THE ROLE OF INFORMATION IN ENVIRONMENTAL GOVERNANCE

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The global environment is changing and policy scholars point to the need for more innovative and information-driven solutions. Sophistications in environmental measurement and modeling may offer opportunities for making environmental policies more transparent and cost-effective, but institutions that oversee policy processes may be slow to change and sometimes resist change. In this dissertation I look at the role of policy networks in conceptualizing the changing nature of environmental governance in the digital age. I study how policy actors develop arguments, mobilize resources, and work around new policy models to resist or control change dynamics. Seen through the perspective of policy networks, the success of new policy ideas depends on how and to what extent incumbent actors are able to interpret, adapt, and absorb changes in their own terms. I focus on innovative policy models such as outcome-based approaches to reform agri-environmental policies in the US. My dissertation centers on an environmental quantification algorithm mobilized to rationalize conservation subsidies in a $10 billion federal US agricultural program. By foregrounding performances of bureaucrats building and using the information infrastructures, I contrast the dynamic potential of data-driven technologies with the rigidity of bureaucracies. I conduct a mixed-methods analysis: historical study of how the algorithm was designed, an ethnography of how the algorithm is used by street-level bureaucrats, and an econometric analysis of public spending on over 55,000 contracts. Drawing attention to the performances of data-driven conservation at different levels of the government opens a critical and timely debate on how information triggers policy innovations. I show that information both disciplines bureaucratic discretion and yet the very legitimacy of the numbers depends on the trust in the bureaucracy's established culture and routines. The paradoxical dynamic ensures that without a change in the larger political-administrative structures that shape confidence in the calculations, data-driven policies may perform calculation but produce little policy change.

BIOGRAPHICAL SKETCH

Ritwick is an interdisciplinary social scientist studying how public and private institutions are transforming in the face of global environmental change. He is particularly interested in the application of digital technologies in creating new and innovative environmental policies. Prior to his doctoral training, Ritwick earned a Master's in Public Administration (M.P.A.) from Cornell Institute of Public Administration. He also received a B.Sc. in Economics and Statistics from Singapore Management University (SMU) in 2007. Ritwick has extensive work experience in public institutions across the world including the UN Department of Economic and Social Affairs (UN-DESA) in New York, The Economics of Ecosystems and Biodiversity (UNEP - TEEB) Initiative in New Delhi, and as an Economist in a private advisory firm, Centennial Asia Advisors, in Singapore. His work has been published in top tier journals, such as The Annals of American Association of Geographers, Cultural Economy, and Land Use Policy. He is currently a Post-doctoral Fellow in the Department of Environmental Studies in New York University (NYU).

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CHAPTER 1: INTRODUCTION

1.1 Dissertation Plan

Central Research Question

The principal objective of this dissertation is to understand how public institutions harness the power of information to address (or avoid addressing) environmental problems. Global environments are changing and government responses are seen as inadequate, sluggish, misdirected, and in overall need of change. Within the observation of a weak state, calls for environmental reform have strengthened around using information resources to go beyond the traditional command and control approaches and encourage private regulation and entrepreneurship. These "economic rationalist" ideas have focused primarily on incentivizing private actions toward sustainability. Economic rationalist ideas come in different forms such as payments for ecosystem services, outcome-based conservation, and pay-for-performance governance. While the models differ in program design and theoretical logic, they rely on environmental information: data-sets, accounting protocols, remote sensing, and ecological modeling, to organize how and where the incentives would be targeted. Assuming that resources available to incentivize private actions are limited, the role of information in guiding resource allocation decisions has implications for the total scope of private-sector involvement in environmental governance. By using high-quality information on the nature and extent of environmental risks and potential benefits, economic rationalists argue that limited public resources can be distributed to private lands in a more efficient manner that maximizes environmental protection for the same level of government funding. Building new informational resources or informational infrastructures has emerged as an important technical and political project in structuring institutional change applied to environmental governance.

However, new policy ideas do not operate in institutional vacuums. Rather policy networks, formal and informal linkages across both governmental actors and non-governmental actors, shape change. Policy networks may be remarkably stable even as they are negotiated and informal. When those currently benefiting from the way things are, i.e. actors in incumbent policy networks, calculate that expected outcomes are unfavorable for their strategic interests, they may develop arguments, mobilize resources, and work around ideas to resist change. Seen through the perspective of policy networks, the success of new policy ideas depends on how and to what extent incumbent actors are able to interpret, adapt, and absorb new policy ideas in their own terms. Moreover, an innovation that supplies incumbent actors the resources to strengthen their legitimacy could fortify rather than weaken authority and thus technological innovations may invariably create conditions for actors to control policy narratives and extend power. It is then inadequate to reference how policy ideas are increasingly reflecting economic rationalist language and instead, to ask how actors position mobilize economic language to position themselves in relation to economic rationalist promises. New infrastructures build upon old ones, and new actors do not simply replace incumbents (Bowker and Star, 2000; Star, 1999). To understand how data-sets, geo-spatial technologies, models, sensor technologies, and all sorts of environmental information infrastructures create conditions for institutional change, it is necessary to take a critical posture toward the practical efforts to marshal these resources when making claims about innovation, efficiency, and responsiveness to policy challenges. I ask:

> **How do public institutions embrace, build, and operate information infrastructures in order to perform economic rationalization and to what extent do information infrastructures destabilize policy networks and trigger institutional change?**

The question merits thinking more closely about the concept of the "performative", a term that has proven useful in understanding how ideas and languages create change by the effectiveness of their enacted forms. To understand the power of economic rationalist language to create changes, I draw attention the practical work of organizing information infrastructures that support economic calculations. I seek to understand how different communities of practice within and outside the network engage with the information infrastructures while keeping their own strategic interests in mind. When I refer to communities of practice, I draw on the work of Lave and Wenger (1991) to focus analytical attention on different social groups who share concerns, problems, and interests in the given topic and who through regular interactions are able to deepen knowledge and expertise on the subject. Moreover, I also ask how actors are able to do what they do, i.e. what systems of checks and balances do actors face and how actors justify their decisions through references to broader rules, norms, technologies, and conventions.

The dissertation brings together ideas from many disciplinary fields: Political

Ecology, Science and Technology Studies, and Ecological Economics. Through my engagement with a variety of literatures, I hope to advance a theoretically stimulating and empirically rich contribution to environmental social science. I advance critical analysis of institutional change in a $10 billion conservation incentive program in the context of US agricultural subsidy policies. Methodologically, I combine a sociological analysis of technological development in Chapter 2, a practice-centered analysis of bureaucratic work in Chapter 3, and a classical econometric analysis of public spending in Chapter 4.

