

Assessing Policy Impacts on Natural Resource Businesses: A Review of Research Methods

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Natural resource businesses exist in an operating environment that is heavily influenced by public policies. For example, public land policies can affect access to raw materials (e.g., wood fiber or mineral resources), environmental regulations can affect the emission of pollutants from processing facilities, and financial subsidies can offset the costs of transportation of materials and investments in infrastructure. Policy instruments that influence natural resource firms include, among others, financial disbursements (grants, loans, cost-sharing policies, direct payments), tax policies (exemptions, allowances, deductions, credits), government rules and regulations, direct purchase by government entities of end products, and government service programs (technical assistance programs, infrastructure development programs). In sectors such as biomass energy generation, which combines motivations for rural economic development, forest restoration, and renewable energy provisioning, there may be several policy instruments operating at multiple scales (e.g., local, state, and federal) that influence business decision-making.

Relevant laws are passed, and programs are crafted, in response to broad public interests such as promoting rural development, generating energy from renewable sources, or providing environmental stewardship on public lands. As with other public policies, there exists a need to determine the successes and shortcomings of policies oriented toward natural resource businesses. Despite the proliferation of natural resource-related laws, programs, and funding opportunities, researchers and policy-makers are often confronted by information gaps regarding policy impacts on natural resource businesses. Researchers have been particularly challenged by the prospect of attempting to measure the interactive influences of multiple policy instruments operating at multiple scales to evaluate how policies and their effects are perceived by businesses, how the policies affect business decision-making processes, and how knowledge of these effects can be used to inform effective policy planning and implementation.

The need to look at policy impacts on business decision-making is critical for the development of robust businesses and associated supply chains. Gaining insight into the decision-making process can aid and educate policy makers on where innovations and changes are taking place within relevant industries and what is influencing them. Such research also has the potential to reveal the impact of state and federal policy on innovation while providing a framework of where to focus future policy efforts. Failing to understand how policies influence businesses and their decision-making processes risks investment in ineffective strategies and areas within the supply chain, and has the potential to increase business uncertainty.

The purpose of this working paper is to review research methods used to assess the influence of public policies on natural resource business decision-making. We describe a suite of research methods that have been used to assess policy impacts on businesses, highlighting their analytical advantages and disadvantages. We emphasize natural resource policies and businesses in our review, but also present literature from other fields as relevant. With this review we attempt to contribute to a greater ability to conduct evaluation for policies and programs targeting natural resource firms.

Methods

We used a multi-pronged approach to searching for relevant material for this methodological review. We began with a known set of research articles on policy impacts on natural resource firms and proceeded to search for additional sources using academic search engines and a targeted review of specific journals. Each publication was reviewed for the methods used, outcomes, stated strengths and weaknesses of the method, and other criteria. See Appendix A, page 21 for additional detail on our search methods. We divide the review that follows into two sections, which broadly cover single-method approaches and mixed-methods approaches. In the single-method section we discuss survey, interview, and secondary data analysis research methods. The multiple-methods approaches

cover interview and secondary data analysis combinations, interview and survey combinations, and case studies.

Results

Single-method approaches

Surveys

The survey method is widely used in researching policy influences on businesses, given that surveys have the capability of collecting consistent, generally quantitative, responses from a sample of a population (such as businesses within a certain sector), allowing researchers to make general claims about the larger population as a whole. Surveys can be used to systematically collect data on opinions, attitudes, beliefs, characteristics, experiences, actions, expectations, self-classifications, or knowledge of a study population. Demographic data are typically collected to test for their relationships with answers to other questions, and firm characteristics are collected as part of business surveys. If given a sufficiently large and representative sample, surveys can be used to draw inferences about populations (of people, businesses, etc.) beyond the sample that was actually surveyed. This is useful when looking to reveal information about the isolated influences of multiple variables on a particular outcome, such as the isolated influence of a particular policy on business decision-making strategies (Stevanov et al. 2016). Single-wave surveys, consisting of data collection (whether by mail, telephone, or via online media) at a single moment in time, are the most common approach because they can be completed within a relatively short timeframe. Sometimes researchers utilize multiple-wave surveys, which are used to gather data over a longer time frame by surveying the same population at multiple points in time.

Advantages and disadvantages of survey methods

There are a number of advantages and strengths of survey research that can assist researchers in understanding the relationship between policy



impacts on business innovation and investment decisions. Because of the standardized nature of the instrument, researchers can make generalizations about the characteristics, actions, or opinions of large or small groups of people and firms (Lanfranchi and Pekovic 2014, Bolo 2011, Broz and Plouffe 2010). Further, a well-designed survey can allow researchers to isolate the influences of multiple variables on an outcome of interest through the use of regression techniques or similar statistical tools. Therefore, a well-designed survey can help researchers make generalizations about the significant changes business owners have implemented over the course of their operations, and can serve to isolate and examine how firm representatives believe specific state and federal policies have affected those changes.

There are, however, a number of disadvantages and weaknesses to the survey method. First, surveys are inflexible in that they do not allow the researcher to modify the instrument throughout the research process, increasing the possibility of measurement error (Stevanov et al. 2016). Second, surveys are not well suited to understanding the in-depth context of social dynamics; they generally achieve “breadth” (representativeness) at the cost of “depth” (level of detail). Third, the limited range of response categories typical of closed-ended questions may miss what is most appropriate to many respondents (Aguilar and Garrett 2009). Further, if a survey has an inadequate sampling procedure or a low response rate then the validity of the survey can be compromised because the researchers may

be unable to accurately identify and define trends (Mola-Yudego and Paavo 2008).

