Punctuations in Policy Outputs: What does Policy Design have to do with it?

Chris Koski (corresponding author), Reed College, ckoski@reed.edu

Saba Siddiki, Syracuse University, ssiddiki@syr.edu

Tyler Brown, Indiana University-Purdue University Indianapolis, tyrbrown@umail.iu.edu

Abstract

An enduring challenge confronting policymakers is how to design and modify policies to yield outputs consistent with policy goals. This challenge would be made easier with more understanding about how changes to different elements of policy design impact policy outputs. Our paper links together scholarship on policy design and punctuated equilibrium theory in assessing whether changes in policy targets, policy instruments, and policy incentives have differing effects on the distributions of changes in policy outputs. In doing so, we test the implication that better designed institutions ought to change policies sufficient to produce outputs that respond to actual rather than concatenated demand. Our empirical examination is a study of net metering policy in the United States over the years 2007-2016.

Keywords

Punctuated equilibrium theory, policy change, energy policy, net metering policy

Paper prepared for the 3rd International Conference on Public Policy
June 28-June 30, 2017
Singapore

*** Working draft: Please do not cite without authors' permission ***

I. Introduction

Public policies are designed and changed to yield outputs consistent with policy goals (Bobrow and Dryzek 1987). Policies undergo maintenance and periodic modification in response to shifting policy goals, problems, and conditions and in response to assessments about policy efficacy (Peters and Pierre 1998). Given, however, that policy environments are fundamentally dynamic (Ostrom and Basurto 2010), and that information regarding policy efficacy abounds, the following policy process questions elicit attention: When do policies change? How do policies change? Do changes to one element of a policy have differing effects on policy outputs than changes to another?

A central tenet of information processing theories, like punctuated equilibrium theory, is that public policy responses to changes in demand do not occur in a friction-less environment (Baumgartner and Jones 1993). Ideally, policymakers would adjust policies to respond to suboptimal changes in outputs relative to goals or to changes in societal goals with relative frequency (Workman and Koski 2017). However, features of human cognition and the design of governance structures prevent such an ideal world (Jones 1994). Thus, rather than policy design updating on a regular basis with a full information search leading to a full range of policy changes, most public policies are adjusted incrementally with occasional major shifts (Baumgartner and Jones 1993).

Our investigation links together scholarship on policy design and punctuated equilibrium theory to assess the relationship between changes in policy design and policy output changes. Our analysis of changes in policy design accounts for changes on three elements – policy targets, policy instruments, and policy incentives (Schneider and Ingram 1997). Our study explores policy design change in relation to policy outputs across multiple policies over a multi-year period. In general, scholarship on policy design offers important insight on the role that changes in design can have for changes in policy outputs or outcomes derived from single, qualitative case studies. However, this scholarship offers little insight about how changes in design lead to different distributions of changes in policy outputs. Integrating scholarship on policy design and punctuated equilibrium theory, we empirically test the implication that policymakers ought to change policies sufficient to produce outputs that respond to actual rather than concatenated demand. In other words: we test the relationship between changes in policy design and punctuated policy outputs.

Our empirical examination is a study of net metering policy design instruments in the United States. Net metering policies create opportunities for residential, commercial, and industrial electricity customers to sell back any onsite excess energy generation. Net metering policies vary in many ways, but along similar dimensions – specifically how much energy utilities must accept from customer generation, eligible electricity sources, and the relative capacity of onsite energy generation.

Net metering policies provide a good case for examining the relationship between policy design and a distributional analysis of policy outputs. Punctuated equilibrium theory has leveraged sub-governmental studies, particularly in the U.S., to describe and analyze patterns of agenda and policy change over time. We collect and code net metering policy design changes over ten years across four policy target, instrument, and incentive measures common to all states devising net metering policies. We then conduct a distributional analysis of changes in policy outputs over the same period to examine the relationship between changes in instruments and changes in outputs. While generally increasing over time, our analysis finds a wide range of distributions of demand responses in the American states relative to policy design in net metering policy. While still exploratory in nature, our analysis finds a relationship between policy designs that change more frequently and less punctuated distributions of outputs; a relationship suggestive of the benefits of adaptive design.

II. Literature Review: Policy Design and Punctuated Equilibrium Theory

Policy Design

Policy design refers to the content or substance of policy (Howlett and Lejano 2013; Schneider and Ingram, 1997). It is through policy design that policymakers convey policy goals, to whom a policy applies, the particular mechanisms or instruments intended to compel the behavior of policy targets to achieve policy goals, incentives and sanctions for performing certain policy activities, and instructions for policy implementation (Howlett 2009; Schneider and Ingram 1997). Also embedded within a policy's design is an implicit causal logic linking instruments, targets, goals; an expectation that the performance of certain activities by policy targets will result in certain outputs or outcomes.

Scholarship on policy design to date generally focuses on categorizing policies, describing policies, and/or analyzing the antecedents and effects of policy design. Scholarship that focuses on categorizing policy takes policies in their entirety and labels them by type. For example, policies are labeled as substantive and procedural (Anderson, 1979), material and symbolic

(Edelman, 1964), distributive, redistributive, and regulatory (Lowi, 1980), and liberal and conservative based on their function or in relation to the political contexts in which they are developed. These examples of policy typologies are helpful for conveying general information about the intent of policies, but lack conceptual precision or a well-defined logic connecting policies and contextual attributes or policy effects. Slightly more useful for analyzing the link between policies and policy behavioral effects are typologies that classify policies based on the kinds of instruments used to compel behavior and their degree of coerciveness (e.g, regulatory or incentive-based), as these are grounded in behavioral assumptions (Salamon, 2002).

Policy design scholarship that focuses on describing policy offers a bit more conceptual precision and offers an analytical platform for connecting policy design attributes and policy effects. In this camp of policy design research, scholars seek to identify a common architecture of policies (Howlett, 2009: Ostrom, 2005; Schneider and Ingram, 1997). Two leading approaches for analyzing the design of governing rules are offered by Schneider and Ingram (1997) and Ostrom (2005). The following discussion focuses on their approaches for studying policy design.

As previously noted, Schneider and Ingram (1997) suggest that most policies explicitly identify policy goals, targets, instruments, incentives, and instructions for policy implementation and imply a causal logic connecting these elements. Ostrom (2005) suggests that policies (formal and informal) are typically comprised of constellations of directives that identify who is eligible to participate in policy relevant decision situations, positions individuals can hold within these situations, allowable, required, and forbidden activities, how information is conveyed within decision situations, collective decision making, expected outcomes of different actions, and finally, rewards and sanctions for compliance with policy directives.

By pointing to common elements of policy designs, both Schneider and Ingram's and Ostrom's approaches offer bases for analyzing whether changes in the features of a policy's design are associated with changes in policy outcomes. Furthermore, they offer bases, within carefully crafted comparative research designs, for comparing how differences in features of policy design across policies yield different policy outcomes. Both Schneider and Ingram and Ostrom explicitly acknowledge the importance of understanding policy change. A guiding assumption under Schneider and Ingram's approach to understanding policy design is that changes to policy tend to be incremental as policymakers generally have an incentive to maintain popular status quo positions (Schneider and Ingram, 1988). Large scale changes can reflect shifts in political power and associated reconsideration about how public resources are allocated and to whom. Ostrom asserts that social processes and the contexts in which they occur are fundamentally dynamic and that tools developed to study the rules governing behavior must be able to capture how the latter changes over time (Ostrom and Basurto, 2010).