I hope that while the dissertation primarily adopts a critical stance, it is also relevant for policy analysis. The ambition motivates the choice of the high profile case-study and methods adopted. Given the scale of environmental problems ahead, it is important to critically engage economic ideas that purport to produce more environmental goods at lower costs. At the same time, it is also important to question who wins and losses when the language of rationality dominates policy discourse. I show in the course of the following chapters the value of moving beyond the debate over economic rationalism as the ideal type for environmental reform and instead focus analytical energies on the practical coordination challenges entailed in working with information infrastructures, a large bureaucracy, and private landholders.

<u>Overall Structure</u>

The dissertation organized in five chapters, including this Introduction:

Chapter 2: Environmental Models and Economic Rationalization: A Critical

Analysis

To understand how communities of practice engage information resources, we must examine how the relevant information infrastructures are conceptualized and built. In this chapter I examine the interactions across different actors within the policy network: political aides, elite bureaucrats, and ecological modelers/scientists, as they assemble an informational infrastructure for advancing outcome-based policies. I observe how the technical negotiations are organized and how problems of validity, accuracy, and precision of data are socially and practically negotiated. By focusing on tool development, I analyze how the model becomes a resource for the political actors to resist rather than initiate change. I found that there was little accountability to the tool development process and the tool's sphere of authority was profoundly circumscribed through policy guidelines. I conclude that centralizing research on narrowly conceptualized technical questions of data adequacy, precision, and validity overlooks how the general approval of principles like evidence-based and data-driven conservation are mobilized to avoid political change.

Chapter 3: Appetite for Imprecision: The Role of Bureaucracy in Implementing a Pay-For-Performance Program

In this chapter, I focus on a specific but often overlooked community within the state-bureaucracy: street-level bureaucrats. Through semi-structured interviews and participant observation of bureaucratic encounters with farmers in localized offices, I observe how the situated nature of the street-level bureaucracy places it in a unique position to interpret, probe, undermine, and promote the economic rationalist agenda. I find that formal rules for working with the information infrastructures often fail to provide adequate direction for the most rational course of action. A combination of professional culture and improvisation help achieve legitimacy for the calculations, creating considerable appetite for imprecision. I conclude that the appetite for imprecision reflects a structural problem conditioned by the interaction of economic rationality with the technical structure of the model, administrative routines and responsibilities, and political opportunism.

Chapter 4: Can Data-Driven Approaches Overcome Institutional Inertia?

I analyze public spending using an econometric approach. I evaluate $2 million program spending between 2010 and 2015 to contract 55,000 farmers to protect their farmlands. I compare current spending with historical conservation spending records and ecological risk indicators. County-wise fertilizer spending records are used to capture ecological risk. I find that program spending does align with ecological risk but historical spending has is a more substantive and significant predictor of spending distribution. I conclude that there is no strong evidentiary base to suggest the program is designed to maximize ecosystem services. This raises an important question for future program design and what the complex information infrastructure in the program served.

Chapter 5: Conclusion

In the final chapter, I summarize the main points of the dissertation. I also offer updates on the program and recent shifts in literature that are not captured by the dissertation. The updates help highlight the importance of studying institutional changes in terms of practical shifts in organizational rules and routines. I conclude that a practice-centered approach reflects my research commitment to understand the creative work of coordinating new ideas, existing professional cultures, and materials/infrastructures to advance strategic goals. Attention to practices draws research toward the grounded and iterative challenges of interpreting policy guidelines and bringing actions into accountable alignment with the guidelines in specific contexts.

1.2 Intellectual Framework

<u>The Economic Rationalists</u>

One body of literature, which we shall characterize as the "economic rationalists", has focused on how we can leverage the best available science to simulate ecosystem processes and predict outcomes. Economic rationalists set their faith in the market as the most effective mechanism for coordinating resource allocations. The possibility of engaging market solutions in environmental policy is predicated on reimagining forests, lands, animals, insects, mountains, and plants in economic terms: ecosystem services, natural capital, and carbon sinks among others. Rationalists represent environmental problems, such as pollution, in terms of externalities caused by market failures. Nobel Prize winning economist Ronald Coase (1960) argued that the central problem for designing environmental policy was not to tax or regulate environmental degradation but simply to appropriate property rights and as new externalities become evident, modify rights to address changing concerns. The logic is that if only we could assign private ownership for resources like land and water, it would be possible to internalize externalities. Property rights would clear the possibility for assigning legal rights and responsibility, and trigger bargaining between actors who stand to be hurt by pollution and those who stand to benefit from polluting. The resulting bargains would eventually achieve an equilibrium state where both actors are equally satisfied (or dissatisfied) and Coase showed mathematically that this would be both sustainable and economically efficient. Under the Coasian perspective, the role of the state is only to secure property rights and resolve property disputes.

Coase's ideas of market coordination have influenced the field of ecological and environmental economics even as the ideal of market construction has not ensued. As Coase himself noted designating property rights to resolve pollution remains a useful theoretical guide but constrained by transaction costs in practice. However, the Coasian and succeeding field of environmental and ecological economics have made a powerful argument to consider the economic value of ecosystems. When we damage ecosystem service functioning, we also lower overall social welfare. If key policy decisions could account for these values, society in general would see the return on investing in preserving natural resources. This reasoning has led to the incorporation of economic concepts such as efficiency, valuation, and returns on investment when designing environmental policies. Joshua Farley (2012), an important economist seeking to carve a new role for economics in environmental governance, echoes the key contribution of economics:

> *"One of the central challenges in economics is to determine how much ecosystem structure should be converted into economic products, and how much left intact to generate ecosystem services"* (Farley, 2012)

For Farley, the central problem is calculating tradeoffs from environmental degradation. Environmental protection does not necessary require denying the social benefits from pollution, resource extraction, habitat loss, and deforestation, but instead to understand that these environmental harms come at a cost. Measuring this cost can help make decisions about the level of harm that would be tolerable and acceptable given the benefit. If we could identify the trade-offs clear and make the benefits/costs calculations transparent, it would be possible to inform policy in a systematic and reasoned matter. A clear and unbiased decision rule based of pre-set set of criteria, weights, and standards can overcome the potential of political capture. Economics, thus, transforms environmental conservation into a problem of creating decision-rules and ideas such as cost-benefit analysis, economic valuation, and optimization emerge as central for assessing government responses to environmental pollution. This central challenge of economics, at least as defined by Farley, directs us to the problem of calculation that lies at the core of this dissertation. The importance of calculations has prompted research into potential ways to integrate ecological models into policy routines, with specific attention to the costs, scales, and types of environmental problems. References to economic rationality, cost-benefit analysis, and data-driven governance capture the essence of this position (Fisher et al., 2016; Polasky et al., 2015). The reliance on data and metrics, and the pragmatic promise of efficiency makes the rationalist model an appealing foundation for top-down institution building. However, much as the economists seem to blackbox the work of calculation and conceptualize the production of numbers as technical and apolitical, political ecologists below remind us that calculation is always a political project.

