyses could consider the optimal amount of centralized renewable energy policy spending or policy output specifically. Oates and Portney (2003) provide guidelines for environmental policy provision by suggesting national intervention for disproportionate spillovers, arguing that the federal government could intervene to disseminate information and support research. They recommend local control over setting standards and establishing their own programs when benefits of those programs are contained within their respective jurisdictions. However, his logic applies when activities are not contained. As we have seen from other centralized policies, such as the Clean Air Act, centralized standards can be met with an element of local control. In this example, the federal government set minimum requirements for air quality and pollution restrictions but provided options for local governments to meet these requirements.[60]

One challenge with any future centralized energy policy will be implementing federal control over a policy area where state and local governments have been actively individually adopting renewable energy policy (Keeler, 2007). As discussed in Chapter One, subnational governments have been policies such as financial incentives and regulations to promote renewable energy development. However, any centralized policy does not have to preempt subnational efforts. Another challenge might be implementing centralized renewable energy policy in a country with a developed fossil fuel industry. It

---

[60] The Clean Air Act (42 U.S.C. §7401 et seq. (1970)) is a centralized policy that permits the U.S. Environmental Agency to set, enforce, and monitor national pollution standards.

is unclear from the literature if renewable energy and fossil fuels are complete substitutes. Owen (2006) argues that renewable energy would be competitive with traditional fossil fuel energy if fossil fuel energy included negative externalities in the price of fossil fuel, although natural gas is more competitive than both renewable energy and fossil fuel in terms of price. Future studies on renewable energy development can further advance the literature by fully considering the role of the federal and subnational governments in renewable energy provision, especially as renewable energy development progresses in the U.S.

Appendix A

Location of Renewable Energy Power Plants by Source

Biomass Energy Power Plants

U.S. Energy Mapping System, U.S. Energy Information Administration

Geothermal Energy Power Plants

U.S. Energy Mapping System, U.S. Energy Information Administration

Hydroelectric Energy Power Plants

U.S. Energy Mapping System, U.S. Energy Information Administration

Solar Energy Power Plants

U.S. Energy Mapping System, U.S. Energy Information Administration

Wind Energy Power Plants
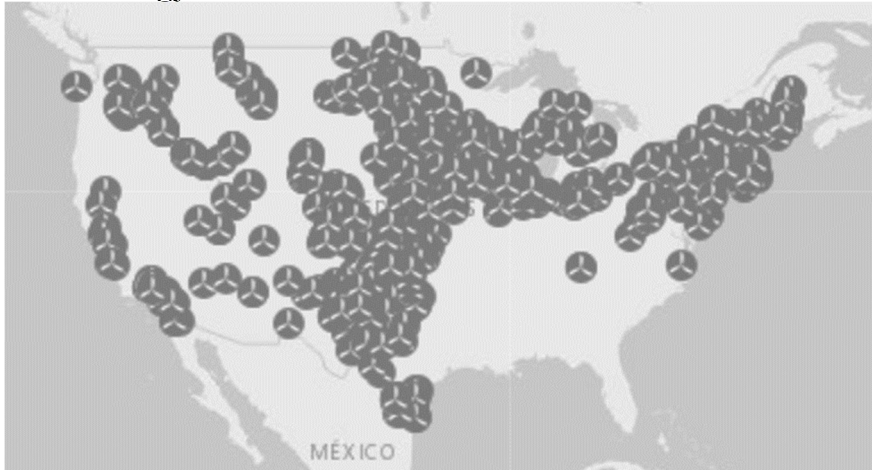
U.S. Energy Mapping System, U.S. Energy Information Administration

Appendix B

Summary Statistics 1

	Mean	Max	Min
Decentralized Funding for RE	0.1	1.0	0.0
Low Political Price	0.2	1.0	0.0
Centralized Funding for RE	0.1	1.0	0.0
Mentions Fossil Fuel Energy	0.4	1.0	0.0
Cosponsors	11.8	230.0	0.0
Bipartisan Support	0.2	1.0	0.0
Democratic Sponsor	0.5	1.0	0.0
Chamber Seniority	6.2	27.0	1.0
Committee Seniority	2.4	26.0	0.0
Energy Committee Member	0.4	1.0	0.0
RE Production Per Cap	0.3	2.2	0.0
FF Energy Production Per Cap	3.2	194.4	0.0
Energy Consumption Per Cap	3.4	11.8	1.8
Observations	1008		

Appendix C

Summary Statistics 2

	mean	max	min
ARRA Grant	0	1	0
ARRA Grants	0	51	0
RE Production	2409	368950	-11292
Sun Energy Production	21	17964	0
FF Energy Production	20292	606620	-2629
Income Per Capita	38229	199813	16664
Population	286	48400	0
Unemployment	7	29	1
July Max Temp	31	42	20
RPS or RE Goal	1	1	0
State RE Production	15330	110000	4
Observations	17954		

References

"1603 Program: Payments for Specified Energy Property in Lieu of Tax Credits." (n.d.)
U.S. Department of the Treasury. Retrieved December 2018 from
https://home.treasury.gov/policy-issues/financial-markets-financial-institutions-
and-fiscal-service/1603-program-payments-for.

"About the State Energy Program." 2019. U.S. Department of Energy. Office of Energy
Efficiency and Renewable Energy. Accessed March 2019 from
https://www.energy.gov/eere/wipo/about-state-energy-program.

Adler, E. S., and J. S. Lapinski. 1997. "Demand-Side Theory and Congressional
Committee Composition: A Constituency Characteristics Approach." *American
Journal of Political Science*, 41(3): 895-918.

Aldy, J. E. 2013. "Policy Monitor A Preliminary Assessment of the American Recovery
and Reinvestment Act's Clean Energy Package." *Review of Environmental
Economics and Policy*, 7(1): 136-155.

Alesina, A. and G. Tabellini. 1990. "A Positive Theory of Fiscal Deficits and
Government Debt," *Review of Economic Studies*, 57(3): 403-414.

Alesina, A., & Tabellini, G. 2007. "Bureaucrats or politicians? Part I: a single policy
task." *The American Economic Review*, 97(1): 169-179.

Alesina, A., & Tabellini, G. 2008. "Bureaucrats or politicians? Part II: Multiple policy
tasks." *Journal of Public Economics*, 92(3): 426-447.

Allers, M. A., & Vermeulen, W. 2016. "Capitalization of equalizing grants and the
flypaper effect." *Regional Science and Urban Economics*, 58: 115-129.

Andreoni, J. 1993. "An experimental test of the public-goods crowding-out hypothesis."
The American Economic Review, 83(5): 1317-1327.