A significant amount of research has been published over the last two decades using both Schneider and Ingram's and Ostrom's approaches as the bases of policy design case studies (see Ostrom 2007 and Ingram et al. 2007 for references to published research using these approaches). Scholars using Schneider and Ingram's approach explore how, through policy design, policymakers convey policy benefits and policy burdens to policy targets based on how the latter are socially constructed and how politically powerful they are. Much of this work links the relationship between policy design and the distribution of policy benefits and burdens to larger implications about democratic governance. The majority of studies employing Ostrom's approach analyze how features of governing rules influence collective decision making, regarding natural resource management. Ostrom's approach is explicitly applicable to governing rules adopted by a government entity (i.e., policies, laws, regulations) as well as those that are unwritten, but tacitly understood by individuals belonging to a particular community (Ostrom, 2005).

Most of the studies employing either Schneider and Ingram's or Ostrom's approach are qualitative case studies. They typically offer a rich account of the design of governing rules and often how they are interpreted (or the implications thereof) for relevant phenomenon. However, from these case studies, it is difficult to draw generalizable conclusions or causal explanation. Additionally, while change in governing rules is explicitly acknowledged in relation to both approaches as being a critical policy phenomenon, the topic has been relatively understudied or addressed anecdotally. To contribute understanding on the relationship between policy design and policy effects that address the aforementioned limitations, in this study, we apply quantitative techniques to assess effects of changes in policy goals, instruments, and incentives over time on changes in policy outputs using policy data for fifty states over a multi-year period. We base our analysis on three of Schneider and Ingram's policy design categories – targets, instruments, and incentives – as these are common to both of the leading policy design description approaches discussed in this section. In analyzing outputs, we seek to determine how policy outputs change in response to changes in policy targets, instruments, and incentives. To guide our expectations, we rely on a policy process theory oriented toward explaining policy stasis and policy change: punctuated equilibrium theory (PET). Integrating scholarship on policy design with scholarship on PET allows us to entertain assumptions about how policies are likely to change, the stimuli that motivate change, and associations between changes in policy design and policy outputs.

Punctuated Equilibrium Theory

There exists very little literature linking punctuated equilibrium theory formally to policy design. Punctuated equilibrium theory can be characterized as a macro-theory of public policy processes, while studies of policy design necessarily focus on characteristics of public policies.

Punctuated equilibrium theory is a unified theory of public policy that has been applied to subnational and national governments across the world (Baumgartner and Jones 1993; Jones and Baumgartner 2005; Baumgartner et al 2006; Breunig and Koski 2009; Green-Pederson and Walgrave 2014). Broadly speaking, the theory is one that understands public policy to be a function of the information processing capacity of governing institutions that must identify and solve problems. Most of the work in PET is focused on agenda-setting through hearings (Baumgartner et al 2009) or public budgeting (Breunig 2006; Breunig and Koski 2006, 2012; Jones et al 2009), however there are multiple applications of PET to public laws (Jones and Whyman 2014) and to media (Wolfe 2012, 2013).

Two central features of PET are that preferences are fixed and that attention is scarce. The theory starts with an understanding of a model of individual decision – making as boundedly rational – a position taken by nearly all major policy theories. Jones' (1994, 2001) work on decision-making argues that not only is attention scarce, but that each individual has a finite capacity. While other theories of public policy processes are interested in understanding how and why beliefs change (see scholarship on the Advocacy Coalition Framework), PET understands individual decision-making to occur as a function of shifts in attention. Individuals have certain items to which they naturally attend and then intermittently attend literally everything else. As individuals are faced with new issues for which they have limited information, they rely on heuristics to make quick decisions rather than engage in a full information search. Full information searches for problems are not only impractical for the individual, but are also generally not possible. Thus, it is that individuals making intermittent decisions for which they have little information are likely going to make choices that come close to, perhaps even asymptotically approach, but never reach their ideal choice.

PET argues that the same constraints on individual decision-making are felt at the institutional level. Institutions have limited attention spans, fixed preferences – either from the individuals who inhabit them or from limitations placed on their search as a function of their organizational mandate, and engage in imperfect information searches. To combat issues related to information processing – both capacity and attention – institutions can choose to delegate to smaller groups. Delegation of authority is common in most organizational types; in the case of PET analyses, delegation of authority also means delegation of attention. Organizational mandates determine attention in terms of the mission of the delegated group, preferences as a function of members, and information processing capacity related to expertise (Workman 2015).

Punctuated equilibrium theory thinks of information processing capacity in organizations as a function of two behaviors: seek and sort. A challenge for organizations in addressing policy problems and efficacy can be a lack of information – call this a deficit problem. The deficit problem is solved by building greater information seeking capabilities through process or resources (Jones and Baumgarter 2015). However, in modern policymaking organizations, the information problem is not a lack of information, but an overwhelming surge of information deluges even the narrowest of policy areas – call this a surplus problem. The surplus problem is solved by institutions investing in sorting strategies, though, like individuals, most institutions rely on heuristics to sort through information.

Organizations apply heuristic filters to information which leads to similar decision-making outputs despite changes in information flows such as problem characteristics or public opinion about a policy. Institutions can produce policy outputs associated with a problem definition that is less relevant as time passes. Policy stability is reinforced by the homogeneity of preferences and patterns of attention that emerged at the creation of the institution. Institutions that do not adapt outputs to match changes in problem characteristics can be overwhelmed by shifts in *attention* which may or may not be a function of shifts in problem characteristics (Jones and Baumgartner 2005). As attention shifts – either attention from stakeholders or superior institutions – a broader range of actors offer alternative definitions of public policy, using alternative (not necessarily new) information. With new information and new actors, a major change – a punctuation – can occur (Baumgartner and Jones 1993).

Punctuations are inherently distributive concepts, dependent upon knowing a range of outcomes associated with either a policy area (across institutions), a set of inferior institutions (within one superior institution), or both (Breunig and Jones 2011; Jones et al 2009). The traditional quantitative conceptualization of punctuated equilibrium theory is a leptokurtic distribution – a curve with an over-dispersion of both incremental and very large changes and an under-dispersion of moderate changes (Breunig and Koski 2006). Policies that are less adaptable to new information exhibit more pronounced leptokurtic distributions insofar as very little policy change occurs. By the time macro-political attention is fixed on these areas, current problem characteristics have deviated significantly from problem characteristics. Once a punctuation occurs, macro-political attention fades, and the new understanding of the policy problem creates an alternate information seeking and sorting regime.

We offer this extended discussion of punctuated equilibrium theory to investigate features of policy design that can contribute to the relative malleability of policies to receiving new information. Notably, broad theories of public policy (e.g., Lowi 1974) suggest that the politics associated with a policy are a function of the policy itself. While this is demonstrably true outside of PET, policy design may dictate politics as a function of how sub-governments seek and sort information. Policy design features may direct attention of policy makers to more diverse and dynamic sources of information and discourage narrower policy image definitions. In other words: Policies may be designed to be expressly adaptable. Adaptable policies should not experience the same pattern of policy change as less adaptable policies; which is to say, all else equal, a policy with information adaptation features in one institution ought to adjust more frequently across a broader range of changes than a less adaptable policy in the same or other similar institution. Additionally, given findings from Jones, Sulkin, and Larsen (2003) showing that punctuated policies produce punctuated outcomes; we also would expect that more adaptable policies would produce less erratic outcomes.

Merging scholarship on policy design and PET, as part of our exploratory analysis, we test the following proposition: *Greater policy change is associated with less punctuation in policy outputs*. We test this proposition in the context of U.S. net metering policy.