Use of surveys in measuring policy influences on businesses

Surveys have frequently been used to measure business experiences with public policies. Single-wave surveys, which represent a “snapshot in time” of a given population, are the most common approach within the literature. Throughout our research, single-surveys were often utilized to understand specific challenges related to biomass utilization, to identify the most effective policy instruments within the complicated policy landscapes, and to identify specific recommendations helpful to improving the natural resources sector. For example, Lanfranchi and Pekovic (2014) administered a single-wave survey questionnaire to nearly 17,000 French firms to understand changes in employee attitudes following the adoption of environmental standards. Individual employees were surveyed to understand their attitudes, involvement, and work effort. Aguilar and Saunders (2011) conducted a single-wave survey to understand the attitudes of public sector professionals in two regions of the U.S. toward various policy instruments for promoting biomass energy. Brukas and Sallnas (2012) administered a survey to forest owners and planners to understand how each population views the effects of forest plans. This survey was administered verbally via a semi-structured interview process so that researchers could take notes on the open-ended questions within the survey.



When conducting a single-wave survey, researchers will often utilize a pilot survey to pre-test their survey instrument. These pilot surveys can be used to improve the quality of the final survey. For example, in their research on woody biomass energy policies, Aguilar and Garrett (2009) pre-tested their survey instrument on members of forestry and working groups. They used the responses to amend the survey, which was then administered to all state foresters and state biomass contacts from the U.S. National Association of State Foresters and members of National Council of Forestry Association Executives.

Qualitative interviews

In the context of natural resource business experiences with policy, interviews are particularly helpful because of their exploratory nature. Since research into business models in sectors such as wood energy generation is in an early stage, exploratory qualitative research strategies can aid in

the understanding of how the industry as a whole functions. This is partly because interviews differ from surveys in that they typically collect contextualized, in-depth information from a smaller number of respondents and largely or exclusively utilize open-ended questions to allow respondents to elaborate and provide detail in their answers. Researchers conducting interviews generally do not attempt to gather a representative sample from a given population, though in some cases they may aim to interview a broadly representative cross-section of respondents in order to collect diverse perspectives. In other cases, interviewers target “key informants,” those most likely to possess detailed information about a particular field or topic. Interview approaches range from highly structured, in which the same questions are asked of all respondents (usually in the same order), to semi-structured, where researchers may vary the exact questions asked so as to follow the leads of greatest importance in each interview.

Advantages and disadvantages of qualitative interview methods

There are a number of advantages to conducting interviews. They allow researchers to gain an in-depth understanding of issues from the perspective of their interviewees. Additionally, interviews allow researchers to conduct exploratory research on topics that have not been examined extensively because research is still at an early stage or where there is a lack of statistically representative data. Interviews can be essential in gaining new insights into what factors influence business decision-making processes. They can also provide perspectives from firms, or various other stakeholders in the industry, on how different policies interact with each other and affect business operations, innovations, and investment decisions. Thus, interviews can potentially set the stage for later survey or other more structured research methods (Richter 2013, Leban et al. 2015). Interviewing key informants representing multiple perspectives can provide a comprehensive view of the challenges and interconnections among various market, institutional, and community issues (Becker et al. 2011). Further, because interviews allow for some level of interaction between the interviewer and the interviewee, researchers have the freedom to amend their questions and steer the discussion in the way they see fit, as well as to seek clarification or probe for elaboration (Leban et al. 2015, Musson 2012, Orozco et al. 2013).

In spite of these advantages, there are a number of disadvantages and weaknesses associated with utilizing interviews as a research method. In contrast with surveys, interviews offer “depth” of contextual detail but typically do so by sacrificing “breadth” or generalizability. Along these lines, qualitative data are generally not analyzable using the powerful statistical tools available for use with quantitative survey data. Both collecting and analyzing interview data can be time-intensive processes. In order to generate valuable data, it is generally necessary to build trust and rapport with interviewees. Even when this is successfully done some interviewees may be reluctant to provide all of the relevant details of their experiences (Gangadharan 2006).

Use of interviews in measuring policy influences on businesses

In their efforts to gain insight into natural resource industries, researchers have utilized various approaches when using interviews to assess policy impacts on businesses. The most common approaches are exclusively interviewing business owners or managers and interviewing a broad array of key stakeholders, generally including—but not limited to—business representatives. In our research, we came across several cases where researchers utilized interviews to acquire helpful information regarding policy impacts.

1. Interviews with business owners / managers

There are a number of examples in the literature where researchers have successfully conducted policy-oriented interview research with business owners and managers in order to yield insight on the factors that influence business-making decisions. For example, Richter (2013) conducted 20 semi-structured interviews with directors, department heads, and senior managers from renewable energy and business sectors within Germany to understand how firms deal with challenges prompted by a transition to renewable energies. Germany was selected for study because the country is one of the world’s leading markets for renewable energies and has established a number of policy targets to transform the energy sector as a measure to fight climate change and resource depletion. Researchers selected the specific business leaders in this study because they were forerunners in each business category. Although this method did not allow researchers to generalize across the industry as a whole, the researchers’ goal in this study was not to evaluate the industry generally, but instead to highlight a number of important industry developments. Because their research focused on forerunners in the industry, their findings revealed insight into what factors stimulate the utilization of biomass and prompt the growth of the industry.

Fischer-Smith (2013) also conducted policy-oriented interview research with business owners to understand the effect of the Earthquake Support Subsidy on small and medium-sized firms. Research was

conducted by means of 26 semi-structured interviews with business owners who were selected to balance respondents from various sectors. The interviews focused on business owners' experiences with policy and also asked them to rank their own individual patterns of interaction with public policies, including how up-to-date their knowledge is, what type of information they find valuable in public policy, and their impressions about what government level makes most decisions. By focusing more on business owners' individual levels of policy experience, context was given to the opinions they were voicing. This helped researchers understand more about whether a policy was unclear because it was inherently confusing, or because a particular business owner has no interest in being involved. An understanding of why a policy is unclear is essential when looking to inform policy-makers in hopes of influencing effective policy planning and implementation. Understanding why the policy is unclear can reveal whether the particular policy needs revision, or whether there is a policy gap in the framework that should be addressed.