Andreoni, J., & Payne, A. A. 2003. "Do government grants to private charities crowd out
giving or fundraising?" *American Economic Review*, 93(3): 792-812.

Andreoni, J., & Payne, A. A. 2011. "Is crowding out due entirely to fundraising?
Evidence from a panel of charities." *Journal of Public Economics*, 95(5), 334-
343.

"American Recovery and Reinvestment Act Program Plan for Office of Energy
Efficiency and Renewable Energy" 2009. Department of Energy. Retrieved from

https://www.energy.gov/sites/prod/files/edg/recovery/documents/Energy_Efficien cy_and_Renewable_Energy_Program_Plan.pdf.

Ashenfelter, Orley. 1978. "Estimating the effect of training programs on earnings". *Review of Economics and Statistics*. 60(1): 47-57.

Ashenfelter, Orley and Card, David. 1985. "Using the longitudinal structure of earnings to estimate the effect of training programs." *The Review of Economics and Statistics*, 67(4): 648-60.

Aslani, A., & Wong, K. F. V. 2014. "Analysis of renewable energy development to power generation in the United States." *Renewable Energy*, 63: 153-161.

Baechler, Michael C., Theresa L. Gilbride, Pam C. Cole, Marye G. Hefty, and Kathi Ruiz. 2015. "Volume 7.3: High-Performance Home Technologies: Guide to Determining Climate Regions by County." U.S. Department of Energy, Building Technologies Office. Prepared by Pacific Northwest National Laboratory.

Bahl, R., Linn, J. F., & Break, G. F. 1993. "Urban public finance in developing countries." *Journal of Economic Literature*, 31(4): 2019-2021.

Baicker, Katherine, Jeffrey Clemens, and Monica Singhal. 2011. "The Rise of the States: U.S. Fiscal Decentralization in the Postwar Period." *Journal of Public Economics*, 96(11-12): 1079-1091.

Bang, G. 2010. "Energy security and climate change concerns: Triggers for energy policy change in the United States?" *Energy Policy*, 38(4): 1645-1653.

Baron, D. 1991. "Majoritarian Incentives, Pork Barrel Programs, and Procedural Control," *American Journal of Political Science*, 35: 57-90.

Baron, D. P., & Ferejohn, J. 1987. "Bargaining and agenda formation in legislatures." *The American Economic Review*, 77(2): 303-309.

Baron, D. P., & Ferejohn, J. A. 1989. "Bargaining in legislatures." *American Political Science Review*, 83(4): 1181-1206.

Batley, S. L., Colbourne, D., Fleming, P. D., & Urwin, P. 2001. "Citizen versus consumer: challenges in the UK green power market." *Energy Policy*, 29(6): 479-487.

Battaglini, M., & Coate, S. 2008. "A dynamic theory of public spending, taxation, and debt." *American Economic Review*, 98(1): 201-36.

Beck, F., & Martinot, E. 2004. "Renewable energy policies and barriers." *Encyclopedia of Energy*, 5(7): 365-383.

Becker, G. 1976. "Toward a more general theory of regulation." *The Journal of Law and Economics*, 19(2): 245-248.

Becker, G. S. 1983. "A theory of competition among pressure groups for political influence." *The Quarterly Journal of Economics*, 98(3): 371-400.

Becker, E. 1996. "The illusion of fiscal illusion: Unsticking the flypaper effect." *Public Choice*, 86(1-2): 85-102.

Bergstrom, T., Blume, L., & Varian, H. 1986. "On the private provision of public goods." *Journal of Public Economics*, 29(1): 25-49.

Besley, T., & Coate, S. 1997. "An economic model of representative democracy." *The Quarterly Journal of Economics*, 112(1): 85-114.

Besley, T., & Coate, S. 2003. "Centralized versus decentralized provision of local public goods: a political economy approach." *Journal of Public Economics*, 87(12): 2611-2637.

Bird, Richard. 1986. "On Measuring Fiscal Centralization and Fiscal Balance in the Federal States." *Government and Policy*, 4(4): 385-404.

Bird, R., Dafflon, B., Jeanrenaud, C., & Kirchgässner, G. 2002. "Assignment of Responsibilities and Fiscal Federalism." In: *Conference Reader of the International Conference on Federalism*, 27–30. St. Gallen (CH), Federalism in a Changing World – Learning from Each Other.

Böhringer, C., Rosendahl, K. E., & Storrøsten, H. B. 2017. "Robust policies to mitigate carbon leakage." *Journal of Public Economics*, 149: 35-46.

Bollinger, Mark, Ryan Wiser, and Naim Darghouth. 2010. "Preliminary evaluation of the impact of the Section §1603 Treasury Grant Program on renewable energy deployment in 2009" LBNL Working Paper 3188E, Lawrence Berkeley National Laboratory

Bordignon, M., Colombo, L., & Galmarini, U. 2008. "Fiscal federalism and lobbying." *Journal of Public Economics*, 92(12): 2288-2301.

Bowman, J. H. 1974. "Tax exportability, intergovernmental aid, and school finance reform." *National Tax Journal*, 27(2): 163-173.

Bradford, D. F., & Oates, W. E. 1971a. "Towards a predictive theory of intergovernmental grants." *The American Economic Review*, 61(2): 440-448.

Bradford, D. F., & Oates, W. E. 1971b. "The analysis of revenue sharing in a new approach to collective fiscal decisions." *The Quarterly Journal of Economics*, 85(3): 416-439.

Bradford, D.F. & Oates, W.E. 1991. "Toward a Predictive Theory of Intergovernmental Grants" In *Oates, ed. Studies in Fiscal Federalism.* Brookfield, Vt.: Edward Elgar Publishing.

Brennan, G., & Pincus, J. J. 1996. "A minimalist model of federal grants and flypaper effects." *Journal of Public Economics*, 61(2): 229-246.

Bromley-Trujillo, R., Butler, J. S., Poe, J., & Davis, W. 2016. "The spreading of innovation: state adoptions of energy and climate change policy." *Review of Policy Research*, 33(5): 544-565.

Brown, M. A. 2001. "Market failures and barriers as a basis for clean energy policies." Energy policy, 29(14): 1197-1207.

Brueckner, J. K. 1999. "Fiscal federalism and capital accumulation." *Journal of Public Economic Theory*, 1(2): 205-224.

Brueckner, J. K. 2000. "Welfare reform and the race to the bottom: Theory and evidence." *Southern Economic Journal*, 66(3): 505-525.

Buchanan, J. M. 1950. "Federalism and fiscal equity." *The American Economic Review*, 40(4): 583-599.

Buchanan, J. M. 1952. "Federal grants and resource allocation." *The Journal of Political Economy*, 60(3): 208-217.