III. Policy Case: U.S. Net Metering Policy

Net metering policies enable distributed energy generation, or power generated through relatively low capacity, decentralized, grid-connected energy infrastructures located in close physical proximity to energy consumption. These infrastructures usually draw from renewable energy sources, such as solar, wind, and geothermal, among others. Common distributed energy infrastructures include photovoltaic solar arrays, wind turbines, and small scale geothermal plants. Compared to large scale, commercial energy generators that can only be installed in certain places and at large scales to maintain profitability, distributed energy generation infrastructures can be connected to smaller buildings (e.g., residential units) and operate at various scales. For these reasons, distributed energy generation infrastructures are regarded as being more flexible and integratable with existing structures than more centralized ones.

Distributed energy generation has increased in prevalence in the last decade in the United States in response to technological advancements, rising energy costs, and concerns about environmental pollution from the combustion of fossil fuels. Proactive and reactive clean energy policies adopted at the state level have also stimulated distributed energy production. States' clean energy initiatives have partly been motivated by federal inaction on renewable energy development (Stoutenborough and Beverlin, 2008); seen by many as a strategy to deal with global climate change.

Numerous states have adopted policies (e.g., renewable portfolio standards) that authorize distributed generation, establish incentives for the use of certain infrastructures, and specify infrastructure requirements. Forty-two states have adopted net metering policies, specifically, which allow generators of distributed energy (e.g., households) to sell energy not consumed on site back to energy retailers at a wholesale or retail rate and receive in return a consumption credit. In effect, distributed energy generators must then only pay retailers for their net energy consumption over a specified period of time. Net metering policies thus target utilities (for compensating) and distributed energy generators (for energy production). As Stoutenborough and Beverlin (2008) note, because of the way net metering policies are structured, the cost of the policy incentive for distributed energy production is borne by utilities.

Most of the states that currently have net metering policies in place enacted them in the early to mid-2000s; however, net metering was first adopted at the state level by Minnesota in 1983. Net metering policies vary in design across states. Most policies identify the types of entities that can participate in net metering programs, eligible technologies, the total amount of energy that can be generated by net metered systems, compensation rates for excess energy production, and details about ownership of renewable energy certificates (i.e., notes indicating a certain amount of renewable energy production). Ownership of certificates is assigned to energy retailers or distributed energy generators that sell their excess energy to retailers. Certificate ownership matters where states require certain types of entities to meet renewable energy production quotas to comply with complementary energy policies; for example, renewable portfolio standards.

Many states' net metering policies have undergone amendments since their initial enactments. Common amendments include adjustments to the overall generation capacities, compensation rates, and eligibility criteria for program participation and allowable technologies. Regarding the latter, 17 states have amended their policies in recent years to allow for aggregated net metering (NCSL, 2017). Whereas a conventional net metering program allows an energy generator to be compensated for excess energy produced from a single source connected to an energy meter, an aggregate net metering program allows a single energy generating customer to offset energy produced from multiple sources, each with their own meter, on a single property (NCSL, 2017).

IV. Methods

Data Collection

Policy design data and operational data from state net metering policies was collected for the years 2007 to 2016. This allows for identification of variation between states net metering policies, and within a state's net metering policy over time.

Policy Design Data

We compiled a longitudinal dataset for state net metering policies, using the Database of State Incentives for Renewables & Efficiency (DSIRE) and policy documents from state legislature and utility regulatory commission websites for all states. Variable descriptions and descriptive statistics of policy design changes are found in Table 1. DSIRE, which is operated by the N.C. Clean Energy Technology Center at N.C. State University and is funded by the U.S. Department of Energy, contains detailed information about each states net metering policy and historical background on changes in the policy. We use DSIRE as a base of knowledge for each state's net metering policy, but we also collect policy documents from state legislature and utility regulatory commission websites for a primary source of data collected. These policy documents consisted of legislative codes, legislative bills, and regulatory commission findings and orders. We also reviewed documents to collect policy design data from each state's net metering policy. For the purpose of our analysis, individual and aggregated generation cap limits are characterized as policy instruments, eligible technologies are characterized as policy targets, and billing/compensation is characterized as a policy incentives.

Table 1. Description of policy design characteristics for US state level net metering policy. Changes in instruments, targets, and incentives calculated over the period spanning 2007-2016.

Policy Design Measure	Description	Policy Changes Mean (sd)
Policy Instruments		
System Cap Limits	Limits in watts – typically KW for residential systems and MW for industrial systems – in the installed capacity of net metering systems. Range of policy changes by state: 0-4.	0.70 (0.91) Range: 0-4
Aggregate Cap Limit Changes	Limits to the percentage of the overall load that a utility must accept from electricity from net metered sources.	0.62 (0.89) Range: 0-3
Policy Targets		
Eligible Technology	Eligible Technology – Types of technologies eligible for net metering, including: geothermal, solar thermal, solar photovoltaics, wind, biomass, hydroelectric, hydrogen, municipal solid waste, combined heat & power, landfill gas, anaerobic digestion, biogas, and microturbines.	2.56 (3.70) Range: 0-13
Policy Incentives		
Billing/Compensation	Design features that affect the rates which utilities must pay customers, the ability of subscribers to bank credits based on excess generation, and the flexibility with which customers can use those banked credits.	0.28 (0.54) Range: 0-2

First, we code components of net metering policy design representative of policy instruments. Net metering policy can influence the amount of energy generated within a customer base by restricting the capacity of net metered customers through system caps. Additionally, net metering policy can control the overall amount of energy that utilities are required to purchase by placing aggregate cap. Most states have established system caps, fewer have established aggregate caps. We are interested in the presence and the change of these instruments; we code each change of in both the system and the aggregate cap as a 1.

Second, we code policy design features that determine net metering program eligibility. We collected data from policy documents on eligible utilities that have to accept net metering customers and eligible technologies that could be included in net metering systems. Eligible technologies identify who is allowed to participate in a state's net metering program; i.e., who is impacted by the policy. Generation caps place limits on how much distributed energy can be produced. Billing/compensation captures the financial incentive of participation in a net metering program. For eligible technologies, we identified a list of technologies that could be included in a state's net metering program (e.g., geothermal, solar photovoltaics, wind, biomass) based on the allowance of one of these technologies by any state in any year during the study period. We assigned a 1 or 0 to each state in each year to reflect whether or not a particular technology was included in a state's net metering program. We then summed our coding across all technologies for a state in a given year; in other words, for each state in each year in the study period, we captured the total number of technologies that were included under a state's net metering program. Our policy change measure considered changes in the total number of eligible technologies from year to year.

Finally, we collected a series of policy incentive tools from state policies: rate of compensation for energy sold back to the utility, the allowance of rollover in credits earned for excess generation, and any disincentive to rollover credits are areas of policy design regarding incentives. The rate of compensation for excess generation is a variation in policy design, as some states mandate that utilities must pay retail rate for excess generation, while other states mandate that states pay a lesser rate for the excess generation. Therefore, the rate of compensation was coded as a binary variable [1 = retail rate, 0 = non-retail avoided cost rate]. Additionally, whether a state allows for the credits for excess generation to rollover over time was coded [1 = allows rollover, 0 = does not allow rollover]. Whether the policy disincentivizes rollover after a certain period of time was coded [0 = none, 1 = credit awarded to utility with no compensation, 2 = credit bought by utility at avoided cost rate]. We coded policy granting of ownership of RECs [0 = not specified, 1 = customer-owned, 2 = utility-owned, 3 = shared by the customer and utility]. Our change measure considers year over year changes in these coded values.