Political Ecological Critique

Economic rationalism, powerful as it is, is also critiqued as problematic or organizing government responses. Political Ecology, while not an especially well-bounded body of knowledge, has advanced the firmest critique of market-governance applied to environmental change. Over the last decade, the broad term: “Neoliberal Natures”, has presented a scaffolding for political ecologists (and other critical scholars) to discuss otherwise incommensurable situated case-studies of market governance across a range of geographic and environmental contexts (Bigger and Dempsey, 2018; Castree, 2008; Heynen et al., 2007; McCarthy and Prudham, 2004). The scaffolding has many focal sub-themes relevant to environmental governance: shifts in political discourses toward market governance, changing role of NGOs and corporations, new modes of environmental finance, political economy of science, and emergence of a new class of payment-centered policy instruments. The political economic perspective has certainly granted a much richer conceptualization of the struggle for resources and raised questions about the historical responsibilities for environmental harm.

Whether or not the market ideal sounds reasonable or morally empty, on most accounts, the market program is in trouble. Rather than generating private sector investments for conservation, environmental conservation is financed by taxpayers, philanthropies, and international and local non-governmental organizations (NGOs) (Dempsey and Suarez, 2016). There also a host of non-market but nonetheless economically rationalist policy models such payments for ecosystem (PES). The concept of PES revives certain market notions such as conditionality and performance evaluation even though the financing might be generated by non-market means. Yet, here too we find a stark divergence between the ideal-type of the rationalized schemes and the lived experiences of programs (Boisvert et al., 2013; Muradian et al., 2013; Van Hecken et al., 2018). It is perhaps harsh to analyze the market program as failed. Supporters may argue that these, say the European carbon market, are the early experiments with market-based schemes and even within experiments, there are some success stories. Overtime, perhaps, institutions will mature and stabilize. Whether or not this is the case depends on understanding the existing experience of programs. I wish to argue that a richer understanding of the limits to market reform lie in understanding the practices of calculation that enable market coordination.

Nonetheless, the lack of strong evidence of market-based institutional change has encouraged political ecologists to search new analytical strategies to situate neoliberalism. For example, a number of recent studies speak in terms of institutional hybridity (Bigger, 2017; Potter and Wolf, 2014). Institutional hybridity recognizes the interplay of multiple institutional arrangements – markets, states, and community, in any single policy process. To the extent that the focus on institutional hybridity also engages the role of information infrastructures, it has been on understanding the use of environmental science to expand commodification, marketization, and privatization. By studying the interests and visions driving the need for metrics and data-systems, we can learn about the broader political structures that these technological innovations perpetuate. A major step in this thinking is reflected in Morgan Robertson's work on wetland banking in the United States. Robertson (2012) argued that ecological models advance a narrow capitalist rendering of ecological value. Investments in building information infrastructures, he argued, are supported by a quest to make comparisons across landscapes in a way that allowed destruction on one to be ‘offset’ by protection on another. Numerical equivalences across lands, ecologies, and labor are the technical foundations upon which transaction-based policies may be applied. To understand the circulation of capital relevant to creating social and environmental problems, we are invited to look at the techno-politics of modeling. Robertson’s work has inspired a large body of geographic literature on environmental metrics, carbon accounting, biodiversity-offset credits, and all sorts of environmental standards.

The focus on political economic structures, while definitely an improvement from the neat specification of the economic rationalist model, has a similar weakness. While one assumes that information can be a powerful resource to discipline politics, the other, does not deny the power of information, but is more concerned with what forms of knowledge are privileged in the process. What they both overlook is the practical work of building the infrastructures and using them to make routine allocative decisions. This practical work, at least in case of public programs, invariably falls on bureaucratic actors. Yet these interactions between models, bureaucrats, and policy targets is largely missing in critical social science literature. We have so far failed to engage how incumbent networks of professional actors embrace, adapt, and resist these new policy ideas. Moreover, actors can harness the power of information not only to trigger change but also to absorb criticism and avoid change. For a policy idea to be successful, it is worth asking both how information helps check on incumbent networks of influence and how information obfuscates responsibility and allows actors to withstand criticism without making any major changes. Such an argumentation suggests that the progressive environmental ideas of evidence-based and data-driven conservation may, under certain conditions, not only be irrelevant for triggering institutional change but may also serve to legitimize existing power structures, weaken accountability relations, and shrink the ability of the governed to check on the incumbent governors. My intuition is that we cannot afford to treat the promise of technological change as perpetuating the same ideologies or visions that created the need for them in the first place. Instead, I argue that the work of building, operating, and repairing information infrastructures that enable calculation is ground zero to understand ongoing institutional changes.

Bureaucracy and Quantification

In studying change in public policy, we avoid a detailed engagement with bureaucratic coordination. Bureaucracies are particularly important for studying institutional change because they are well cushioned to absorb demands for change. Max Weber (1978) argued that the system of rules and routines makes the bureaucracy the most efficient form of organization for public institutions. Rules and routines send the message that it is not the individual official but the system behind the individual that makes decisions. The bureaucrat is the person making the decision, but the decision itself is above the individual or the politics. This preserves the legitimacy of the bureaucracy as a nonpartisan institution that is simply carrying out political agendas. Later scholars, such as Andrew Mathews (2011), have rightfully shown that, for all its talk of stability, bureaucrats, particularly street-level bureaucrats who interact directly with policy subjects, routinely apply discretion in what information they share with subjects and their supervisors. According to Akhil Gupta (2012), this observation poses questions of Weber's efficiency narrative of the bureaucracy. More importantly by highlighting the innovative role of street-level bureaucrats, the observation also suggests that the bureaucracy produces arbitrary outcomes. This dynamic of referencing the rigor of data-driven technologies while also controlling how these technologies are designed suggests that discipline is only one element of what information infrastructures do. As such, we cannot merely conceptualize environmental metrics, standards, and accounting systems as technological innovations to discipline the bureaucracy, and must look for what else the mobilization of data does for the bureaucracy.