Buchanan, J. M., & Tullock, G. 1962. "The calculus of consent" Ann Arbor: University of Michigan Press.

Buchanan, J. M., & Wagner, R. E. 1970. "An efficiency basis for federal fiscal equalization." In *The Analysis of Public Output*. National Bureau of Economic Research: 139-162.

"CA1 Personal Income Summary: Personal Income, Population, Per Capita Personal Income" 2017. U.S. Bureau of Economic Analysis

Callahan, Richard, Sandra O. Archibald, Kay A. Sterner, and H. Brinton Milward. 2012. "Key actions that contribute to successful program implementation: Lessons from the recovery act." *Assessing the Recovery Act.* Washington, DC: IBM Center for the Business of Government.

Card, David, and Alan B. Krueger. 2000. "Minimum Wages and Employment: A Case Study of the Fast-Food Industry in New Jersey and Pennsylvania: Reply." *American Economic Review*, 90(5): 1397-1420.

Card, D., & Payne, A. A. 2002. "School finance reform, the distribution of school spending, and the distribution of student test scores." *Journal of Public Economics*, 83(1): 49-82.

Case, A. C., Rosen, H. S., & Hines, J. R. 1993. "Budget spillovers and fiscal policy interdependence: Evidence from the states." *Journal of Public Economics*, 52(3): 285-307.

Carley, S. 2009. "State renewable energy electricity policies: An empirical evaluation of effectiveness." *Energy policy*, 37(8): 3071-3081.

Carley, S. 2011. "The era of state energy policy innovation: A review of policy instruments." *Review of Policy Research*, 28(3): 265-294.

Charles Stewart III and Jonathan Woon 2017. "Congressional Committee Assignments, 103rd to 114th Congresses, 1993--2017: U.S. House of Representatives." Accessed Dec. 2017 from http://web.mit.edu/17.251/www/data_page.html#2.

Christiansen, N. 2013. "Strategic delegation in a legislative bargaining model with pork and public goods." *Journal of Public Economics*, 97: 217-229.

Chubb, J. E. 1985. "The political economy of federalism." *American Political Science Review*, 79(4): 994-1015.

Cogan, J. F., & Taylor, J. B. 2010. "What the government purchases multiplier actually multiplied in the 2009 stimulus package." (No. w16505). National Bureau of Economic Research.

Courant, P. N., Gramlich, E. M., & Rubinfeld, D. L. 1978. "The stimulative effects of intergovernmental grants: Or why money sticks where it hits." University of Michigan, Institute of Public Policy Studies.

Dahlberg, M., & Edmark, K. 2008. "Is there a 'race-to-the-bottom' in the setting of welfare benefit levels? Evidence from a policy intervention." *Journal of Public Economics*, 92(5): 1193-1209.

Dahlby, B. 2008. "The marginal cost of public funds: Theory and applications." MIT press.

Dahlby, B., & Ferede, E. 2016. "The stimulative effects of intergovernmental grants and the marginal cost of public funds." *International Tax and Public Finance*, 23(1): 114-139.

Davies, R. B., & Vadlamannati, K. C. 2013. "A race to the bottom in labor standards? An empirical investigation." *Journal of Development Economics*, 103: 1-14.

Davoodi, H., Zou, H., 1998. "Fiscal decentralization and economic growth: A cross-country study." *Journal of Urban Economics*, 43(2): 244-257.

DeBoer, J. 2012. "Centralization and decentralization in American education policy." *Peabody Journal of Education*, 87(4): 510-513.

Delmas, M. A., & Montes-Sancho, M. J. 2011. "US state policies for renewable energy: Context and effectiveness." *Energy Policy*, 39(5): 2273-2288.

Desposato, S. W., Kearney, M. C., & Crisp, B. F. 2011. "Using cosponsorship to estimate ideal points." *Legislative Studies Quarterly*, 36(4): 531-565.

Downs, A. 1957. "An economic theory of political action in a democracy." *The Journal of Political Economy*, 65(2): 135-150.

DSIRE. Database of State Incentives for Renewables & Efficiency. NC Clean Energy Technology Center. Accessed Mar. 2019.

Dunlap, R. E., & McCright, A. M. 2008. "A widening gap: Republican and Democratic views on climate change." *Environment: Science and Policy for Sustainable Development*, 50(5): 26-35.

Dunlap, R. E., McCright, A. M., & Yarosh, J. H. 2016. "The political divide on climate change: Partisan polarization widens in the US." *Environment: Science and Policy for Sustainable Development*, 58(5): 4-23.

Eckel, C. C., Grossman, P. J., & Johnston, R. M. 2005. "An experimental test of the crowding out hypothesis." *Journal of Public Economics*, 89(8): 1543-1560.

Egan, P. J., & Mullin, M. 2017. "Climate change: US public opinion." *Annual Review of Political Science*, 20: 209-227.

"Electric Power Annual: Table 4.1. Count of Electric Power Industry Power Plants, by Sector, by Predominant Energy Sources within Plant." 2018. U.S. Energy Information Administration. Retrieved Feb. 2019 from https://www.eia.gov/electricity/annual/pdf/epa.pdf.

"Electricity." 2017. U.S. Energy Information Administration. Retrieved from https://www.eia.gov/electricity/data/eia923/.

"Energy Efficiency and Conservation Block Grant Program." (n.d.) U.S. Department of Energy Office of Energy Efficiency and Renewable Energy. Retrieved from https://www.energy.gov/eere/wipo/energy-efficiency-and-conservation-block-grant-program.

"Energy from moving water." 2017. U.S. Energy Information Administration. Retrieved from https://www.eia.gov/energyexplained/?page=hydropower_home.

"Energy Jurisdiction." 2017. U.S. House of Representatives Energy and Commerce Committee. Accessed Mar. 2018 from http://energycommerce.house.gov.

Epple, D., & Nechyba, T. 2004. "Fiscal decentralization." *Handbook of Regional and Urban Economics*, 4: 2423-2480.

Epstein, D., & O'Halloran, S. 2001. "Legislative organization under separate powers." *Journal of Law, Economics, and Organization*, 17(2): 373-396.

Farhar, B.C., 1994. "Trends in US Public Perceptions and Preferences on Energy and Environmental Policy." *Annual Review of Energy and Environment*, 19: 211—239.

"Federal Financial Interventions and Subsidies in Energy in Fiscal Year 2016" 2018. U.S. Energy Information Administration. Retrieved Feb. 2019 from https://www.eia.gov/analysis/requests/subsidy/.

Feiock, R. C., Kassekert, A., Berry, F. S., & Yi, H. 2009. "Institutional incentives and early adoption of sustainable energy innovations." In *APSA 2009 Toronto Meeting Paper*.