A descriptive analysis of policy data shows that states that have net metering policies have periodically amended them over the study period, especially on the policy target, policy instrument, and policy incentive categories used as a basis for our analysis – eligible technologies, individual and aggregated generation limits, and billing/compensation. Across all states over the study period, we observed 35 changes to individual system cap limits, 31 changes to aggregate cap limits, 14 changes to billing and compensation values, and 128 changes across eligible technologies.

Utility Net Metering Data

We compiled a longitudinal dataset of operational data from net metering programs, using survey data from the U.S. Energy Information Administration (EIA). EIA has collected operational data from utilities regarding their net metering programs using Form EIA-861 since 2007.[1] The data include number of net metering customers, energy sold back to the utility from a net metered generator in MWh, and total combined capacity of net meter generators in MW. We aggregate each of these metrics to utility-level and by sector of customer. The EIA collects metering customers and energy sold back to the utility data has been collected since 2007; capacity data of net metering generators has been collected since 2010. These data descriptions and descriptive statistics are found in Table 2.

Table 2. Description of policy output measurements for US state level net metering policy. Changes are year over year between 2007-2016. Total figures here; as well residential (Res), commercial (Com), and industrial (Ind) subcategories.

Policy Output Measure	Description	Sub-cat	Mean (sd)	Mean Pct Change (sd)
Net Metering Customers	Number of residential, industrial, and commercial entities that have registered with a utility to participate in net metering	Total	6953 (32975)	125.2 (658.8)
		Res	6443 (31717)	127.3 (558.9)
		Com	473 (1195)	82.4 (171.7)
		Ind	38.2 (210)	44.9 (112.2)
Installed Capacity	Overall capacity of net metering customers to generate electricity in megawatt hours (MWh)	Total	104.3 (354.1)	51.5 (72.1)
		Res	48.8 (192.5)	52.5 (69.8)
		Com	43.0 (117.0)	61.2 (123.1)
		Ind	12.5 (66.7)	70.3 (222.4)
Buyback	Electricity purchased by utility from net metering customers in megwatts (MW)	Total	43148 (435320)	1285 (9181)
		Res	81004 (54301)	1288 (7827)
		Com	18564 (180673)	7936 (128828)
		Ind	16518 (235820)	806 (4728)

[1] Form-EIA 861 was adapted to include a short form survey option for utilities, which only collected whether the utility had a net metering program. This short form survey reduced the number of utilities reporting specific customer, capacity, and energy sales to the utility data.

Data Analysis

Our goal in this paper is to investigate the relationship between policy design and the distribution of policy outputs. Thus, our analyses focus not on a more standard discussion of whether policy designs lead to variations in particular outputs, but, rather, on the influence of policy design change profiles of states on the pattern of policy change that exists at the state level. We later regress quantified distributions of changes in policy outputs on the dimensions of policy design we measure.

We are specifically interested in changes across three net metering related policy outputs by state: net metering subscribers, net metering electricity buyback, and installed capacity of net metering electricity in megawatt hours (MWh). We additionally consider the target groups associated with these policy outputs: residential, commercial, and industrial applications. Our study period of 2007-2016 is the longest available for net metering data in the United States and allows for some sense of the longitudinal relationship between categories, states, and tools. However, the short time period means that, for the most fine grain analysis of change in policy output by target group and instrument, we only have seven observations for each state.

As a starting point, we examine the distribution of changes across all states. As indicated in our descriptive statistics tables, the rates of change in some states for net metering variables is quite high; thus, the standard histogram associated with distributional analyses is not particularly instructive to the naked eye given the extreme positive skew. In many cases, our study is capturing the very beginning of net metering programs in states; for example, states move from literally one or two subscribers, to 100 or 1000, which are several orders of magnitude greater. We find similar characteristics for energy buyback and energy generation.

Instead of histograms, then, we calculate l-k scores for each policy output by target. L-k scores are commonly used in distributional analysis, particularly so in studies investigating punctuated equilibrium theory. L-k scores are analogous to kurtosis scores insofar as they measure the fourth moment of a distribution – with the mean, standard deviation, and skewness as the first, second, and third moments respectively. While standard kurtosis scores are sensitive to outliers, L-k scores are less so. L-k statistics typically range between 0 and 1, with an l-k score of .12 approximating to a normal distribution. Higher values than .12 are indicative of increasing leptokurtosis which indicates an overdispersion of small changes around the mean and very large changes. Values lower than .12 represent a platykurtic distribution for which changes are more evenly distributed throughout the entire range of the distribution in contrast to the normal.

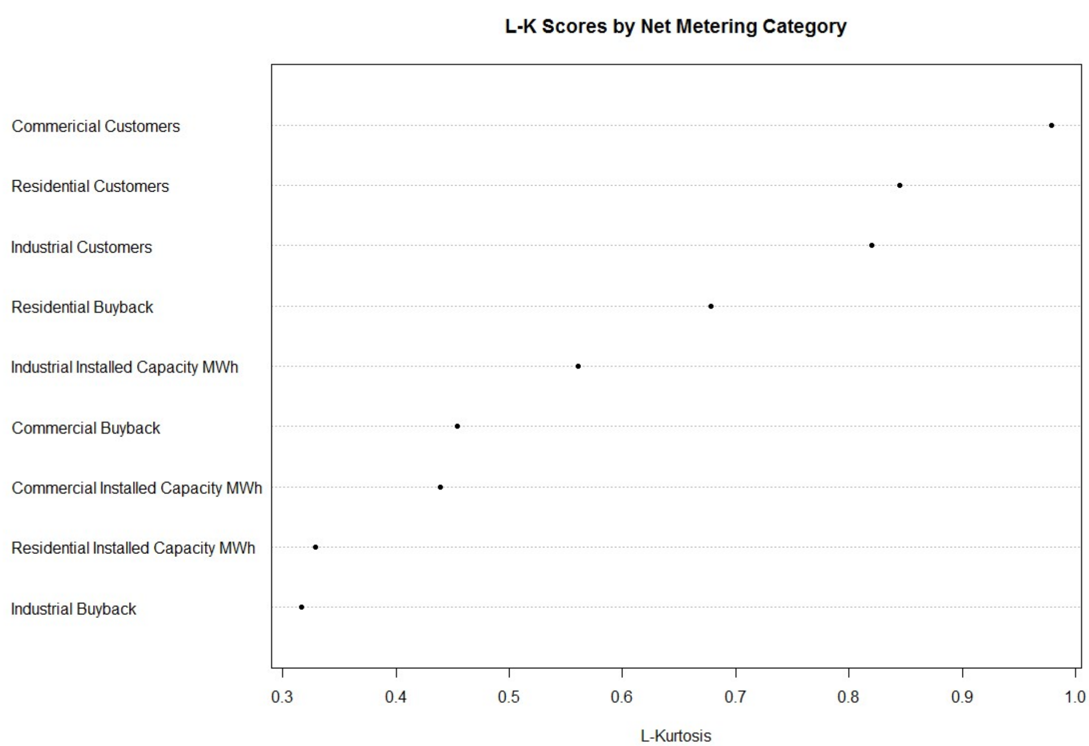
V. Results

Policy Outputs – Net Metering at the State Level

Figure 1 provides a sorted dotplot of l-k scores by net metering categories pooled changes across states and across years. In contrast to many previous studies of policy change using l-k scores, it is important to remember that all categories have a mean much higher than zero, which is to say that in most cases we expect a consistently high growth rate. As we previously state, many states have relatively new net metering programs and thus the markets for net metering are nowhere near saturated.