Ted Porter's (1996) study of cost-benefit analysis (CBA) presents a useful historical comparison to understand why bureaucratic agencies adopt quantification routines. Porter argues that CBA served both to extract control away from elite bureaucrats and to advertise objectivity and rationality for the Army Corps of Engineers in the face of imminent distrust. Porter writes:

> *"The transformation of cost-benefit analysis as the universal standard of rationality ... cannot be attributed to the megalomania of experts but rather to a bureaucratic conflict in a context of overwhelming public distrust".*

The public distrust problem sounds similar to contemporary public concerns about environmental change. Moreover, the promise of using information infrastructures to trigger discipline may present an extension of the use of CBA. Porter proposes a need to think about the surge of CBA in terms of “mechanical rationality”, a specific form of rationality where important decisions are made by an unbiased and standardized decision rule. While the idea itself is not unreasonable, it is important to explore how public sector actors mobilize data routines to make claims of responsiveness and efficiency.

The economic rationalist language has much to offer to the bureaucracy much as the bureaucracy has much to offer the rationalist position. The label of economic rationalization is particularly powerful because it presents itself as an apolitical and asocial project, principles important to bureaucracies. Decisions are seen as driven by data and not judgement. Thus, bureaucrats may benefit from mobilizing the language of economics, maximization, and optimization and strategically referencing informational resources in order to gain legitimacy for these actions.

At the same time, the bureaucracy has much to offer to the organization of information infrastructures. The bureaucracy is particularly reliable for large-scale data-collection and modeling efforts. Espeland and Stevens (2008) in their meta-review of the sociology of quantification highlight that quantification is predicated upon large scale coordination of standardized information collection, curation, and combination. Scholars in infrastructure studies further point out that an infrastructure is not simply about building a new system, say a bridge, a grid, or an accounting standard, but requires constant repair and maintenance (Jackson, 2014; Star, 1999). The bureaucracies rule and routines are well placed to coordinate large scale quantification and help generate legitimacy for the numbers are rooted in a fair and apolitical process.

In relying on the state-bureaucracy to develop quantification systems that is also meant to wrestle decision-making autonomy away from politics and bureaucrats, and into the hands of a decision tool or algorithm hints at the paradox at the center of this dissertation. This is not to suggest corruption but a more complex set of somewhat mundane technical and administrative negotiations. Disciplining bureaucratic discretion, while concurrently relying on the bureaucracy to organize economic rationalism, highlights that change depends on the muscle of incumbent actors at risk of losing power to resist change and the institutions that govern their actions.

1.3 Practice-Centered Analysis

The dissertation draws on practice theory to advance critical analysis. Following practice theory, I argue a productive and so far overlooked set of insights on institutional change can be drawn by attending to the performances of quantifying. Practice Theory has a rich intellectual tradition traceable to the philosophers James and Dewey and later to the works by Wittgenstein, Schultz, and Garfinkel. Within the traditional sociological domain, we can trace ideas of practice to the works by Giddens, Bourdieu, and Thevenot, to name a few. The dissertation is particularly inspired by post-structural traditions in Science and Technology Studies (STS) such as the works of Callon, Pinch, Mol, and Suchman.

Overall, by practice, I mean a commitment to understand institutional changes from the ground up. I set aside two otherwise important questions[1]: a) a technical question of whether such data-driven technologies are accurate in assessing environmental risk and b) the moral question of whether models overlook important social-ecological complexities and privilege specific epistemic positions. Instead, the practice-centered approach understands terms such as environmental risk and morality as social and technical accomplishments and invites us to examine the performative work entailed in achieving these labels and what the labels mean for organizing social relations.

To explore the power of economic logics through the notion of practice, I draw extensively from Callon's (1998a) book titled "Laws of Markets". Developing his argument fortuitously in environmental economics, Callon suggested that a market externality is not known *a priori* to the negotiation and bargaining of the transaction, and is instead a result of social and technical process of framing interactions as such. Coase's idea of constructing market by delineating property rights is not wrong but incomplete. Coase suggested one mechanism, the legal structure of property rights, to reframe the market, but what is missing is an appreciation of other processes of framing markets. The frame surely has a legal and regulatory (e.g. taxes, fines, regulations etc.) dimension but also a technical (e.g. metrics and standards that convey quality), and thus material dimension. Technologies, or what Callon and Muniesa (2005) call "calculative devices" are important for market participants to establish

[1] The questions are important for a broader analysis of information and environmental governance but I argue that these cannot be adequately pursued through a sociological or economic analysis.

some sense of quality and quantity, and build trust in the exchange. These frames may sometimes be well-established but the scope of what is bought and sold is never complete and always subject to negotiation. Callon (1998a, p. 17) explained:

> *"What the notion of externality shows, in the negative, is all the work that has to be done, all the investments that have to be made in order to make relations visible and calculable in the network".*

Callon is following the symmetry principle established in STS: to treat all forms of knowledge production, whether the claims have been established as "scientific facts" or not as social accomplishments. Thus, the externality is a negative accomplishment of relations as outside the market, but what is in fact framed into the market transaction, say the units and quality of a product, are also outcomes of social and technical processes. Economic theory is not invalid here but the performativity theory argues that it is through the work of framing interactions in terms of economic ideas that economic theory becomes validated. Given felicitous conditions, actors begin to structure interactions based on their understanding of theoretical economic rules such as profit maximization and with reference economic models and rules when justifying their actors. Following Callon's idea of performativity requires that we look at the continuity of iterations across action and language to understand economic behavior. Ideas, things, and words do not have a single unchanging sense but are subject to interpretation and change as the terms are used in specific setting to advance specific ends.

From a policy perspective, the above argument has an important take-away. It is possible to identify who shapes performative acts and or what these felicitous conditions are. In studying public institutions, we can ask what democratic checks and balances ensure public concerns rather than elite interests are advanced through change. When certain actions are framed into or outside the transaction, it is possible to assign responsibilities and then sanctions or incentives. The work of demonstrating the economic value of ecosystem services in price terms is one such effort at a very large scale to “internalize” externalities, reframe market transactions, and assign blame for environmental degradation.