Feiock, R. C., Francis, N., & Kassekert, T. 2010. "Explaining the adoption of climate change policies in local government. In *Midwest Political Science Association's annual meeting*, Chicago, IL, USA: 22-25.

Feldstein, M. 1975. "The income tax and charitable contributions: Part I—Aggregate and distributional effects." *National Tax Journal*, 28(1): 81-100.

Feldstein, M. S. 1975. "Wealth neutrality and local choice in public education." *The American Economic Review*, 65(1): 75-89.

Fenno, Richard F., Jr. 1973. "Congressmen in Committees." Boston: Little, Brown and Company.

Fenno, R. F. 1978. "Home style: House members in their districts." Boston: Little, Brown.

Fenno, R. F. 1977. "US House members in their constituencies: An exploration." *American Political Science Review*, 71(03): 883-917.

Ferejohn, J. 1986. "Incumbent performance and electoral control." *Public Choice*, 50(1): 5-25.

Filimon, R., Romer, T., & Rosenthal, H. 1982. "Asymmetric information and agenda control: The bases of monopoly power in public spending." *Journal of Public Economics*, 17(1): 51-70.

Fischlein, M., Feldpausch-Parker, A. M., Peterson, T. R., Stephens, J. C., & Wilson, E. J. 2014. "Which way does the wind blow? Analysing the state context for renewable energy deployment in the United States." *Environmental Policy and Governance*, 24(3): 169-187.

Fisher, Ronald C., 1982. "Income and Grant Effects on Local Expenditure: The Flypaper Effect and Other Difficulties," *Journal of Urban Economics*, 12(3): 324–45.

Fiorina, M. P., & Abrams, S. J. 2008. "Political polarization in the American public." *Annual Review of Political Science*, 11: 563-588.

Frey, B. S., & Eichenberger, R. 1999. "The New Democratic Federalism for Europe: Functional. Overlapping and Competing Jurisdictions." Cheltenham.

Galle, B. D., & Leahy, J. K. 2009. "Laboratories of democracy? Policy innovation in decentralized governments." *Emory Law Journal*, 58(6): 1333.

Gamkhar, S. 2000. "Is the response of state and local highway spending symmetric to increases and decreases in federal highway grants?" *Public Finance Review*, 28(1): 3-25.

Gamkhar, S. and H. Ali 2008. "Political economy of grant allocations: The case of federal highway demonstration grants." *Publius: The Journal of Federalism,* 38(1): 1-21.

"Global Renewable Energy." 2017. IEA/IRENA Joint Policies and Measures Database. International Energy Agency. Retrieved from https://www.iea.org/policiesandmeasures/renewableenergy/

Goett, A.A., Hudson, K. and Train, K.E. 2000. "Customers' Choice Among Retail Energy Suppliers: The Willingness-To-Pay for Service Attributes." *Energy Journal*, 21(4): 1-28.

Gordon, N. 2004. "Do federal grants boost school spending? Evidence from Title I." *Journal of Public Economics*, 88(9-10): 1771-1792.

Gramlich, E. M. 1977. "Intergovernmental Grants: A Review of the Empirical Literature", In *W.E. Oates, ed., The Political Economy of Fiscal Federalism*: 219-40.

Gramlich, E. M., Galper, H., Goldfeld, S., & McGuire, M. 1973. "State and local fiscal behavior and federal grant policy." *Brookings Papers on Economic Activity*, 1973(1): 15-65.

"Green Power Purchasing Goal for Federal Government." 2018. DSIRE. Retrieved Jun. 2018 from http://programs.dsireusa.org/system/program/detail/1060.

Grossman, Philip J. 1994. "A political theory of intergovernmental grants." *Public Choice*, 78(3-4): 295-303.

Hahn, R. W. 1990. "The political economy of environmental regulation: Towards a unifying framework." *Public Choice*, 65(1): 21-47.

Hamilton, B. W. 1983. "The flypaper effect and other anomalies." *Journal of Public Economics*, 22(3): 347-361.

Hamilton, J. H. 1986. "The flypaper effect and the deadweight loss from taxation." *Journal of Urban Economics*, 19(2): 148-155.

Hayek, F. A. 1945. "The use of knowledge in society." *The American Economic Review*, 35(4): 519-530

Heutel, G. 2014. "Crowding out and crowding in of private donations and government grants." *Public Finance Review*, 42(2): 143-175.

Hines, J. R., & Thaler, R. H. 1995. "Anomalies: The flypaper effect." *The Journal of Economic Perspectives*, 9(4): 217-226.

"How Much Electricity Does an American Home Use?" U.S. Energy Information Administration. Frequently Asked Questions. Retrieved Mar. 2019 from https://www.eia.gov/tools/faqs/faq.php?id=97&t=3.

Howe, Peter D., Matto Mildenberger, Jennifer R. Marlon, and Anthony Leiserowitz. 2015. "Geographic variation in opinions on climate change at state and local scales in the USA." *Nature Climate Change*, 5: 596–603.

Hudak, J. 2014. "Presidential pork: White house influence over the distribution of federal grants." Brookings Institution Press.

Iimi, A., 2005. "Decentralization and economic growth revisited: An empirical note." *Journal of Urban Economics*, 57(3): 449-461.

Inman, R. P. 1971. "Towards an econometric model of local budgeting." In *Proceedings of the Annual Conference on Taxation under the Auspices of the National Tax Association*, 64: 699-719.

Inman, R. P. 1979. "The fiscal performance of local governments: An interpretative review." *Current issues in urban economics*, The John Hopkins Press: Baltimore, 270-321.

Inman, R. P. 1987. "Federal assistance and local services in the United States: The evolution of a new federalist fiscal order." (No. 2283). National Bureau of Economic Research.

Inman, R. P. 1989. "Federal assistance and local services in the United States: The evolution of a new federalist fiscal order." (No. 2283). National Bureau of Economic Research Cambridge.

Inman, R. P. 2003. "Transfers and bailouts: Enforcing local fiscal discipline with lessons from US federalism." In *Fiscal decentralization and the challenge of hard budget constraints*. Cambridge, MA: MIT Press: 35-83.

Inman, R. P. 2008. "The flypaper effect." (No. w14579). National Bureau of Economic Research.

Inman, R. P. 2010. "States in fiscal distress." (No. w16086). National Bureau of Economic Research.

Inman, R. and D. Rubinfeld. 1997a. "Rethinking Federalism." *Journal of Economic Perspectives*. 11(4): 43-64.

Inman, R. P., & Rubinfeld, D. L. 1997b. "The political economy of federalism." In *Perspectives on Public Choice: A Handbook.* Mueller, ed. Cambridge University Press.