All categories exhibit leptokurtic distributions, but there exists substantial variation across categories. Three initial patterns emerge from this figure. First, all types of subscribers – residential, commercial, and industrial – are the most leptokurtic categories in the entire dataset and all share similar levels of leptokurtosis. This indicates relatively steady growth rates in the number of targets punctuated by significant increases and decreases. The ranges of these variables are very large given that some years, particularly for industrial and commercial users, experience complete evacuations of customers while other years several thousand percent increases.

Figure 1. L-Kurtosis Scores by Net Metering Categories (Pooled Across States and Years)



While both energy buyback and installed capacity of energy generation experience a range of leptokurtic distributions as a function of target population, the variation is inverted depending on the policy output. The second pattern that emerges is that buyback elicits the greatest variation in l-k scores across target groups. Buyback of net metering policy is affected by two things – capacity of targets to generate electricity and the amount of energy generation by net metering that utilities must take on as part of their load (known as an aggregate cap). Buyback is also affected by the price that electricity generators are paid per MWh insofar as this price leads to decisions related to installation of onsite electricity generation. Industrial buyback is the least punctuated of all the distributions in the entire dataset, while residential buyback approaches the highest.

Third, installed capacity of energy generation is, generally, the least leptokurtic of all categories (though, importantly, is still leptokurtic). It is important to remember that installed capacity is not the same as energy that is purchased by the utility. That the number of subscribers would be the most leptokurtic categories but the actual energy generated the least is an intriguing puzzle. In theory, these two categories ought to be related; however, there exist caps on both the aggregate amount of energy a utility must take on, but also the amount that can be individually generated by a target. These caps may smooth out the impact of the volatile subscriber rate on actual energy generation.

In sum, while the distribution of the number of subscribers, the amount of energy produced, and the energy purchased by utilities ought to follow similar patterns given their mutual dependence, differences in policy outputs exist across targets and types. Broadly, these variations can be explained by the variations we know to exist across states in the US from our coding of net metering policies.

In general, this pattern conforms to the demands of utilities which ultimately desire a stable supply of power. A major challenge for utilities moving into the renewables market is the volatility of electricity from non-nuclear, non-hydro, and non-fossil fuels sources. Utilities and balancing authorities must firm and shape the erratic power that enters the grid from intermittent sources such as wind and solar. Net metering represents more diffuse balancing challenges than large scale renewable energy; hence, utilities are interested in reducing energy spikes and crashes associated with net metering. Politically, governments are challenged by constituents who would like to be given the opportunity to turn direct generation into additional revenue, thus, there exist few policies that specifically restrict constituents' access to net metering.[2] This category is highly volatile – policy interventions in buyback and generation act as a firming and shaping of this demand. Utilities are better able to hand volatility on their financial balance sheet (buyback) than in their electricity balance sheet (generation). There is a lot to unpack from Figure 1; however, we can say that policy design, in broad strokes, is able to shape the distribution of policy outputs.

Next, we plot the l-k scores of the three policy output variables – subscribers, buyback, and generation – by state. For this analysis, we must combine the target groups – residential,

[2] Although this is gaining momentum with states reexamining their net metering policies. 3 states have revoked their net metering policy, grandfathering in current customers though. Others are considering tariffs and fees for the distributed generation to be paid to the utility.

commercial, and industrial – given that there are simply too few observation-years per state to produce a reliable distributional measure for estimation. The results are found in Figures 2-4.

Figure 2. L-Kurtosis Scores of Net Metering Customers by State

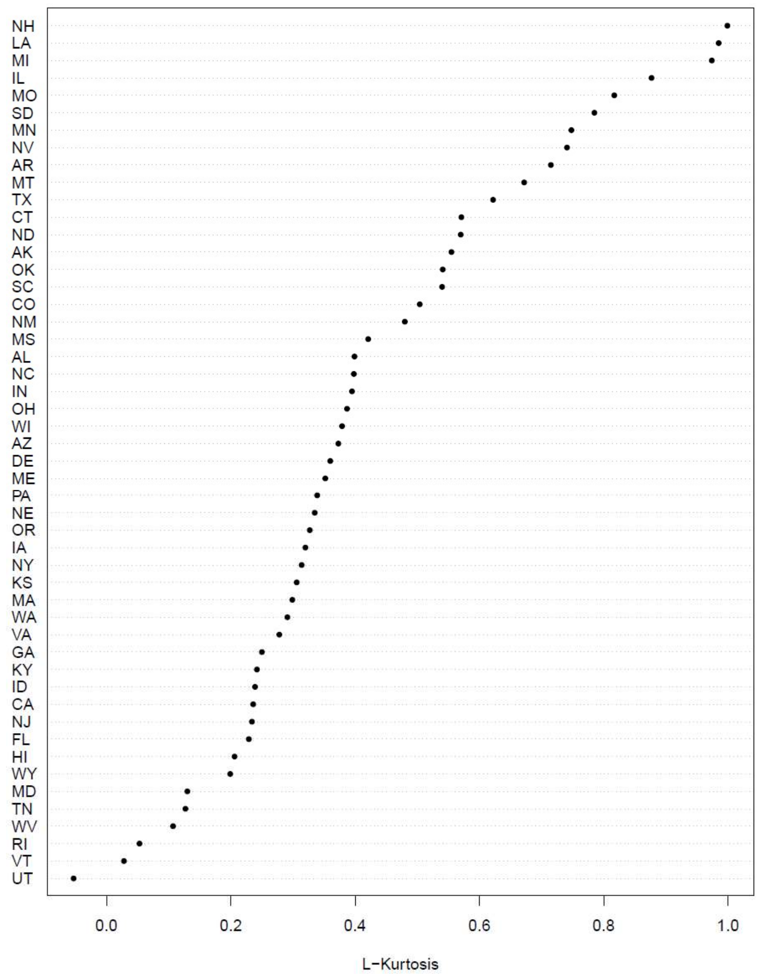


Figure 3. L-Kurtosis Scores of Energy Sold Back to the Grid from Net Metering by State