2. Interviews with multiple key stakeholders representing various roles

As previously mentioned, a multitude of policies operate at the national, state, and local level that can affect natural resource businesses. This complex interaction of policies at multiple scales complicates business experiences with policies and can make policy evaluation a difficult task. Interviews with various key stakeholders beyond those associated with private firms can highlight nuances in local policy impacts. For example, Becker et al. (2011) conducted interviews with federal, state, tribal, and local government staff, loggers, manufacturers, community leaders, and environmentalists across eight states to understand what stakeholders felt was necessary to encourage the use of biomass. The stakeholder interviews focused on the connections between the market, related institutions, and communities in order to identify challenges to biomass utilization in the local context. Leban et al. (2015) also conducted semi-structured interviews with various expert representatives from policy, ecology, and research and education sectors to gain a comprehensive understanding of what policy instruments and external factors stimulate the use

of biomass. From the policy sector, researchers interviewed representatives from governmental institutions, ministries, and agencies that shape and affect forest policy decisions directly. From the ecology sector, researchers interviewed representatives from NGOs, public institutes and other bodies that influence policy indirectly. Finally, from the research and educational sector, interviews were conducted with representatives of research and educational organizations that provide decision-makers with data and analyses. This study revealed specific policy instruments and external factors driving the use of biomass in an unstable market where there was a lack of statistical data. This allowed researchers to successfully identify patterns regarding policy influences on the uptake of biomass.

Chappin et al. (2009) utilized interviews with experts and business professionals to study the effects of environmental policies on the adoption of cogeneration of heat and power installations in the Dutch paper industry. The authors commented that many studies only explore the resource-based impacts of environmental policies. Therefore, they attempted to distinguish this study from others by including behavioral and intra-organizational explanations in their findings and by focusing on the complexities caused by the simultaneous implementation of multiple environmental policies. They did this to analyze the overall accumulation of policy instruments and to identify the distinct effects of specific policies over time. Expert interviews were conducted to assist in the identification of relevant policies. Then, researchers conducted interviews with business professionals. An issue identified in this study was that because they focused on the effects of policies over time, many of the policies were enacted decades before the interviews and people involved in decisions surrounding those policies were no longer with the firm. Additionally, because the policies were enacted so long ago, researchers had to prompt respondents with an overview of policy instruments, highlight key events, and recall context. This had the potential to affect the content of the responses. Despite these difficulties, this study was still able to successfully study the effects that complex policy interactions can have on an industry.



Secondary data analysis

Secondary data analysis offers a way to reconceptualize and reformulate existing data to answer a number of different research questions. What differentiates secondary data analysis from most other methods is that the data under analysis were not collected for the current study and that the research team conducting the analysis is generally separate from the team that originally collected the data. These data can come from a variety of sources, including governmental studies, industry research, or prior academic endeavors. Econometric analysis, which conducts statistical analyses based on economic models, is often used to determine the impact of public policies on outcomes of interest, such as economic activity. While not all econometric analyses exclusively use secondary data, we include this method here because of its heavy reliance upon secondary data to populate its models.

Advantages and disadvantages of secondary data analysis methods

One key advantage of secondary data analysis is that it can be less expensive and faster to utilize existing data than to collect new data. Additionally, the data involved in secondary data analysis are often of high quality if they were generated by agencies or organizations with large budgets for data collection and quality control. Econometric methods can reveal the economic effects of policies that may be difficult to capture with other research methods (Kemp and Pontoglio 2011). Econometric analyses can provide researchers with tools for isolating and examining the effects of complex environmental policies that are otherwise difficult to quantify.

The main weakness in conducting secondary data analysis is the validity of the data (Nielsen-Pincus et al. 2013). When a researcher has collected data for a particular purpose, it can be difficult to assure that the data will also be appropriate for a secondary purpose. The researcher often needs to determine whether the current research questions align in such a way as to provide a valid measure of the variables being analyzed in the current study. Additionally, secondary data analysis is not well suited for measuring certain factors, such as the motivat-

ing forces behind decisions or changes made. Researchers have acknowledged the difficulty in measuring the effects of environmental policies with econometric methods specifically. This is because the design aspects of environmental policies often include variables such as strictness, enforcement, differentiation of instruments, and instrument combination, all of which are difficult to integrate into an econometric analysis. Additionally, the synergies of these different aspects influence the overall effectiveness of the policy. Further, researchers may be limited by a lack of available data regarding new or rapidly changing policies or markets (Von Detten and Faber 2013).

Use of secondary data analysis in measuring policy influences on businesses

1. Econometric analysis

Econometric analysis involves the use of statistical modeling for the purpose of testing research questions, analyzing market trends, or forecasting future trends. What distinguishes econometric methods from other quantitative secondary methods is the orientation toward specifically economic models and analytic techniques. Econometric analyses are particularly useful in the energy landscape because they can provide a method of empirical investigation of problems at various scales. For example, they can be used to look at how energy prices and regulations influence innovation. There are a number of examples of researchers utilizing econometric analyses to measure policy impacts on businesses. For example, econometrics has been used to examine the effects policies have on businesses regarding their decisions on things such as product development, cleaning processes, and waste management activities (Kemp and Pontoglio 2011). Jenner et al. (2013) looked at the effects of taxes in encouraging the adoption of renewable energy technologies in Europe. To do this, researchers gathered data regarding the effectiveness of feed-in tariffs as a method of encouraging renewable energy generation (solar and onshore wind power development) in 26 European Union (EU) countries. In order to provide a detailed treatment of the policies, researchers looked at a number of different factors including variability in tax size, contract

duration, digression rate, and electricity price and production cost to estimate and examine the return on investment.