Inman, R. P. 2008. "The flypaper effect." (No. w14579). National Bureau of Economic Research.

Jaffe, A. B., Newell, R. G., & Stavins, R. N. 2005. "A tale of two market failures: Technology and environmental policy." *Ecological Economics*, 54(2-3): 164-174.

Janeba, E., & Schjelderup, G. 2009. "The Welfare Effects of Tax Competition Reconsidered: Politicians and Political Institutions." *The Economic Journal*, 119(539): 1143-1161.

Johnson, N. 2009. "Does the American Recovery and Reinvestment Act meet local needs?" *State and Local Government Review*, 41(2): 123-127.

"Jurisdiction." n.d. U.S. Senate Committee on Energy & Natural Resources. Accessed Mar. 2018 from www.energy.senate.gov.

Kahneman, Daniel, Jack Knetsch, and Richard H. Thaler. 1991. "Anomalies: The Endowment Effect, Loss Aversion and Status Quo Bias," *Journal of Economic Perspectives*, 5(1): 193–206.

Keeler, A. G. 2007. "State greenhouse gas reduction policies: a move in the right direction?" *Policy Sciences*, 40(4): 353-365.

Kellermann, M., & Shepsle, K. A. 2009." Congressional careers, committee assignments, and seniority randomization in the US House of Representatives." *Quarterly Journal of Political Science*, 4(2): 87.

Kiewiet, D. R., & McCubbins, M. D. 1991. "The logic of delegation." University of Chicago Press.

Knight, B. G. 2000. "Supermajority voting requirements for tax increases: evidence from the states." *Journal of Public Economics*, 76(1): 41-67.

Knight, B. 2002. "Endogenous federal grants and crowd-out of state government spending: Theory and evidence from the federal highway aid program." *American Economic Review*, 91(1): 71-92.

Knight, B. 2004. "Parochial interests and the centralized provision of local public goods: evidence from congressional voting on transportation projects." *Journal of Public Economics*, 88(3): 845-866

Knight, Brian. 2005. "Estimating the Value of Proposal Power." *American Economic Review*, 95(5): 1639-1652.

Knight, B. 2008. "Legislative representation, bargaining power and the distribution of federal funds: Evidence from the US congress." *The Economic Journal*, 118(532): 1785-1803.

Kolstad, C. D., & Toman, M. 2005. "The economics of climate policy." *Handbook of Environmental Economics*, 3: 1561-1618.

Konisky, D. M. 2007. "Regulatory competition and environmental enforcement: Is there a race to the bottom?" *American Journal of Political Science*, 51(4): 853-872.

Krehbiel, K. 1990. "Are congressional committees composed of preference outliers?" American Political Science Review, 84(1): 149-163.

Krehbiel, K. 2004. "Legislative organization." *Journal of Economic Perspectives*, 18(1): 113-128.

Krehbiel, K., Shepsle, K. A., & Weingast, B. R. 1987. "Why are congressional committees powerful?" *American Political Science Review*, 81(3): 929-945.

Krosnick, J. A., Holbrook, A. L., & Visser, P. S. 2000. "The impact of the fall 1997 debate about global warming on American public opinion." *Public Understanding of Science*, 9(3): 239-260.

Kydes, A. S. 2007. Impacts of a renewable portfolio generation standard on US energy markets. Energy Policy, 35(2): 809-814.

Laird, F. N., & Stefes, C. 2009. "The diverging paths of German and United States policies for renewable energy: Sources of difference." *Energy Policy*, 37(7): 2619-2629.

Leblanc, W., Snyder Jr, J. M., & Tripathi, M. 2000. "Majority-rule bargaining and the under provision of public investment goods." *Journal of Public Economics*, 75(1): 21-47.

Leduc, S., & Wilson, D. 2017. "Are State governments roadblocks to federal stimulus? Evidence on the Flypaper Effect of Highway Grants in the 2009 Recovery Act." *American Economic Journal: Economic Policy*, 9(2): 253-92.

Leduc, S., & Wilson, D. 2013. "Roads to prosperity or bridges to nowhere? Theory and evidence on the impact of public infrastructure investment." NBER Macroeconomics Annual, 27(1): 89-142.

Library of Congress. Accessed Jan.—Jun. 2018 from http://congress.gov.

Lockwood, B. 2002. "Distributive politics and the costs of centralization." *The Review of Economic Studies*, 69(2): 313-337.

Lockwood, B. 2005. "Centralized versus decentralized provision of local public goods: a legislative bargaining approach." University of Warwick Economics Working Paper.

Lockwood, B. 2008. "Voting, lobbying, and the decentralization theorem." *Economics & Politics*, 20(3): 416-431.

Longo, A., Markandya, A., & Petrucci, M. 2008. "The internalization of externalities in the production of electricity: willingness to pay for the attributes of a policy for renewable energy." *Ecological economics*, 67(1): 140-152.

Lorz, O., & Willmann, G. 2005. "On the endogenous allocation of decision powers in federal structures." *Journal of Urban Economics*, 57(2): 242-257.

Lutz, B. 2010. "Taxation with representation: Intergovernmental grants in a plebiscite democracy." *The Review of Economics and Statistics*, 92(2): 316-332.

"Maps" (n.d.) U.S. Department of Energy, National Renewable Energy Laboratory. Retrieved Nov. 2017 from https://www.nrel.gov/gis/maps.html.

Margolis, R. M., & Kammen, D. M. 1999. "Evidence of Under-investment in Energy R&D in the United States and the Impact of Federal Policy." *Energy Policy*, 27(10): 575-584.

Mayhew, David R. 1974. Congress: The Electoral Connection. New Haven: Yale University Press.

McClure Jr, C. E. 1999. "The tax assignment problem: Conceptual and administrative considerations in achieving subnational fiscal autonomy." In *Seminar on Intergovernmental Fiscal Relations and Local Financial Management*. National Economic and Social Development Board of the Royal Thai Government and the World Bank, Chiang Mai, Thailand, February.

McClure, C. E., Jr. 2001."The Tax Assignment Problem: Ruminations on How Theory and Practice Depend on History." National Tax Journal, 54(2): 339-363.

McCright, A. M., & Dunlap, R. E. 2003. "Defeating Kyoto: The conservative movement's impact on US climate change policy." *Social Problems*, 50(3): 348-373.

Megdal, S. B. 1987. "The flypaper effect revisited: An econometric explanation." *The Review of Economics and Statistics*, 69(2): 347-351.

Menanteau, P., Finon, D., & Lamy, M. L. 2003. "Prices versus quantities: choosing policies for promoting the development of renewable energy." *Energy policy*, 31(8): 799-812.