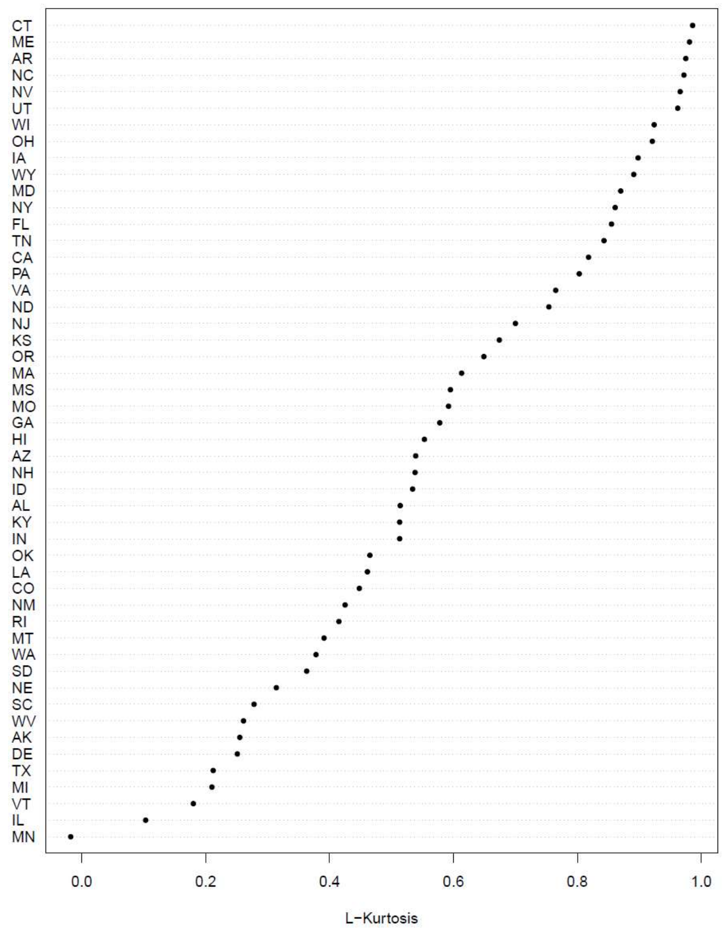
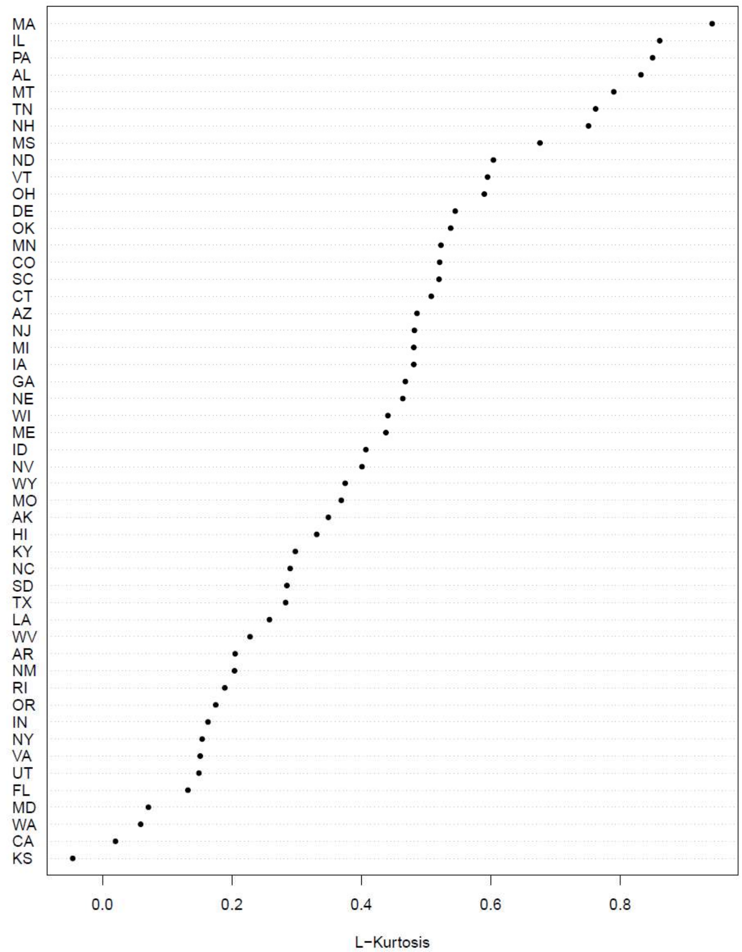


Figure 4. L-Kurtosis Scores of MWh Installed Capacity by Net Metering by State



These figures are useful for gaining a general sense of the variation in patterns of distributional change across states. In general, states have higher l-k scores for energy sold back to the grid than for energy generation or subscribers, indicating that at the individual state level, there are mechanisms at work in buyback programs that create more punctuated outcomes than for energy generation or for subscription. A correlation of these three l-k scores reveals weak relationships between customers and buyback (Pearson's r = -.30, p = .04) and a weak positive relationship between customers and energy generation (Pearson's r = .26, p = .06), but no relationship between buyback and energy generation. In general, we can say that states that have more punctuated uptake of net metering in the form of customers are associated with more punctuated energy production, but less punctuated energy buyback. In contrast with our national story, there are states in which subscriber bases can provide the control over grid fluctuations; however, these are relatively weak associations. Thus, what we can say about net-metering policy in American states is that it is challenging to identify specific states as inherently producing punctuated net metering outputs.

Regression Analysis of State Level Distributions and Policy Design

Figures 2-4 show substantial variation across categories and states in terms of distributions of net metering policy outputs. The results motivate our analysis of the relationship between policy design characteristics and policy outputs. In Table 1, we present the results of modeling the influence of changes in policy design elements that we identify in our coding of net metering regulations and the l-k scores for the three categories of policy outputs for all states found in Figures 2-4. We use ordinary least squares (OLS) regression to examine each net metering policy output type (subscribers, buyback, installed capacity) by state for a sample size of 50. Then we regress these output variables against the number of changes in four common design features that can be found in any net metering policy: individual system caps, aggregate system caps, eligible technologies for net metering, and billing and compensation limits. We posit that the number of changes in these design elements by state is an indicator of attention to net metering, with some limitations. It can generally be said that states that change net metering policy designs more frequently pay more attention to net metering, however, it is challenging to understand variation in attention within non-changing states. Still, we can get a sense of the overall adaptability of states to changes in net metering demands in examining the influence of changes in design variables on the distribution of net metering outputs at the state level.

Each of these policy design features is directed at a particular type of decision-making, irrespective of the target (i.e. residential, commercial, and industrial). Individual system caps are directed at the choices citizens or firms make regarding how large a system to install. Aggregate system caps are not directed at individuals at all, but, rather, set a limit on the amount of energy from net metering a utility must allow to be placed onto the grid. Eligible technologies affect individual decisions regarding the type of electrical generation device citizens and firms are allowed to install. Billing and compensation regulations affect individual decisions regarding potential gains from excess energy generation, but also affect utility costs regarding purchases from individuals.

In addition to policy design variables, we also understand that net metering policy is subject to broader policy goals and institutional features peculiar to energy policymaking at the state level. Many net metering policies exist as a broad response for states to meet self-imposed renewable portfolio standards. States with renewable portfolio standards (RPS) ought to attend renewable energy issues more than states that do not. Nearly all generation of electricity as a part of net metering is renewable; thus, a state with an RPS ought to have more sustained attention to net metering outputs, thereby producing less punctuated distributions. We include a variable for RPS by state for which states that have a mandatory RPS are scored 2, a voluntary RPS are scored 1, and no RPS receive a 0.

Institutionally, all states have some form of regulatory utility commission (RUC) that is responsible for setting rates, advising policy, and making policy. Regulatory utility commissions are widely constructed but generally serve to regulate utilities as monopolies in the public interest. In 11 states, regulatory utility commission members are directly elected by the public rather than appointed by the governor (except in Virginia where the utility commission is elected by the legislature). It is possible that an independent utility commission is incentivized to better attend to net metering issues than other appointed commissions given that net metering directly affects constituents in ways that most other utility policy does not.

The regression modeling ultimately investigates which policy design changes can act to smooth distributions – or, make less punctuated – or which changes exacerbate extreme changes. The model results are found in Table 3. Model fits are acceptable for buyback and installed capacity; however, not for understanding the distribution of subscribers at the state level.