A number of other studies also demonstrate the usefulness and versatility of an econometric method of studying policy effects on firms, including many investigations of policy influences on renewable energy generation. Guo et al. (2013) utilized econometric analyses to explore the effects of woody biomass policies on the siting decisions of new bioenergy projects. Additionally, Shrimali and Kniefel (2011) used econometric analyses to estimate the effects of state policies on the uptake and utilization of various emerging renewable electricity sources including wind, biomass, geothermal, and solar photovoltaic. Haitao and Powers (2010) also conducted an econometric analysis to measure the stringency and evaluate the impacts of renewable portfolio standard policies on in-state renewable electricity development. Finally, Martin et al. (2012) used econometrics to estimate the impact of the EU Emissions Trading System (ETS) on firms.

2. Non-econometric secondary data analyses

There are also a number of examples of non-econometric methods of secondary data analysis in the literature. Broz and Plouffe (2010) used a non-econometric secondary data approach to determine how monetary policies affect firms' monetary decisions. They utilized data from the World Bank's World Business Environment Survey (WBES), which collected firm-level data by administering a survey to firm managers from nearly 10,000 different businesses. The authors note that their analysis sought to provide a more proximate understanding of how monetary anchors impact private-sector inflation concerns. This study is a notable example of a secondary data analysis because of the robustness of the data used. The authors stated that a micro-level approach provides a more proximate relationship and corresponding analysis of monetary policies than a broader analysis would be able to accomplish. While their study was not specifically focused on natural resource businesses, this same approach could help researchers study and understand different innovation tactics and policies on



a small scale to help sustain businesses in the face of various energy, environmental, natural resource management, and other relevant policies.

Gangadharan (2006) also utilized data from the World Bank by analyzing data from a 1995 World Bank survey conducted in Mexico. The 1995 survey was designed to represent Mexican industries in categories that were defined by sector, size class, and location. The World Bank surveyed representatives at 236 plants (62 in food sector, 62 in chemical sector, 51 in non-metallic minerals, 61 in metals) about compliance with environmental regulation and management. As part of a secondary data analysis, Gangadharan (2006) examined incentives that firms face to initiate environmental improvement programs and comply with regulations. This research analyzed firms' compliance with environmental laws and examined if they have implemented any improvement programs with respect to their environmental performance or if they had plans to undertake improvements. The significance of this study was that researchers used the existing data to reformulate the analysis to gain an understanding

into why some firms comply with policy even when there is little financial incentive to do so while others continually violate environmental regulations.

Calel and Dechezlepretre (2016) compared the thousands of firms in the EU that are regulated under the ETS, the largest policy initiative of its kind in the world. Research was conducted to determine whether firms filed climate-related patents or patents protecting low-carbon technologies. To analyze patent data, researchers looked to the World Patent Statistical Database, which is maintained by the European Patent Office. Their analysis exhausted the database of 8.5 million European firms, 5,000 of which were regulated under the EU ETS. This patent-based secondary data analysis was an effective research method because it afforded researchers the opportunity to comprehensively evaluate the EU ETS and its effects on businesses. Researchers looking to understand what policy mechanisms prompt natural resource business innovations could use a similar research strategy as Calel and Dechezlepretre, so long as most innovations are captured through the filing of patents.





Mixed-method approaches

Mixed-method research differs from single-method research in that it allows researchers to approach problems from multiple angles simultaneously by overcoming the inherent limitations of single methods. Researchers can thus “triangulate,” cross-checking data collected via one method against data collected via other methods. Because of their multi-faceted nature, mixed-method approaches are particularly useful in helping to highlight areas where further research is needed, or where different research methods could be useful (Brukas and Sallnas 2012).

Interview / secondary data analysis combinations

Interview and secondary data analysis combinations are a common mixed-method approach to research: the secondary data analysis provides broad, representative patterns while interview data provide depth and context. There are a number of examples of this approach in the literature. Gossum et al. (2009) conducted a comprehensive analysis

to evaluate and estimate the level of support for various new policy instruments for forest expansion in northern Belgium. To do this, researchers first conducted 26 interviews with representatives of various political parties, Parliament, cabinet advisors of the Minister of the Environment, interest groups, experts, environmental NGOs, and other stakeholders. Next, the researchers conducted four interviews with experts on forest expansion policy, to obtain a second dataset that consisted of highly specified information. Finally, the researchers conducted a web-based search on countries with a high similarity in culture, socio-economic structure, population density, and forest cover to find possible transferable policy instruments. This web-based search, which comprised their third set of data, was conducted to inform the design of proposed policy instruments. Researchers emphasized the need to collect three distinct datasets to triangulate their findings and increase the validity of the study. Their analysis allowed them to indicate regulation gaps and also to comment on design options for policies.



Interview / survey combinations

Interview and survey combinations are also a common mixed-method research approach. Interviews may be used to understand key concerns and patterns that are then tested through a more extensive and representative sample of actors, or interviews can be used following the survey to aid in interpretation of results. There are a number of examples of this mixed-method approach in the literature. Orozco et al. (2013) collected their data in two phases to gain an understanding of Oregon's forest sector innovation system. In the first phase, they administered semi-structured interviews to allow freedom to probe for clarification or elaboration. Interview results were then used to inform survey development. For example, data collected during the interviews were used to identify the specific organizations, policies, and incentives to ask about in the survey phase of the study. To supplement the interview process, researchers also collected data via a web-based secondary data analysis to help inform the survey development process. Their survey was mailed to a group of representatives from various forestry agencies, firms, and associations in Oregon.