Menz, F. C., & Vachon, S. 2006. "The effectiveness of different policy regimes for promoting wind power: Experiences from the states." Energy policy, 34(14): 1786-1796.

Moniz, Ernest. 2015. "How we solve climate change." U.S. Department of Energy. Retrieved Sept. 2016 from http://energy.gov/articles/how-we-solve-climate-change.

Mouw, C. J., & Mackuen, M. B. 1992. "The strategic agenda in legislative politics." *American Political Science Review*, 86(1): 87-105.

"Multi-State Initiatives." 2019. Center for Climate and Energy Solutions. Retrieved Mar. 2019 from https://www.c2es.org/content/multi-state-initiatives/.

Musgrave, Richard A. 1959. Theory of Public Finance: A Study in Public Economy. NY: McGraw-Hill.

Musgrave, R. A. 1961. "Approaches to a fiscal theory of political federalism." In *Public Finances: Needs, Sources, and Utilization*. Princeton University Press: 97-134.

Niskanen, William A. 1971. Bureaucracy and Representative Government. Transaction Books.

Niskanen, William A. 1975. "Bureaucrats and politicians." *Journal of Law and Economics*, 18(3): 617-643.

Niskanen, William A., Jr. 1991. "A Reflection on Bureaucracy and Representative Government." In Blais André Blaise and Stéphane Dion, Eds., *The Budget Maximizing Bureaucrat: Appraisals and Evidence.* Cambridge University Press: 13–31.

Niskanen, W. A. 2008. Reflections of a political economist. Cato Institute.

Oates, Wallace E. 1972. Fiscal federalism. NY: Harcourt Brace Jovanovich.

Oates, Wallace. 1991. Studies in Fiscal Federalism. Brookfield, Vt.: Edward Elgar Publishing.

Oates, Wallace E. 1993. "Fiscal decentralization and economic development." *National Tax Journal*, 46(2): 237-243.

Oates, W. E. 1996. Taxation in a federal system: the tax-assignment problem. University of Maryland, Department of Economics.

Oates, W. E. (1979). "Lump-sum intergovernmental grants have price effects." In Mieszkowski, Peter, and William H. Oakland, Eds., *Fiscal Federalism and Grants-in-Aid*: 23-30.

Oates, Wallace E. 1999. "An essay on fiscal federalism." *Journal of Economic Literature*, 37(3): 1120-1149.

Oates, W. E. 2005. "Toward a second-generation theory of fiscal federalism." *International Tax and Public Finance*, 12(4): 349-373.

Oates, W. E. 2008. "On the evolution of fiscal federalism: theory and institutions." *National Tax Journal*, 61(2): 313-334.

Oates, W. E., & Portney, P. R. 2003. "The political economy of environmental policy." *Handbook of Environmental Economics*, 1: 325-354.

Ostrom, V., Tiebout, C. M., & Warren, R. 1961. "The organization of government in metropolitan areas: a theoretical inquiry." *American Political Science Review*, 55(4): 831-842.

Office of Management and Budget. "Table 1.1—Summary of Receipts, Outlays, and Surpluses or Deficits (-): 1789–2024." Retrieved from https://www.whitehouse.gov/omb/budget/Historicals.

Office of Management and Budget. "Table 12.2—Total Outlays for Grants to State and Local Governments, by Function and Fund Group: 1940–2022." Retrieved from https://www.whitehouse.gov/omb/budget/Historicals.

Office of Management and Budget. "Table 12.3—Total Outlays for Grants to State and Local Governments, by Function, Agency, and Program: 1940–2018." Retrieved from https://www.whitehouse.gov/omb/budget/Historicals.

Ogawa, H., & Wildasin, D. E. 2009. "Think locally, act locally: Spillovers, spillbacks, and efficient decentralized policymaking." *American Economic Review*. 99(4): 1206-1217.

Olmsted, G. M., Denzau, A. T., & Roberts, J. A. 1993. "We voted for this?: Institutions and educational spending." *Journal of Public Economics*, 52(3): 363-376.

Olney, W. W. 2013. "A race to the bottom? Employment protection and foreign direct investment." *Journal of International Economics*, 91(2): 191-203.

Osborne, M. J., & Slivinski, A. 1996. "A model of political competition with citizen-candidates." *The Quarterly Journal of Economics*, 111(1): 65-96.

"Overview and Status Update of the §1603 Program" 2017. U.S. Department of the Treasury: Recovery Act. Retrieved Feb. 2018 from https://www.treasury.gov/initiatives/recovery/Pages/recovery-act.aspx

Owen, A. D. 2006. "Renewable energy: Externality costs as market barriers." Energy *Policy*, 34(5): 632-642.

Painuly, J. P. 2001. "Barriers to renewable energy penetration; a framework for analysis." *Renewable Energy*, 24(1): 73-89.

Pasqualetti, M. J. 2000. "Morality, space, and the power of wind-energy landscapes." *Geographical Review*, 90(3): 381-394.

Payne, A. A. 1998. "Does the government crowd-out private donations? New evidence from a sample of non-profit firms." *Journal of Public Economics*, 69(3): 323-345.

Peltzman, S. 1976. "Toward a more general theory of regulation." *Journal of Law and Economics*, 19(2): 211-240.

Persson, T., & Tabellini, G. 1994. "Does centralization increase the size of government?" *European Economic Review*, 38(3): 765-773.

Persson, T., Roland, G., & Tabellini, G. 2000. "Comparative politics and public finance." *Journal of Political Economy*, 108(6): 1121-1161.

Persson, T., & Tabellini, G. E. 2000. Political Economics: Explaining Economic Policy. MIT press.

Persson, T., & Tabellini, G. 2002. "Political economics and public finance." *Handbook of Public Economics*, 3: 1549-1659.

Peterson, P. E. 2012. The Price of Federalism. Brookings Institution Press.

Pigou Arthur, C. 1920. The Economics of Welfare. London, McMillan.

Potoski, M. 2001. "Clean air federalism: Do states race to the bottom?" *Public Administration Review*, 61(3): 335-343.

"Program Evaluation" 2015. U.S. Department of Energy Office of Energy Efficiency and Renewable Energy. Retrieved Jun. 2017 from https://www.energy.gov/eere/wipo/about-energy-efficiency-and-conservation-block-grant-program.

"Proposal: Affordable Clean Energy (ACE) Rule." 2018. U.S. Environmental Protection Agency. Retrieved Feb. 2019 from https://www.epa.gov/stationary-sources-air-pollution/proposal-affordable-clean-energy-ace-rule.

Qian, Y., & Weingast, B. R. 1997. "Federalism as a commitment to preserving market incentives." *The Journal of Economic Perspectives*, 11(4): 83-92.