Table 3. Influence of Policy Design on Policy Punctuations by State

	Dependent Variable		
	L-k Scores Customer (1)	L-k Scores Energy Buyback (2)	L-k Scores Installed Capacity (3)
Policy Targets			
Eligible Technologies	0.006 (0.014)	-0.010 (0.014)	-0.022* (0.012)
Policy Instruments			
Individual System Cap Changes	0.028 (0.068)	-0. 154** (0.067)	0.174*** (0.058)
Aggregate Generation Cap Changes	-0.064 (0.066)	0.022 (0.065)	-0.084 (0.056)
Policy Incentives			
Billing/Compensation Changes	-0.014 (0.098)	0.070 (0.097)	-0.001 (0.084)
RPS	0.069 (0.045)	0.007 (0.045)	0.017 (0.039)
Structure of Decision-Making			
Elected RUC	0.165* (0.094)	-0.214** (0.093)	0.182** (0.081)
Constant	0.305*** (0.084)	0.729*** (0.083)	0.337*** (0.072)
Observations	50	50	50
R^2	0.119	0.245	0.269
Adjusted R^2	-0.004	0.140	0.166
F Statistic (df = 6; 43)	0.971	2.327**	2.631**

Note: *p<0.1; **p<0.05; ***p<0.01

VI. DISCUSSION

Three general themes emerge from the model results that together offer partial support for our exploratory research proposition – that greater policy change is associated with less punctuation in policy outputs. First, policy design is influential over the distribution of policy changes in energy buyback and installed energy capacity. Specifically, individual system caps lead to fewer punctuations in buyback, but greater punctuations in installed capacity. A suggestion from this argument is that governments that intervene more in net metering policy can smooth out – make less punctuated – the amount of power that comes onto the grid via policy (negative coefficient for buyback), but, that these choices lead to more wild swings in how much energy people install (positive coefficient for installed capacity).

In contrast to individual system caps, eligible technology changes smooth out installed capacity. Changes in eligible technologies affect the range of systems allowed and offer a flexible response to utility and utility customer demand. However, most of these changes are expansions of eligibility rather than contractions. It could be that these tools have a limited long-term capacity to affect distributional changes. However, an implication from this finding is that a measured rollout of technologies can anticipate demand and lead to a more responsive policy. Regression results in Table 3 yield non-findings across all policy output variables for changes in aggregate system caps and billing/compensation. While non-findings are a challenging place from which to draw conclusions, we suggest that punctuations arise from individual decisions and that policy design levers that anticipate individual decision-making are better for creating smoother policy. Aggregate caps and tools related to reimbursement are less immediately related to the types of systems individuals might install to participate in net metering.

Second, changes in policy design do not affect the distribution of subscriber changes. This finding makes sense from a design perspective given that the policy tools we identify here do not explicitly restrict or allow for net metering at the individual level. At the same time, however, subscribers are consistently the most punctuated policy output across states, which means that there might be other factors that account for the distribution of changes subscribers – other institutional or policy features that create conditions for major shifts in consumer demand for net metering.

Third, institutional variables offer mixed findings. Renewable Portfolio Standards do not affect the distribution of changes in policy outputs across states. This finding suggests that RPS may focus attention broadly on renewable energy, but not specifically on net metering policies. However, elected RUCs emerges as a consistent source of influence over policy output distributions, and, curiously in the same direction as individual system caps. System caps and elected RUCs are negatively correlated, indicating that the mechanisms here are likely to be different. Ultimately, RUCs are concerned with responding to citizens demands and balancing – literally, in the case of electricity – the needs of utilities. Installed energy capacity represents opportunities to responds to citizen demands for distributed generation. Elected commissions have preference sets that result from distinct priorities associated with independent constituencies. These preferences could cause officials to expand their agenda to include a wide variety of energy-related items beyond a narrower set associated with the confines of an organizational mission. In an expanded agenda spaced, regulatory utility commissioner attention will be spread thin, causing a familiar swing in attention to problems and overcorrection in responses.

Altogether, our study makes important contributions to the study of policy design. Notably, it is the first to explicitly merge scholarship on policy design with the PET. Schneider and Ingram embrace similar theoretical expectations about the policy process as does PET; namely, that the policy process is dominated by incrementalism as a result of political motivations. Bringing PET and its assumptions regarding information processing to bear on the study of policy design facilitates the development of nuanced propositions about not only how policies are likely to change over time but also the distribution of policy effects linked to policy design over time. Additionally, this study is one of only several that examines change in policy design elements over a multi-year period and across multiple jurisdictions. The vast majority of policy design studies that seek to evaluate policies at the element (i.e., target, instrument, incentive) level are single case studies based on qualitative data. Further, many of these studies focus on cases at single points in time.

No study is without limitations. A primary limitation of this research is the focus on a single policy case, net metering policy. Without including other types of policies within our analysis, we are not able to speak to the generalizability of our research findings. A logical next step for our research is to expand our research design to include an assessment of other types of policies. A second limitation concerns the variables included in our regression analysis. For the exploratory analysis reported in this paper, we include a truncated list of explanatory factors alongside policy design variables. PET scholarship provides ample empirical guidance regarding factors that contribute to policy stasis and punctuation. Subsequent analyses will incorporate an expanded list of explanatory factors.

Future research might also consider more specifically the underlying dynamics of temporality of policy change. Plainly, some policy changes may be responding to demand, others may be stoking it. In this article, we can infer from the data whether policy design changes are in response to changing problem definitions (buyback) and when we think policy change overcorrects (installed capacity), but other research might specifically investigate these linkages.

VII. Conclusion and Policy Implications

Chief among the functions of public policies in democratic societies is to facilitate the attainment of outputs and outcomes valued by citizens and their elected representatives (Bobrow and Dryzek, 1987). Our study offers the first attempt to clarify how the distribution of policy outputs change in response to changes in different elements of policy design.

In addition to contributions to scholarship, our research has several general and case specific policy implications. Generally, our study empirically underscores the idea that policymakers have at their disposal through policy designs several levers for influencing behavioral change and resultant policy outputs and outcomes (Howlett 2009). Policymakers can manipulate to whom policies apply, through what mechanisms to compel policy relevant behaviors, and the strength of rewards and sanctions for engaging in policy activities. The choice of how to craft policies along these design elements must necessarily be informed by behavioral assumptions; that is, how policy targets are likely to respond to policy instruments and incentives (Schneider and Ingram 1990). Additionally, it requires consideration of the *relative* influence of adjusting certain design levers to maximize the potential for producing desired policy outputs and outcomes.

Further, when considering the effects of manipulating policy design elements, one can assume, as we empirically demonstrate through our study, that punctuated responses in policy outputs may be less likely when the extent of behavior change elicited through policies is less extreme (Mazmanian and Sabatier 1980). In our case, for example, we find that governments that intervene more in net metering policy can make less punctuated the amount of power that comes onto the grid through policy, but that these choices lead to more punctuation in how much energy people install. For utilities, adjusting to state net metering policies likely does not require dramatic shifts in their operation; in effect, it likely just requires adapting existing operations to accommodate new policy information. For individuals to opt into participating in their state's net metering program requires embracing a social-technological transition; i.e., potentially significant behavioral modifications. Given the behavioral leap associated with program participation, it is more difficult to predict how individuals will respond to new or modified policy information.

Our research also offers policy implications for states attempting to balance three dimensions of political conflict in net metering: requirements for states to reach renewable energy targets; desires of citizens to directly generate and be compensated for their energy; and the capacity of utilities to meet these demands. In general, we show that utilities are forced to contend with an uneven and erratic supply of net metering customers and policy design changes, generally cannot help this. However, active policy design can be used to create balanced growth in energy integration. The challenges for net metering are emblematic of the challenges that face governments and utilities in transitioning to a carbon-less, resilient energy future. Future research might consider more specifically the underlying dynamics of temporality of policy change. Plainly, some policy changes may be responding to demand, others may be stoking it. In this article, we can infer from the data whether policy design changes are in response to changing problem definitions (buyback) and when we think policy change overcorrects (installed capacity), but other research might specifically investigate these linkages.