Another example of an interview and survey mixed-method approach is Engau and Hoffman's (2010) evaluation of perceived uncertainty regarding regulation targeting carbon-intensive industries. Often, when interview and survey combinations are utilized, the interview is done prior to surveying, given that conducting interviews can assist in the development of survey instruments. Engau and Hoffman (2010) deviated from this traditional approach and conducted a survey first and then conducted interviews with executives from affected firms after survey data had been analyzed, helping them cross-verify their quantitative results and support their conclusions.

Case studies

Case studies represent a unique research strategy in which multiple data sources are used to understand the intricacies of one or more "cases" of a particular phenomenon to answer a research question. The cases themselves may be chosen for many reasons, including to maximize variability, to focus on ei-

ther representative or atypical cases, or to test the limits of a particular theory, but they are generally not chosen randomly. Case study researchers attempt to detail the inner workings of a particular example (or examples) of a phenomenon in order to illuminate important relationships and dynamics, or to build hypotheses for future studies (Yin 2014). The boundaries of case studies may vary widely, from entire countries or sectors to studies of individual innovations or businesses.

Advantages and disadvantages of case study approaches

There are a number of strengths and advantages to using a case study as a research strategy. Case studies' greatest strength is their deep empiricism—their ability to detail a complex suite of intersecting factors that inform the dynamics of the cases under study. This ability to examine the various intersecting factors in the cases under study makes the case study research method well suited to look at the complexities involved in natural resource business decision-making processes. The flexibility of the case study research method also allows researchers to develop expansive descriptions, generate hypotheses, and make comparisons across cases (Buttoud et al. 2011). Additionally, case studies can be used for hypothesis testing, particularly when they analyze an "extreme" or "critical" case (Flyvbjerg 2006). Further, case studies can produce a wide range of findings based on various data sources (persons, times, places), methods (observations, interviews, etc.), and data types (textual, quantitative, etc.). This potential mix of primary and secondary data, in addition to the numerous ways data are collected, offers researchers the opportunity to substantiate their findings through the convergence of multiple data sources (Kah-Hin and Yeo 2012).

There are also a number of disadvantages and weaknesses to case study research. First, case studies can often be more complex and time-intensive than other research strategies. Second, the diversity and complexity in many policy systems makes it difficult to directly compare policies in a case study or across cases (McCormick and Kaberger 2007). Additionally, because data are generally col-

lected from a smaller number of units, and because phenomena are examined by applying an in-depth analysis to a controlled area of focus, statistical generalization is normally not possible (Stevanov et al. 2016). Referring specifically to bioenergy systems, researchers have voiced concern with using case study research. This is because the field of bioenergy is relatively new, and there is great diversity in the field, making it difficult to compare multiple bioenergy case studies (McCormick and Kaberger 2007).

Use of case studies in measuring policy influences on businesses

Common case study approaches to assessing policy impacts on businesses include case studies of success stories, comparative case studies, sectoral case studies, and spatial case studies.

1. Success case studies

Within the case study method, researchers often focus studies on success stories within a given sector. Case studies that highlight success stories in natural resource industries can help researchers understand what decision-making strategies, innovation decisions, and policy impacts have resulted in significant and positive changes for business owners. Kah-Hin and Yeo (2012) conducted a case study to categorize barriers to energy efficiency and to gain an understanding of the relationships between them. Their research focused on Glaxo Wellcome Manufacturing Singapore's energy efficiency because this firm has been active and successful in pursuing energy efficiency and conservation measures for over a decade. Researchers analyzed the various stages of the energy efficiency barriers via a feedback loop to look at the motivation behind energy efficiency and conservation initiatives, the capability of the initiatives to be successful, the corresponding implementation of the initiatives, and finally, the results. Madlener (2007) undertook a case study that looked at two different biomass district heating (BDH) plants in the Vorarlberg province in Austria. The case studies were used to analyze and draw conclusions about BDH plants at a national level, at the level of the federal province of Vorarlberg, and also at the plant level. One of the

plants was a successful BDH plant, chosen for the purpose of understanding what factors influenced its success. Research focused on the role of public policy, local actors, and economics on the market diffusion dynamics of rural BDH plants. The goal of their research was to identify what factors make a plant successful in order to serve as a model for later BDH developments.

2. Comparative case studies

Comparative case studies allow researchers to compare multiple cases of a common phenomenon. Buttoud et al. (2011) focused their case study on firms demonstrating four distinct avenues of innovation in the forestry sector. They analyzed institutional innovations in relation to forestry policymaking in Austria, Scotland, and France in order to reflect on the role of the market, analyze the inter-linking of policy decisions, and to develop ideas regarding how to promote innovation in the forestry sector. Rogge et al. (2012) interviewed diversified and specialized technology providers as well as both large and small corporate actors in both established power generation fields, such as coal and gas, and emerging power generation areas, such as wind and biogas. The diversity of the sample was essential to capture the wide range of corporate responses to the EU ETS. Interviews were conducted with experts, in addition to people representing technology, strategy, sales, and climate policy areas. Researchers said that the mixed and comparative case study approach was especially useful for studying complex contemporary phenomena of emerging power generation fields. Hoberg et al. (2016) conducted a comparative case study of four Forest Stewardship Plans (FSPs) in British Columbia to examine the effects of regulatory reform on forestry practices and innovation. The sample was chosen by means of a broad survey and interview process to identify four FSPs that spanned an array of company sizes, geographic locations, and commitments to various forestry-related initiatives. By comparing FSPs that were implemented in a variety of sectoral and spatial areas, researchers were able to conduct an in-depth exploration to analyze and compare behavioral responses to regulatory reform within a diverse study sample.