Rabe, Barry G. 2007. Can Congress Govern the Climate? Washington, DC: Brookings Institutions and John Brademas Center for the Study of Congress.

Rabe, Barry G. 2008. "States on steroids: the intergovernmental odyssey of American climate policy." *Review of Policy Research*, 25(2): 105-128.

Rabe, B. 2011. "Contested federalism and American climate policy." *Publius: The Journal of Federalism*, 41(3): 494-521.

"Recovery Act Recipient Data." 2017. U.S. Department of Energy. Received Jan. 2018 from https://www.energy.gov/downloads/recovery-act-recipient-data.

"Recovery Act." n.d. U.S. Department of Energy. Accessed Dec. 2016 at https://www.energy.gov/recovery-act.

"Renewable Energy Explained." 2018. U.S. Energy Information Administration. Accessed Dec. 2018 from https://www.eia.gov/energyexplained/?page=renewable_home.

Roberts, R. D. 1984. "A positive model of private charity and public transfers." *The Journal of Political Economy*, 92(1): 136-148.

Roberts, R. D. 1987. "Financing public goods." *Journal of Political Economy*, 95(2): 420-437

Rodden, J. 2003. "Reviving Leviathan: fiscal federalism and the growth of government." *International Organization*, 57(4): 695-729.

Roe, B., Teisl, M.F., Levy, A., and Russell, M. 2001. "US consumers' willingness to pay for green electricity." *Energy Policy*, 29(11): 917-925.

Samuelson, Paul A. 1954. "The Pure Theory of Public Expenditure." *Review of Economics and Statistics*, 36(4): 387–389.

Samuelson, Paul A. 1955. "Diagrammatic Exposition of a Theory of Public Expenditure." *Review of Economics and Statistics*, 21: 350–356.

Sautter, John A., and Kari Twaite. 2009 "A Fractured Climate? The Political Economy of Public Utility Commissions in an Age of Climate Change." The Electricity Journal 22: 68-76.

Schneider, Saundra K., and William G. Jacoby. 2012. "Are Americans 'Intuitive Federalists'?" Paper presented at the 2012 Annual Meetings of the Midwest Political Science Association.

Schragger, Richard. 2016. City Power: Urban Governance in a Global Age. New York: Oxford University Press.

Schwab, R. M., & Oates, W. E. 1991. "Community composition and the provision of local public goods: A normative analysis." *Journal of Public Economics*, 44(2): 217-237.

Segendor, B. 1998. "Delegation and threat in bargaining." *Games and Economic Behavior*, 23(2): 266-283.

Shepsle, K. A., & Weingast, B. R. 1987. "The institutional foundations of committee power." *American Political Science Review*, 81(1): 85-104.

Singhal, M. 2008. "Special interest groups and the allocation of public funds." *Journal of Public Economics*, 92(3): 548-564.

Sovacool, B. K. 2008. "The best of both worlds: Environmental federalism and the need for federal action on renewable energy and climate change." Stan. Envtl. LJ, 27: 397.

Sovacool, Benjamin. K. 2009. "The Importance of Comprehensiveness in Renewable Electricity and Energy-Efficiency Policy." *Energy Policy*, 37(4): 1529-1541.

"State and Local Government Finances Summary: 2010" Census Bureau. State & Local Government Finance. Retrieved Mar. 2016 from http://www2.census.gov.

"State Energy Production Estimates, 1960 Through 2015." n.d. State Energy Data System (SEDS) Report Archives. U.S. Energy Information Administration. Retrieved Nov. 2017 from https://www.eia.gov/state/seds/archive/#2015.

"State Renewable Portfolio Standards and Goals." 2019. National Conference of State Legislatures. Retrieved Mar. 2019 from http://www.ncsl.org/research/energy/renewable-portfolio-standards.aspx.

Stewart III, C., & Woon, J. 2017. Congressional committee assignments, 103rd to 115th Congresses, 1993–2017. Senate, Jun., 24.

Stoutenborough, J. W., Bromley-Trujillo, R., & Vedlitz, A. 2014. "Public support for climate change policy: consistency in the influence of values and attitudes over time and across specific policy alternatives." *Review of Policy Research*, 31(6): 555-583.

Strumpf, K. S. 2002. "Does government decentralization increase policy innovation?" *Journal of Public Economic Theory*, 4(2): 207-241.

Table 1.3 Democratic and Republican Seats in the House, by Region, 69th – 115th Congresses, 1925-2017. The Brookings Institution. Vital Statistics on Congress. Accessed May 2018 from http://brookings.edu.

Table 1.5 Democratic and Republican Seats in the Senate, by Region, 69th – 115th Congresses, 1925-2017. Accessed May 2018 from http://brookings.edu.

Table 12.3—Total Outlays for Grants to State and Local Governments, by Function, Agency, and Program: 1940—2019. (2019). Office of Management and Budget. Retrieved from https://www.whitehouse.gov/omb/historical-tables/.

Table P5B. Primary Energy Production Estimates, Renewable and Total Energy, in Trillion Btu, Ranked by State, 2016. 2019. U.S. Energy Information Administration State Energy Data System (SEDS): 1960-2016. Retrieved Mar. 2019 from https://www.eia.gov/state/seds.

Talbert, J. C., & Potoski, M. 2002. "Setting the legislative agenda: The dimensional structure of bill cosponsoring and floor voting." *Journal of Politics*, 64(3): 864-891.

Terman, J., & Feiock, R. 2014. "Third-party federalism: Using local governments (and their contractors) to implement national policy." *Publius: The Journal of Federalism*, 45(2): 322-349.

Terman, J. N., Kassekert, A., Feiock, R. C., & Yang, K. 2016. "Walking in the shadow of Pressman and Wildavsky: expanding fiscal federalism and goal congruence theories to single-shot games." *Review of Policy Research*, 33(2): 124-139.

Thaler, Richard H. 1990. "Anomalies: Saving, Fungibility, and Mental Accounts," *Journal of Economic Perspectives*, 4: 193–20.

"The Clean Power Plan." 2017. Union of Concerned Scientists. Retrieved 2017 from http://www.ucsusa.org/our-work/global-warming/reduce-emissions/what-is-the-clean-power-plan.

Tiebout, Charles M. 1956. "A Pure Theory of Local Expenditures." *Journal of Political Economy*. 64(5): 416-424

Tommasi, M., & Weinschelbaum, F. 2007. "Centralization vs. Decentralization: A Principal-Agent Analysis." *Journal of Public Economic Theory*, 9(2): 369-389.