However, to the extent, “internalizing externalities” is a desired or despised project, it is difficult to do. To internalize externalities through economically rationalized public policies, public institutions could create new laws that require measuring costs and benefits and develop technologies to automate evidence-based decisions and restrain politics. However, a key insight from STS is that rules and norms are always subject to interpretation in given contexts. Technologies do not merely act upon society but are co-constituted with changes in society and political fields. Thus, I advance institutional analysis not by examining the changing nature of rules, formal or informal, but by studying how actors in situated settings interpret rules, improvise when the rules are not enough to guide their actions, and how they justify their improvisations in ways that aim to preserve strategic interests. Improvisation is a practical response to uncertainty. Recognizing the importance of uncertainty in public policy has inspired a widening body of work focused on the role of improvisation in institutional change[2]. Through the dissertation, I demonstrate the analytical purchase in looking beyond variations in political language and instead to engage improvisation and negotiations as important to social change.

1.4 Concluding remarks

The rapid diffusion of technical innovations in computing, algorithms, datasets, and sensing technologies may create opportunities to destabilize unsustainable policies and trigger policy innovation, but they may also create resources and languages for actors to preserve order. Given the central role of the state-bureaucracy in coordinating US agricultural policies (Potter and Wolf, 2014; Wolf, 2017, 2013), I ask how the state-bureaucracy performs calculation and to what extent these calculations advance economic rationalism. I combine a sensitivity toward the appeal of the political language of economics and attention to the actual material changes and practices of public sector actors. I will argue that information infrastructure create conditions for policy networks to perform engagement with ideas of economic rationality and quantification to advance their legitimacy. To understand how institutions are changing at a time when economic logics dominate policy imaginations, it is necessary to go beyond the appeal inherent to phrases like economic rationality, and instead examine how actors in policy networks capitalize the near universal appeal of data-

[2] The importance of improvisation in public policy is most effectively expressed in the term “institutional work” (Cleaver, 2012; Lawrence et al., 2009; Lounsbury and Glynn, 2001). Institutional work refers to a combination of practices of rule-making, rule-following, resource mobilization, and improvisation. It is different from the idea of implementation because institutional work is entailed even in setting agendas.

driven approaches, and ask to what extent they control the procedures of decision-making. With focus on an extensive bureaucratic network's role in producing quantification, I contrast the dynamic potential of data-driven technologies with the reliable rigidity of bureaucracies.

1.5 References

Bigger, P., 2017. Hybridity, possibility: Degrees of marketization in tradeable permit systems. Environ. Plan. A 0308518X17737786. https://doi.org/10.1177/0308518X17737786

Bigger, P., Dempsey, J., 2018. The ins and outs of neoliberal natures. Environ. Plan. E Nat. Space 1, 58.

Boisvert, V., Méral, P., Froger, G., 2013. Market-Based Instruments for Ecosystem Services: Institutional Innovation or Renovation? Soc. Nat. Resour. 26, 1122–1136. https://doi.org/10.1080/08941920.2013.820815

Bowker, G.C., Star, S.L., 2000. Sorting Things Out: Classification and Its Consequences. MIT Press.

Çalışkan, K., Callon, M., 2009. Economization, part 1: shifting attention from the economy towards processes of economization. Econ. Soc. 38, 369–398. https://doi.org/10.1080/03085140903020580

Callon, M., 1998. Laws of the Markets. Wiley.

Callon, M., Muniesa, F., 2005. Peripheral Vision: Economic Markets as Calculative Collective Devices. Organ. Stud. 26, 1229–1250. https://doi.org/10.1177/0170840605056393

Castree, N., 2008. Neoliberalising nature: the logics of deregulation and reregulation. Environ. Plan. A 40, 131–152.

Cleaver, F., 2012. Development Through Bricolage: Rethinking Institutions for Natural Resource Management, 1 edition. ed. Routledge, Abingdon, Oxon ; New York, NY.

Coase, R.H., 1960. Problem of Social Cost, The. J. Law Econ. 3, 1.

Dempsey, J., Suarez, D.C., 2016. Arrested Development? The Promises and Paradoxes of “Selling Nature to Save It.” Ann. Am. Assoc. Geogr. 106, 653–671. https://doi.org/10.1080/24694452.2016.1140018

Espeland, W.N., Stevens, M.L., 2008. A Sociology of Quantification. Eur. J. Sociol. Arch. Eur. Sociol. 49, 401–436. https://doi.org/10.1017/S0003975609000150

Farley, J., 2012. Ecosystem services: The economics debate. Ecosyst. Serv. 1, 40–49. https://doi.org/10.1016/j.ecoser.2012.07.002

Fisher, K.A., Winsten, J.R., Spratt, E., Anderson, R., Smith, R., 2016. Pay-for-performance Conservation: A How-To Guide. Winrock International.

Gupta, A., 2012. Red tape: Bureaucracy, structural violence, and poverty in India. Duke University Press.

Heynen, N., McCarthy, J., Prudham, S., Robbins, P., 2007. Neoliberal Environments: False Promises and Unnatural Consequences, 1 edition. ed. Routledge, London ; New York.

Jackson, S.J., 2014. Rethinking Repair, in: Gillespie, T., Boczkowski, P., Foot, K. (Eds.), Media Technologies: Essays on Communication, Materiality and Society. The MIT Press, Cambridge, Mass.

Lawrence, T.B., Suddaby, R., Leca, B. (Eds.), 2009. Institutional Work: Actors and Agency in Institutional Studies of Organizations, 1 edition. ed. Cambridge University Press, Cambridge, UK ; New York.

Lounsbury, M., Glynn, M.A., 2001. Cultural entrepreneurship: stories, legitimacy, and the acquisition of resources. Strateg. Manag. J. 22, 545–564. https://doi.org/10.1002/smj.188

Mathews, A.S., 2011. Instituting Nature: Authority, Expertise, and Power in Mexican Forests. MIT Press.