3. Sectoral case studies

Sectoral case studies allow researchers to focus on a specific business, governmental, or non-profit sector. Raitio (2012) combined interviews and a legal analysis to analyze the relationship of collaborative planning to the regulatory context in Finland. The goal of the study was to understand the role regulatory structures play in collaborative natural resource planning strategies and decisions. Forbord et al. (2012) conducted a sectoral case study that examined five different businesses operating at various stages in the bioenergy supply chain. Experts assisted the researchers in their selection of the five case studies to exemplify the growth of new bioenergy firms in the Netherlands. Each case study represented a different business actor operating at a certain stage in the supply chain, which gave the

researchers a comprehensive look into the Netherlands' bioenergy sector. The Oregon State University (OSU) Chemical Engineering Department, the OSU Institute for Natural Resources, and the OSU Oregon Wood Innovation Center (2007) developed a case study to assess barriers to biomass utilization and identify opportunities for increased utilization. To do this, researchers conducted interviews with 23 stakeholders from the landowner sector (industrial private and non-industrial private), from the forestry sector (biomass users), and from the pulp and paper sector. The high volume of stakeholder opinions gave researchers an extensive look into the biomass sector by identifying barriers and opportunities related to the biomass utilization in Oregon.



4. Spatial case studies

Spatial case studies allow researchers to focus their study on a specific geographic area of interest. Thornley and Cooper (2008) conducted a spatial case study to look at the capacity of bioenergy electricity generation and actual bioenergy outputs for four European countries. They utilized a spatial case study to compare the growth of the bioenergy industries with the country's national energy policy. The data juxtaposing the capacity of bioenergy generation and actual bioenergy output were compared against a timeline of policy initiatives from 1990 to 2007. Researchers also conducted interviews with experts who had direct experience with the bioenergy industry to understand the details of policy development during the study time frame.

Researchers also often conduct spatial/sectoral case studies. Spatial/sectoral case studies allow researchers to focus their study on a sector within a specific geographic location of interest. McCormick and Kaberger (2007) conducted a spatial/sectoral case study that examined 12 cases of bioenergy system development from eight European countries. Not only did they seek to study the challenges confronting the EU and its member states in regards to their implementation of bioenergy systems, but they also sought to study the bioenergy sector to break down the supply chain to truly understand all of the elements at play within the whole system. Researchers identified four major areas within bioenergy systems as biomass resources, supply systems, conversion technologies, and energy services. Researchers also acknowledged the role of various

actors from outside the bioenergy sector that play a role in how the system functions. Researchers analyzed their case studies from this spatial/sectoral approach to explore the EU bioenergy sector as a whole.

Other approaches

Aside from the various single-method and mixed-method approaches that were discussed throughout this paper, there are other research methods that do not fit into any one of the generalized categories previously mentioned. One example is a study done by Aguilar (2009), where the goal was to help guide the establishments of wood-based bioenergy plants in the Southern part of the United States. Researchers classified their mixed-methods approach as a "spatial econometric analysis," which utilized a survey questionnaire, a spatial case study analysis, and an econometric analysis. First, researchers conducted a literature review to develop a survey that was then sent to owners and managers of sawmills. Next, they conducted an exploratory spatial analysis and gathered data about location patterns of sawmill companies. Then, researchers performed a spatial econometric analysis incorporating GIS data. Researchers noted that the survey was useful in identifying the location preferences based on decision makers' opinions, the spatial analysis helped identify where future expansions can be expected, and the econometric model allowed them to see what policies were successful and what recommendations should be made.

Summary and conclusions

In this paper we reviewed various approaches used to study the effects of policy instruments on natural resource business decision-making. Understanding these diverse methodological approaches, including their advantages and disadvantages, is essential for academics and policy analysts attempting to determine the effectiveness of natural resource policies and programs and inform the design of effective public policies. One important conclusion from our review is that there is no single method that is clearly superior for assessing policy impacts on firms; the method chosen in a particular case should reflect the specific research question under study as well as considerations such as the presence or absence of prior research in the field, availability and quality of existing data, and the accessibility and knowledge level of potential research subjects.

When investigating rapidly changing environments and areas that lack robust or extensive data, approaches such as surveys and interviews are useful. Survey methods may be preferred when the objective is to draw inferences about population (of people, businesses, etc.) Successful survey research depends on the existence of a well-defined population, a means for generating a representative sample of that population, and the presence of a sufficiently large number of individuals willing to complete a survey instrument. Surveys may be less appropriate, however, where the population is unknown or poorly defined or where not enough information is known to construct meaningful response categories. Interviews can be used to generate in-depth information and detail on policy impacts. This information can be useful in its own right, and can also be a resource for informing surveys (or for interpreting the results of prior surveys).

When looking to re-conceptualize and re-frame an existing area of study, researchers can utilize secondary data analysis, which offers researchers another way of understanding how policies affect

businesses. Secondary data analyses may also offer the chance to utilize high quality data, which can increase the validity of the findings. Econometric methods can reveal the economic effects of policies, and offer researchers a way to isolate the economic effects of complex environmental policies that would be otherwise difficult to quantify with other research methods.

Mixed-method approaches offer researchers options for overcoming the inherent limitations of single methods by allowing them to approach problems from multiple angles simultaneously. For example, researchers can utilize combinations of interviews, surveys, and secondary data analyses to provide a multifaceted picture of policy impacts. As a particular mixed-method research strategy, the case study may be useful for detailing the complex suite of intersecting factors that inform the dynamics of the case or cases under study. This allows researchers to develop expansive descriptions, generate hypotheses, and make comparisons across cases in order to assess interactive policy systems as well as individual policies in isolation.