References

Anderson, James E. 1979. *Public policy making,* 2nd edition. New York: Holt, Rinehart & Winston.

Baumgartner, Frank R, and Bryan D. Jones. *Agendas and Instability in American Politics*. Chicago: University of Chicago, 1993.

Baumgartner, Frank R., Christoffer Green-Pedersen, and Bryan D. Jones. "Comparative Studies of Policy Agendas." Journal of European Public Policy 13, no. 7 (2006): 959 - 74.

Baumgartner, Frank R., Christian Breunig, Christoffer Green-Pedersen, Bryan D. Jones, Peter B. Mortensen, Michiel Nuytemans, and Stefaan Walgrave. 2009. "Punctuated Equilibrium in Comparative Perspective." *American Journal of Political Science* 53, no. 3: 603-20.

Baumgartner, Frank R, Bryan D Jones, and Peter B Mortensen. 2014. "Punctuated Equilibrium Theory: Explaining Stability and Change in Public Policymaking." *Theories of the Policy Process* (59-103).

Breunig, Christian. 2006. "The More Things Change, the More Things Stay the Same: A Comparative Analysis of Budget Punctuations." *Journal of European Public Policy* 13 (7): 1065-81.

Breunig, Christian, and Chris Koski. 2006. "Punctuated Equilibria in the American States." Policy Studies Journal 34(3): 363-79.

Breunig, Christian, and Chris Koski. 2012. "The Tortoise or the Hare? Incrementalism, Punctuations, and Their Consequences." *Policy Studies Journal* 40(1): 45-68.

Breunig, Christian, and Bryan D. Jones. 2011. "Stochastic Process Methods with an Application to Budgetary Data." *Political Analysis* 19 (1):103-117.

Bobrow, Davis B. and John S. Dryzek. 1987. *Policy Analysis by Design.* Pittsburgh: University of Pittsburgh Press.

Edelman, Murray. 1964. *The Symbolic Uses of Politics*. Urbana: University of Illinois Press.

Green-Pedersen, Christoffer and Stefaan Walgrave. 2014. *Agenda Setting, Policies, and Political Systems: A Comparative Approach*. Chicago: University of Chicago Press.

Howlett, Michael. 2009. “Governance Modes, Policy Regimes, and Operational Plans: A Multi-Level Nested Model of Policy Instrument Choice and Policy Design.” *Policy Sciences* 42 (1): 73-89.

Howlett, Michael and Raul P. Lejano. 2013. "Tales from the Crypt: The Rise and Fall (and Rebirth?) of Policy Design." *Administration & Society* 45 (3): 357-381.

Ingram, Helen, Anne Schneider, and Peter deLeon. 2007. "Social Construction and Policy Design." In Paul A. Sabatier, ed. *Theories of the Policy Process*. Boulder: Westview Press, 93-126.

Jones, Bryan D. 1994. *Reconceiving Decision-Making in Democratic Politics: Attention, Choice, and Public Policy*. Chicago: University of Chicago Press.

Jones, Bryan D. 2001. *Politics and the Architecture of Choice: Bounded Rationality and Governance*. Chicago: University of Chicago Press.

Jones, Bryan D. and Frank R. Baumgartner. 2005. *The Politics of Attention: How Government Prioritizes Problems*. Chicago, University of Chicago Press.

Jones, B. D. and F. R. Baumgartner. 2012. "From There to Here: Punctuated Equilibrium to the General Punctuation Thesis to a Theory of Government Information Processing." *Policy Studies Journal* 40(1): 1-20.

Jones, B. D. and F. R. Baumgartner. 2015. *The Politics of Information: Problem Definition and the Course of Public Policy in America*. Chicago, University of Chicago Press.

Jones, Bryan D., Frank R. Baumgartner, Christian Breunig, Christopher Wlezien, Stuart Soroka, Martial Foucault, Abel François, Christoffer Green-Pedersen, Chris Koski, Peter John, Peter B. Mortensen, Frédéric Varone, and Stefaan Walgrave. 2009. "A General Empirical Law of Public Budgets: A Comparative Analysis." *American Journal of Political Science* 53 (4): 855-73.

Jones, Bryan D., Frank R. Baumgartner, and James L. True. 1998. "Policy Punctuations: U.S. Budget Authority, 1947-1995." *The Journal of Politics* 60 (1): 1-33.

Jones, Bryan D., Tracy Sulkin, and Heather A. Larsen. 2003. "Punctuations in Political Institutions." *American Political Science Review* 97 (1):1-23.

Jones, Bryan D., and Michelle Whyman. 2014. "Lawmaking and Agenda Setting in the United States, 1948–2010." In *Agenda Setting, Policies, and Political Systems: A Comparative Approach* (p. 36-52) ed. Christoffer Green-Pedersen and Stefaan Walgrave. Chicago: University of Chicago Press.

Lowi, Theodore J. 1972. "Four Systems of Policy, Politics, and Choice." *Public Administration Review* 32 (4):298-310.

Mazmanian, Daniel and Paul Sabatier. 1980. "Conceptual Framework." *Policy Studies Journal* 538-60.

National Council of State Legislators. 2016. “State Net Metering Policies.” http://www.ncsl.org/research/energy/net-metering-policy-overview-and-state-legislative-updates.aspx. Accessed March 13, 2018.

Ostrom, Elinor. 2005. *Understanding Institutional Diversity*. Princeton: Princeton University Press.

Ostrom, Elinor. 2007. “Institutional Rational Choice: An Assessment of the Institutional Analysis and Development Framework.” In Paul A Sabatier, ed. *Theories of the Policy Process*. Boulder: Westview Press, 21-64.

Ostrom, Elinor and Xavier Basurto. 2010. “Crafting Analytical Tools to Study Institutional Change.” *Journal of Institutional Economics* 7 (3): 317-343.

Peters, B. Guy and John Pierre. 1998. “Governance without Government? Rethinking Public Administration.” *Journal of Public Administration Research and Theory* 8 (2): 223-243.

Schneider, Anne, and Helen Ingram. 1988. "Systematically Pinching Ideas: A Comparative Approach to Policy Design." *Journal of public policy* 8, no. 01 (1988): 61-80.

Schneider, Anne, and Helen Ingram. 1990. "Behavioral Assumptions of Policy Tools." *The Journal of Politics* 52 (2): 510-529.

Ann L. Schneider and Helen Ingram. 1997. *Policy Design for Democracy.* Lawrence: University Press of Kansas.

Wolfe, Michelle. 2012. "Putting on the Brakes or Pressing on the Gas? Media Attention and the Speed of Policymaking." *Policy Studies Journal* 40(1): 109-126.

Wolfe, Michelle, Bryan D. Jones and Frank R. Baumgartner. 2013. "A Failure to Communicate: Agenda Setting in Media and Policy Studies." *Political Communication* 30(2): 175-192.

Workman, Samuel. 2015. *The Dynamics of Bureaucracy in the U.S. Government: How Congress and Federal Agencies Process Information and Solve Problems*. New York: Cambridge University Press.

Workman, Samuel and Chris Koski. 2017. “Plying the Backwaters and Harnessing the Flow: Harmonizing Information Search with Processing Capacity in Policymaking.” Working paper.