McCarthy, J., Prudham, S., 2004. Neoliberal nature and the nature of neoliberalism. Geoforum 35, 275–283. https://doi.org/10.1016/j.geoforum.2003.07.003

Muradian, R., Arsel, M., Pellegrini, L., Adaman, F., Aguilar, B., Agarwal, B., Corbera, E., Ezzine de Blas, D., Farley, J., Froger, G., Garcia-Frapolli, E., Gómez-Baggethun, E., Gowdy, J., Kosoy, N., Le Coq, J. f., Leroy, P., May, P., Méral, P., Mibielli, P., Norgaard, R., Ozkaynak, B., Pascual, U., Pengue, W., Perez, M., Pesche, D., Pirard, R., Ramos-Martin, J., Rival, L., Saenz, F., Van Hecken, G., Vatn, A., Vira, B., Urama, K., 2013. Payments for ecosystem services and the fatal attraction of win-win solutions. Conserv. Lett. 6, 274–279. https://doi.org/10.1111/j.1755-263X.2012.00309.x

Polasky, S., Tallis, H., Reyers, B., 2015. Setting the bar: Standards for ecosystem services. Proc. Natl. Acad. Sci. 112, 7356–7361. https://doi.org/10.1073/pnas.1406490112

Porter, T.M., 1996. Trust in Numbers: The Pursuit of Objectivity in Science and Public Life. Princeton University Press.

Potter, C.A., Wolf, S.A., 2014. Payments for ecosystem services in relation to US and UK agri-environmental policy: disruptive neoliberal innovation or hybrid policy adaptation? Agric. Hum. Values 31, 397–408. https://doi.org/10.1007/s10460-014-9518-2

Robertson, M., 2012. Measurement and alienation: making a world of ecosystem services. Trans. Inst. Br. Geogr. 37, 386–401. https://doi.org/10.1111/j.1475-5661.2011.00476.x

Star, S.L., 1999. The Ethnography of Infrastructure. Am. Behav. Sci. 43, 377–391. https://doi.org/10.1177/00027649921955326

Van Hecken, G., Kolinjivadi, V., Windey, C., McElwee, P., Shapiro-Garza, E., Huybrechs, F., Bastiaensen, J., 2018. Silencing Agency in Payments for Ecosystem Services (PES) by Essentializing a Neoliberal 'Monster' Into Being: A Response to Fletcher & Büscher's 'PES Conceit.' Ecol. Econ. 144, 314–318. https://doi.org/10.1016/j.ecolecon.2017.10.023

Weber, M., 1978. Economy and Society: An Outline of Interpretive Sociology. University of California Press.

Wolf, S.A., 2017. Accountability, Rationality, and Politics: Critical Analysis of Agri-environmental Policy Reform in USA, in: Bonanno, A., Wolf, S.A. (Eds.), Resistance to the Neoliberal Agri-Food Regime: A Critical Analysis. Routledge.

Wolf, S.A., 2013. US Agr-environmental Policy: Neoliberalization of Nature Meets Old Public Management, in: The Neoliberal Regime in the Agri-Food Sector: Crisis, Resilience, and Restructuring. Routledge, p. 191.

CHAPTER 2: ENVIRONMENTAL MODELS AND ECONOMIC RATIONALIZATION: A CRITICAL ANALYSIS

2.1 Introduction

Pay-for-performance (PfP) is an overarching phrase used primarily to uphold the following objective in environmental governance: to organize conservation investments based on outputs rather than inputs. In policy terms, the principle refers to environmental policy instruments that tie conservation spending to measurable and quantifiable changes to ecosystem services. Under an ideal-type PfP arrangement, public actors charged with making resource allocation decisions would have to make their decisions by first comparing the predictions of different investment options and then picking the combinations that maximize total environmental returns on investment (Fisher et al., 2016). To the extent the PfP principle translates into a formal governance model, it is heavily shaped by economic concepts of maximization and optimization, and efficiency. While advocates of PfP speak in economic terms, critical scholars link PfP-like programs to ideological positions associated with neoliberalism and new public management (Le Galès, 2016). Much of the critical literature has coalesced around the performative dimensions of environmental measurement. They pinpoint how the frenzy to measure and economize every minute change in ecosystems is reconstituting nature into an economic asset to be cautiously exploited and preserved according to market rules (Robertson, 2012). The neoliberal critique sees environmental quantification as a powerful political project that is strategically harnessing the social trust granted to science and measurement to advance policy programs such as carbon markets, wetland banking, and biodiversity offsets (Cooper, 2015; Lave et al., 2010; Robertson, 2012). While the neoliberal critique has generated significant momentum, I will suggest that the turn to performance quantification is also shaped by other political forces that are critical to explaining institutional change and lack thereof in environmental governance. Moreover, given the contemporary challenges confronting environmental politics such as shrinking budgets (Shortle et al., 2012), questions about the value of conservation (Adams, 2014), and weakening trust in some private and public environmental organizations (Bernstein, 2011), the assurances of rationalization have a certain appeal within the progressive environmental movement.

Whether or not increased references to environmental performance quantification are transforming how we think about and govern nature, it is worth asking how technical systems of quantification are designed, built, and operated. The field of Science and Technology Studies (STS) reminds us that quantitative information is never produced in institutional vacuums, unencumbered from social and political forces (Bowker and Star, 2000; Gitelman, 2013; Lovell, 2014; MacKenzie, 2009). Given that the performance measurement tools, in theory, are meant to discipline the decision-making capacity of political institutions, it begs to ask how and in what ways political institutions attempt to blunt the disciplinary power of quantification routines.

In this paper, I present a grounded analysis of the development of an environmental performance scoring model that is meant to rationalize spending in the largest agri-environmental policy (AEP) in the US – the Conservation Stewardship

Program (CSP). The US AEP context offers an important case of incomplete neoliberalism. Wolf (2017) argues that despite over thirty years of political posturing toward markets, efficiency, and spatial targeting, the actual AEP policy structure has remained remarkably resilient to neoliberal policy ideas (Also see: Batie, 2009; Doering et al., 2013). While the policy structure may have remained stagnant, the set of environmental issues meant to be addressed under AEP such as nutrient pollution, greenhouse gas emissions, and loss of biodiversity habitats has grown over the last three decades (Claassen et al., 2001). To the extent there is a coherent demand for policy reform, it has centered on leveraging data-driven technologies to better target resource allocation and introduce more competition among recipients of AEP funding (Claassen and Horan, 2000). Such a reform agenda is premised on having technical procedures to calculate environmental performance at the farm level. In this paper, I study the how environmental performance quantification models are developed and how different stakeholders within the established policy network position themselves in relation to the model's development. While the case and political economic context presented in this study focus on US agriculture, the insights on the politics of market-centered reform will be useful for thinking more generally about the role of science, calculation, indicators, and models as mechanisms to expand rationality.