In addition to the various methods discussed in this paper, there are other research methods that could be utilized. For example, we did not find any examples in the literature of a technology case study, which can be used to show how different regulatory mechanisms encourage innovations that are both incremental and radical (Kemp and Pontoglio 2011). There is also relatively little existing research that attempts to analyze the impacts of policy systems as a whole, a task that implies greater methodological complexity than studying individual policies in isolation. Given the proliferation of public policies that affect natural resource businesses, as well as the diversity of firms engaged in natural resource utilization, much work remains to be done in understanding business decision-making to inform policy design and support innovation.

Summary of reviewed literature

Author(s)	Year	Title	Journal	Method(s)
Aguilar, Francisco X.	2009	Spatial econometric analysis of location drivers in a renewable resource-based industry: The U.S. South lumber industry	<i>Forest Policy and Economics</i> 11(3): 184-193	Mixed-methods (spatial econometrics analysis)
Aguilar, Francisco Garrett, Gene H. E.	2009	Perspectives of woody biomass for energy: Survey of state foresters, state energy biomass contacts, and National Council of Forestry Association executives	<i>Journal of Forestry</i> 107(6): 297-306	Single-wave survey
Aguilar, Francisco Saunders, Adam M.	2011	Attitudes towards policy instruments in promoting wood-to-energy initiatives in the United States	<i>Southern Journal of Applied Forestry</i> 35(2): 73-79	Single-wave survey
Becker, Dennis R. McCaffrey, Sarah M. Abbas, Dalia Halvorsen, Kathleen E. Jakes, Pamela Moseley, Cassandra	2011	Conventional wisdoms of woody biomass utilization on federal public lands	<i>Journal of Forestry</i> 109(4): 208-218	Key stakeholder interviews
Bolo, Awino Z.	2011	An empirical investigation of selected strategy variables on firms performance: A study of supply chain management in large private manufacturing firms in Kenya	<i>Journal of Public Administration and Policy Research</i> 3(8): 228-236	Survey
Broz, J. Lawrence Plouffe, Michael	2010	The effectiveness of monetary policy anchors: Firm-level evidence	<i>International Organizations</i> 64(4): 695-717	Non-econometric secondary analysis
Brukas, Vilis Sallnas, Ola	2012	Forest management plan as a policy instrument: Carrot, stick or sermon?	<i>Land Use Policy</i> 29: 605-613	Single-wave survey
Calel, Raphael Dechezlepretre, Antoine	2016	Environmental policy and directed technological change: evidence from the European carbon market	<i>The Review of Economics and Statistics</i> 98(1): 173-191	Non-econometric secondary analysis
Chappin, Maryse M. H. Vermeulen, Walter J. V. Meeus, Marius Hekkert, M. P.	2009	Enhancing our understanding of the role of environmental policy in environmental innovation: Adoption explained by the accumulation of policy instruments and agent-based factors	<i>Environmental Science and Policy</i> 12(7): 934-947	Key stakeholder interviews
Engau, Christian Hoffman, Volker H.	2010	Corporate response strategies to regulatory uncertainty: Evidence from uncertainty about post-Kyoto regulation	<i>Policy Sciences</i> 44(1): 53-80	Mixed-methods (interview / survey combination)
Fischer-Smith, Ruth	2013	The earthquake support subsidy for Christchurch's small and medium enterprises: Perspectives from small business owners	<i>Small Enterprise Research</i> 20(1): 40-54	Business owner / manager interviews
Flyvbjerg, Bent	2006	Five misunderstandings about case-study research	<i>Qualitative Inquiry</i> 12(2): 219-245	Case study
Forbord, Magnar Vik, Jostein Hillring, Bengt	2012	Development of local and regional forest based bioenergy in Norway – Supply networks, financial support, and political commitment	<i>Biomass and Bioenergy</i> 47: 164-176	Sectoral case study
Gangadharan, Lata	2006	Environmental compliance by firms in the manufacturing sector in Mexico	<i>Ecological Economics</i> 59(4): 477-486	Non-econometric secondary data analysis

Author(s)	Year	Title	Journal	Method(s)
Gossum, Peter V. Ledene, Liselot Arts, Bas De Vreese, Rik Van Langenhove, Gudrun Verheyen, Kris	2009	New environmental policy instruments to realize forest expansion in Flanders (north-east Belgium): A base for smart regulation?	<i>Land Use Policy</i> 26: 935-946	Mixed-methods (interview / survey combination)
Guo, Zhimei Hodges, Donald G. Young, Timothy M.	2013	Woody biomass policies and location decisions of the woody bioenergy industry in the southern United States	<i>Biomass and Bioenergy</i> 56: 268-273	Econometric analysis
Hoberg, George Malkinson, Leah Kozak, Laura	2016	Barriers to innovation in response to regulatory reform: Performance-based forest practices regulation in British Columbia	<i>Forest Policy and Economics</i> 62: 2-10	Comparative case study
Jenner, Steffen Groba, Felix Indvik, Joe	2013	Assessing the strength and effectiveness of renewable electricity feed-in tariffs in European countries	<i>Energy Policy</i> 52: 385-401	Econometric analysis
Kah-Hin, Chai Yeo, Catrina	2012	Overcoming energy efficiency barriers through systems approach – A conceptual framework	<i>Energy Policy</i> 46(C): 460-472	Success story case study
Kemp, Rene Pontoglio, Serena	2011	The innovation effects of environmental policy instruments – A typical case of the blind men and the elephant?	<i>Ecological Economics</i> 72: 28-36	Econometric analysis, mixed-methods, technology case study
Lanfranchi, Joseph Pekovic, Sanja	2014	How green is my firm? Workers' attitudes and behaviors towards job in environmentally-related firms	<i>Ecological Economics</i> 100: 16-29	Single-wave survey
Leban, Vasja Malovrh, Spela P. Stirn, Lidija Z. Krc, Janez	2015	Forest biomass for energy in multi-functional forest management: Insight into the perceptions of forest-related professionals	<i>Forest Policy and Economics</i> 71: 87-93	Key stakeholder interviews
Madlener, Reinhard	2007	Innovation diffusion, public policy, and local initiative: The case of wood-fuelled district heating systems in Austria	<i>Energy Policy</i> 35(3): 1992-2008	Success story case study
Martin, Ralf Muuls, Mirabelle Wagner, Ulrich J.	2013	Carbon markets, carbon prices, and innovation: Evidence from interviews with managers	<i>Annual Meetings of the American Economic Association, San Diego</i>	Econometric analysis
McCormick, Kes Kabberger, Tomas	2007	Key barriers for bioenergy in Europe: Economic conditions, know-how and institutional capacity, and supply chain coordination	<i>Biomass and Bioenergy</i> 31: 443-452	Spatial / sectoral case study
Mola-Yudego, Blas Pelkonen, Paavo	2008	The effects of policy incentives in the adoption of willow short rotation coppice for bioenergy in Sweden	<i>Energy Policy</i> 36: 3062-3068	Survey
Musson, Anne	2012	The build-up of local sustainable development politics: A case study of company leaders in France	<i>Ecological Economics</i> 82(C): 75-87	Interviews
Nielsen-Pincus, Max Krumenauer, Matt MacFarland, Katherine Moseley, Cassandra	2013	Impacts of biomass producer or collector tax credit on Oregon's wood fuels market and economy	Ecosystem Workforce Program Working Paper #32	Econometric analysis