Turnbull, G. K. 1992. "Fiscal illusion, uncertainty, and the flypaper effect." *Journal of Public Economics*, 48(2): 207-223.

"Updated Capital Cost Estimates for Utility Scale Electricity Generating Plants" 2016. U.S. Energy Information Administration. Retrieved Mar. 2019 from https://www.eia.gov/analysis/studies/powerplants/capitalcost/.

U.S. Census Bureau, Census of Population and Housing. Retrieved from https://www.census.gov/prod/www/decennial.html.

U.S. Census Bureau, TIGER data files. Retrieved from https://www.census.gov/geo/maps-data/data/tiger.html.

U.S. Bureau of Labor Statistics. Local Area Unemployment Statistics. Retrieved from https://www.bls.gov/lau/.

U.S. Energy Mapping System. U.S. States State Profiles and Energy Estimates. U.S. Energy Information Admailistration. Retrieved Nov. 2017 from https://www.eia.gov/state/maps.php?v=Renewable.

Volden, C. and A. Wiseman. 2007. "Bargaining in Legislatures over Particularistic and Collective Goods," *American Political Science Review*, 101(1): 79-92.

Wallis, J. J., & Oates, W. E. 1988. "Decentralization in the public sector: An empirical study of state and local government." In *Fiscal federalism: Quantitative* studies. University of Chicago Press: 5-32.

Warr, P. G. 1982. "Pareto optimal redistribution and private charity." *Journal of Public Economics*, 19(1): 131-138.

Weicher, J. C. 1972. "Aid, expenditures, and local government structure." *National Tax Journal*, 25(4): 573-583.

Weingast, B. R. 2009. "Second generation fiscal federalism: The implications of fiscal incentives." *Journal of Urban Economics*, 65(3): 279-293.

Weingast, Barry R., and William J. Marshall. "The industrial organization of Congress; or, why legislatures, like firms, are not organized as markets." *Journal of Political Economy*, 96(1): 132-163.

Weingast, B. R., & Moran, M. J. 1983. "Bureaucratic discretion or congressional control? Regulatory policymaking by the Federal Trade Commission." *Journal of Political Economy*, 91(5): 765-800.

Weingast, B. R., Shepsle, K. A., & Johnsen, C. 1981. "The political economy of benefits and costs: A neoclassical approach to distributive politics." *The Journal of Political Economy*, 89(4) 642-664.

"What is renewable energy?" 2017. U.S. Energy Information Administration. Retrieved Nov. 2017 from https://www.eia.gov/energyexplained/?page=renewable_home.

"What is U.S. electricity generation by energy source?" n.d. U.S. Energy Information Administration. Retrieved Nov. 2017 from https://www.eia.gov/tools/faqs/faq.php?id=427&t=4.

Wildasin, D. E. 1991. "Income redistribution in a common labor market." *The American Economic Review*, 81(4): 757-774.

Wildasin, D. E. 2004. "The institutions of federalism: Toward an analytical framework." *National Tax Journal*, 57(2): 247-272.

Winer, S. L. 1983. "Some evidence on the effect of the separation of spending and taxing decisions." *Journal of Political Economy*, 91(1): 126-140.

Wiser, R., 2007. "Using Contingent Valuation to Explore Willingness to Pay for Renewable Energy: A Comparison of Collective and Voluntary Payment Vehicles." *Ecological Economics*, 62(3-4): 419-432.

Woon, J. 2008. "Bill sponsorship in Congress: the moderating effect of agenda positions on legislative proposals." *The Journal of Politics*, 70(1): 201-216.

Woon, J. 2009. "Issue Attention and Legislative Proposals in the US Senate." *Legislative Studies Quarterly*, 34(1): 29-54.

Wrede, M. 2006. "Uniformity requirement and political accountability." *Journal of Economics*, 89(2): 95-113.

Wüstenhagen, R., Wolsink, M., & Bürer, M. J. 2007. "Social acceptance of renewable energy innovation: An introduction to the concept." *Energy policy*, 35(5): 2683-2691.

Xie, D., Zou, H., Davoodi, H., 1999. "Fiscal decentralization and economic growth in the United States." *Journal of Urban Economics*, 45(2): 228-239.

Young, A. T., & Sobel, R. S. 2013. "Recovery and Reinvestment Act spending at the state level: Keynesian stimulus or distributive politics?" *Public Choice*, 155(3-4): 449-468

Zampelli, E. M. 1986. "Resource fungibility, the flypaper effect, and the expenditure impact of grants-in-aid." *The Review of Economics and Statistics*, 68(1): 33-40.

VITA

Whitney Michelle Davis

EDUCATION

Master of Public Policy   Aug. 2016
University of Kentucky, Martin School of Public Policy and Administration,
Lexington, KY

Bachelor of Science in Financial Economics (cum laude)   May 2010
Centre College, Danville, KY

PUBLICATIONS

Bromley-Trujillo, Rebecca, J. S. Butler, John Poe, and Whitney Davis. 2016. "The
Spreading of Innovation: State Adoptions of Energy and Climate Change Policy."
Review of Policy Research, 33(5): 544-565.

RESEARCH PRESENTATIONS

Association for Budgeting and Financial Management, Denver, CO   2018
"Learning from the Joneses: The Social learning Effect of Regional Councils of
Government on Municipal Fiscal Slack in Suburban Chicago"

Association for Budgeting and Financial Management, Seattle, WA   2016
"Analyzing the Effects of Decentralized Public Goods: The Case of Climate Policy"

Association for Budgeting and Financial Management, Washington, D.C.   2015
"Competing Economic and Political Interests in the Distribution of Energy Grants to
States"

American Society for Public Administration Conference, Chicago, IL   2015
"Diffusion of Local Renewable Energy Policies in the United States"

Southeastern Conference for Public Administration, Atlanta, GA   2014
"Predicting the Determinants of Renewable Energy and Energy Conservation Grants
from the Federal Government to States"

PROFESSIONAL EXPERIENCE

Legislative Research Commission, Frankfort, KY   2017—Present
Staff Economist

The Henry Clay Center for Statesmanship,
Transylvania University, Lexington, KY   2016—2017
Mentor

University of Kentucky, Lexington, KY
    Research Assistant   2013—2017
    Economics and Statistics Lecturer   2015—2016
    Teaching Assistant   2014—2016
    Graduate Assistant, Outreach Coordinator   2012—2013

Trinity Episcopal Church, Danville, KY   2009—2012
Financial Secretary and Administrative Assistant

PROFESSIONAL ACTIVITIES & HONORS

Association for Public Policy Analysis & Management   2014—Present
Hughes Award   2015
Delta Epsilon Iota Academic Honor Society   2014
Omicron Delta Epsilon Honor Society for Economics   2009