2.2 Quantification and Bureaucratic Governance

The centrality of quantification to bureaucratic organization is well established in STS and the history of public administration. In his extensive work on the modernist construction of the state-bureaucracy, Weber (2007) pointed out that the strength of the bureaucratic organization lay in decoupling decision-making from individual bureaucrats and instead performing decisions as results of rules, routines, and division of responsibilities. Similarly, Porter's historic study of cost-benefit analysis argues that the modern trust in numbers is not simply a cultural phenomenon but a political process through which bureaucracies jockey the trust in numbers to claim accountability when confronted with public distrust. Similar arguments about the use of science to perform accountability is found in the works by Desrosieres (2002) and Busch (2007).

The mobilization of information to extend political legitimacy is not limited to the state. Economic and political geographers make a similar argument in the context of green bonds and corporate finance (see Bigger, 2015; Lippert 2015; Friedberg 2017). Lippert (2015) demonstrates how accountants and corporate heads in a Fortune 500 company manage business information to perform sustainability accounting to position themselves strategically in relation to a changing expectations from stakeholders including regulators, consumers, and suppliers. In contrast to Lippert, Friedberg (2017) looks at the entire supply chain of actors and technologies that enable large food companies to make claims about sustainable production. She mobilizes the term assemblage to frame how sustainability accounting emerged as a part of the marking strategy of food companies. At the same time, while much of STS literature points to the performative power of numbers in shaping meaning and organizing behavior, the limits to the power of numbers is less understood. Asdal's (2011) study of emissions calculations in a factory offers relevant insights. She found that the emission's accounts were not very useful to hold a polluting factory accountable for their emissions when the numbers were not backed by robust sanctioning or rewarding authority. The regulatory authority, in her case study, asked a polluting factory to abide by a given emissions baseline but despite the baseline, the polluters repeatedly failed to meet baselines. She argues that a baseline without adequate regulatory muscle has a limited performative potential. Eventually the baseline was negotiated down to a level that ensured that both groups could make claims about achieving change. Studying social interactions that sparked the numbers offered a powerful insight, not into the disciplining power of numbers, but toward the powerlessness of the regulator.

To better conceptualize the role and power of numbers and metrics in strengthening a neoliberal or hyper-rationalist environmental policy, some scholars suggest looking at the institutional context within which the numbers are generated, i.e. the rules and practices that oversee the quantification project. Espeland and Sauder's (2007) work on the sociology of quantification points out that much of quantification requires not only sophisticated technologies but also the integration of technologies with existing and new routines and professional communiities. Studying the coordination mechanisms can produce useful insights to how information comes to act in certain ways and who benefits or loses from their existence (Bowker and Star, 2000; Star, 1999). In the context of public policy and quantification, it is worth examining how public sector actors relate to new economic models such as PfP and to what extent they are able to control and shape the performance quantification project that is meant to subject them to new accountability tests.

Bourdieu (1994) suggested that to study what the state is and does, it is insufficient to look at the symbolic capital yielded by state actors (e.g: Ferguson, 1990; Scott, 1999) or study the discursive ideas mobilized (Hall, 1993). Instead Bourdieu suggests we look at the bureaucracy as a “microcosm” or a “universe of agents” who are fitted with their own interests. The mobilization of performance measurements and targets may seem to constrain the bureaucracy but it is worth asking how specific agents engage these ideas and why. This point is more clearly illustrated in Muniesa’s (2014) study of a specific French budgetary reform called LOFT (Loi organique relative aux lois de finances). Muniesa shows the ways in which the LOFL was shaped by political interests and how the policy, to a large extent, undermined the economic rationalist promise. He concludes that LOFL could be interpreted as both a plea for economization of the state and as a mechanism to defend its politicization. Because the project of rationalization must unfold within specific institutional fields, we cannot conclude whether or not performance calculation leads to a neoliberal policy path. However, we can draw some insights about the nature of the state itself. Muniesa suggests that: “*performance targets and indicators constitute a semiotic haze which envelops the state as a colossal attempt at accounting for the performance of its action, that is, of its agency*” (ibid, 109). By “semiotic haze” Muniesa is talking about the vast task of coordinating civil servants, consultants, politicians, and specialists of all kinds. Every effort to make visible a state’s managerial choices can also help hide how states are strategically structured to obscure accountability. In this paper I build on the pragmatic commitment to look at specific actors and actor-groups as they coordinate actions among themselves and with other components of public administration.

I argue that it is possible to understand the nature and direction of institutional change by focusing attention on the actors and the policy networks they inhabit. Policy networks are the formal and informal linkages across both governmental and non-governmental actors that can oversee, resist, and precipitate organizational changes such as the adoption of PfP-like ideas. Policy networks tend to be sticky and resistant to change (Kenis and Schneider, 1991). Path dependency, rather than change, is the norm (Considine et al., 2009). As Muniesa points out, it is unclear why incumbent state actors would devise new disciplinary tests that appear to curtain their own autonomy unless they see value in the project or find the change necessary to maintain legitimacy. Thus, understanding how and to what extent incumbent policy networks control and manage performance quantification merits deeper consideration. Success of new policy idea depends on the embrace and advocacy of the ideas by actors within the network, the ability of the actors to resist change, and the political appetite demanding change. The absurdity in holding public sector actors accountable through performance tests and relying on public agencies to administer these tests lies at the heart of this paper.

2.3 Agri-Environmental Policies (AEP) - Background

Agri-environmental policies are a mix of federal government programs that target the production of environmental goods from private lands. These programs are charged with addressing a number of intractable environmental problems from agricultural production: water pollution, soil degradation, greenhouse gas emissions, and biodiversity losses (Boody et al., 2005). Policies are organized through the US

Department of Agriculture (USDA) with the Natural Resource Conservation Agency (NRCS) as the primary agency within the USDA charged with implementing conservation programs. Funding for AEPs are authorized by Congress through the omnibus Farm Bill. When Farm Bill negotiations come around every five years, there is a frenzy of debates in which stakeholders promote their signature programs and negotiate funding to shore up their respective constituencies. The Farm Bill process is structured in a way that environmental policy discussions are conducted in parallel with other non-agricultural and non-environmental policies such as food stamps and nutrition labels. The complex set of issues requiring negotiation in the Farm Bill means that while compromises are reached to ensure continuity, the details about policy implementation are typically underspecified (Lehrer, 2010).