Author(s)	Year	Title	Journal	Method(s)
Orozco, Nadine Hansen, Eric Knowles, Chris Leavengood, Scott	2013	Oregon's forest sector innovation system: An investigation towards advanced performance	<i>The Forestry Chronicle</i> 89(2): 225-234	Mixed-methods (interview / survey combination)
OSU Chemical Engineering Department OSU Institute for Natural Resources OSU Oregon Wood Innovation Center	2007	Woody biomass in Oregon – Current uses, barriers, and opportunities for increased utilization, and research needs	<i>Oregon Biofuels and Biomass</i> : 1-97	Sectoral case study
Raitio, Kaisa	2012	New institutional approach to collaborative forest planning on public land: Methods for analysis and lessons for policy	<i>Land Use Policy</i> 29: 209-316	Sectoral case study
Richter, Mario	2013	Business model innovation for sustainable energy: German utilities and renewable energy	<i>Energy Policy</i> 62: 1226-1237	Business owner / manager interviews
Rogge, Karoline S. Schneider, Malte Hoffman, Volker H.	2012	The innovation impact of the EU Emissions Trading System – Findings of company case studies in the German power sector	<i>Ecological Economics</i> 70(3): 513-523	Comparative case study
Shrimali, Gireesh Kniefel, Joshua	2011	Are government policies effective in promoting deployment of renewable electricity resources?	<i>Energy Policy</i> 39: 4726-4741	Econometric analysis
Stevanov, Mirjana Dobsinska, Zuzana Surovy, Peter	2016	Assessing survey-based research in forest science: Turning lemons into lemonade?	<i>Forest Policy and Economics</i> 68(C): 105-117	Survey, case study
Thornley, Patricia Cooper, Deborah	2008	The effectiveness of policy instruments in promoting bioenergy	<i>Biomass and Bioenergy</i> 32: 903-913	Spatial case study
Von Detten, Roderich Faber, Fenn	2013	Organizational decision-making by German state-owned forest companies concerning climate change adaptation measures	<i>Forest Policy and Economics</i> 35: 57-65	Secondary data analysis
Yin, Haitao Powers, Nicholas	2010	Do state renewable portfolio standards promote in-state renewable generation?	<i>Energy Policy</i> 38: 1140-1149	Econometric analysis
Yin, Robert K.	2014	Case Study Research: Design and Methods	Fifth Edition: Sage Publications	Case study

Appendix A: Methods used to gather research data

We used a multi-pronged approach to searching for relevant material for this methodological review. We began with a known set of articles from prior research and publications on policy impacts on natural resource firms. We then proceeded to search for additional sources using academic search engines and a targeted review of specific journals. Articles were selected based on their intent to assess policy impacts on businesses; only those articles with sufficient methodological detail to contribute to our analysis were included. The academic search engines used included Business Economics and Theory, Business Source Complete, EconLit, Environmental Studies and Policy, Google Scholar, Health and Wellness Resource Center, HeinOnline, ProQuest Political Science, and Westlaw. In conducting our searches we used a number of search terms including “business owner(s),” “business manager(s),” “policy effect(s),” “policy impact(s),” “legal impact(s),” “legal effect(s),” “decision-making,” “business decisions,” “decision-making process,” “policy implementation strategies,” “program implementation strategies,” “policy implementation,” “policy assessment,” “program assessment,” “program implementation,” “policy

implementation research,” “program implementation research,” “program uptake,” “policy uptake,” “program effectiveness,” and “policy effectiveness.” We also paired these various search terms with secondary search term such as “firms,” “business,” “opinion,” “perception,” “research,” and “research strategies” to keep the search focused on the types of articles we were trying to elicit. The specific journals reviewed were Forest Policy and Economics and Ecological Economics. For this targeted journal review, we reviewed every issue published since 2005, manually scanning for articles that appeared to provide new methodological insights or that otherwise appeared relevant to our objectives. Our review of the articles was used to populate an Excel database with information regarding the method, method summary, whether it was a single- or mixed- methods approach, whether there was a single policy or multiple policies analyzed, advantages and disadvantages of the study, and notes on whether the topical area was relevant to our own research. We used this database, along with the details of our literature review, to inform our synthesis of methods.