Conservation spending under the Farm Bill has grown significantly since 1996 and along with increased funding there has been a surge in demands to rationalize how the money is spent. The demand for clarity in spending have emerged from external environmental groups as well as also from lawmakers and federal government watchdogs: e.g. the Governmental Accountability Office (GAO) and the Office of Management and Budget (OMB). In so far as criticism has forced the USDA to respond, the USDA has adopted the following strategies: presenting evidence about the scientific basis of spending decisions (Doering et al., 2013), relying on standards to deflect questions of inconsistency or political bias (Choe and Fraser, 1999), and investing in large research and data gathering projects to quantify and promote impacts such as the Conservation Effects Assessment Program (Wolf, 2017). Overall, such strategies promote the value of existing policy structures but to the extent they inject fiscal discipline is ambiguous.

The lack of major institutional changes to AEP suggests that demanding more accountability is an insufficient political lever to force changes. Wolf (2014; 2017) suggests that the AEP policy field is structured in a way where the incumbent state-bureaucracy is strongly positioned to sustain its position of influence. He argues that there is very little appetite in Farm Bill negotiations to intensify controls on how farm bill funds are actually spent. The policy coalition that supports AEP is diverse and each has successfully cut their own share of pie. Negotiations center on who gets how much rather than how and whether the funds are spent in ways that most cost-effectively advances public interests. Moreover, the Farm Bill policy structure is highly impenetrable; any effort to restructure the policy process and coalition places high costs and uncertainty upon actors involved in the network. Change is thus comfortably resisted. In the context of conservation which forms a small but not insignificant part of the Farm Bill, subsidies present a common ground for the diverse group of agricultural stakeholders to achieve consensus (Lehrer and Becker, 2010). Instead of rendering the coalition fragile, this diversity imparts resilience toward a specific set of policy commitments – farm-level payments, broad-based targeting, incomplete effort to engender competition, reliance on the NRCS field offices, and a weak verification regime (Potter and Wolf, 2014).

The political context of US AEP supports a preliminary hypothesis that there is limited appetite to engage in data-driven conservation. In the next few sections we will evaluate this specific claim by looking at a specific effort to advance fiscal disciple by formally linking resource allocation decisions to environmental performance in the

Conservation Stewardship Program. The paper focuses specifically on how the relevant quantification infrastructure and models are built and structured, and what their design/operation means for the larger institutional project of rationalizing environmental spending.

Methods

The research relies on a three-year research project which included multiple methods and research sites. I combine thirty-one semi-structured interviews with analysis of official policy and technical documentation to recreate a brief history of model's development. Interviewees included environmental policy advocates, staffers on Senate and House Agricultural Committees, high-level bureaucrats including two former Natural Resource Conservation Service (NRCS) chiefs, ecological engineers, programmers, and a range of environmental subject-matter specialists. Interviewees were asked about their role in developing the environmental model, the challenges they faced in completing their tasks, and the innovations that shaped quantification in practice. Interview responses were verified against each other to reconstruct the historical narratives, significant frictions, and resolutions. Some interviews were conducted in person but because the actors are spread across the US, most of the interviews were conducted over the phone and audio recorded. Specific phrases in each transcript were coded following an iterative technique (Miles and Huberman, 1994; Rubin and Rubin, 2005). In the second round of coding, codes were modified to reflect patterns of answers across the group. I paid attention to both group-level patterns and actor improvisations and workarounds.

I roughly follow the approach developed within the social construction of technology (SCOT) tradition to analyze data on tool development (Bijker, 2010; Bijker et al., 2012). The SCOT tradition emphasizes the importance of different social groups and their interpretations of the technology as important factors shaping the stabilization and closure of technologies. To group my interviewees into social categories, I relied on two main criteria: 1) members within the group share similar meanings about the technical artefact, and 2) members have some stake in tool's development. Three social groups are identified: political aides, elite bureaucrats, and subject matter specialists. While "users" of the technology are local bureaucrats, it is not clear to what extent they were involved in the tool's development and thus they are not included here as a social group. Nonetheless, local bureaucrats play a significant role in interpreting and rolling out the program on the ground (Ghosh, 2009).

I also collected Congressional reports, testimonies, and interim and final program rule documents available through the Federal Register. I procured documents from interviewees including technical documentation on the scoring system and spreadsheets of early versions of the model. I submitted official requests to procure documents not available in the public domain using the Freedom of Information Act (FOIA).

2.4 Case Study: Conservation Stewardship Program: Policy Origins

The rest of the paper is built around a case study of tool development in the Conservation Stewardship Program (CSP). The CSP was authorized by the 2008 Farm Bill and was a reinvention of a previous program with the same acronym - the

Conservation Security Program (hereafter CStP). Below I review the history of the CStP to situate the appeal of performance quantification under the CSP.

Conservation Security Program (CStP)

The CStP was authorized in 2002 but was immediately stalled in the rule-making phase for two years. The Secretary of Agriculture claimed that the law was written as an entitlement program and the sanctioned funding of $2 billion would be insufficient. The claims were supported by independent government watchdogs[3]. In 2004, a compromised version of the CStP was rolled out with eligibility restricted to only 18 watersheds. To ensure accountability toward environmental priorities, payments were distributed in a tiered manner with the highest tiers representing the highest level of environmental stewardship. A new tagline was adopted: "Reward the best, motivate the rest". The tagline suggests that the program office was juggling multiple political concerns: the legal need to implement the CStP, a fiscal need to keep spending under control, and a historic political commitment to support farm incomes. While the NRCS mentioned plans to scale up the CStP to all 2,119 watersheds within 10 years (GAO, 2006), the program was eventually eliminated in just four years when the CSP was introduced. There was broad disenchantment with the CStP. The tiered strategy

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[3] Cost estimates of the CStP were repeatedly revised (GAO, 2006). The Congressional Budget Office (CBO) (a bipartisan agency under Congressional leadership) calculated that the CStP would cost the treasury $8.9 billion, much higher than the original budget of $2 billion for ten years. Similarly, the Office of Management and Budget (OMB) raised its ten-year estimate from $5.9 billion to $9.7 billion. When the GAO investigated these cost-estimations, they too reinforced the conclusion that a vague legal mandate was creating uncertainty in implementing the program.

along with the watershed approach was broadly rejected by stakeholders as too narrow and against the intent of the law. The program left stakeholders including environmental groups such as the National Sustainable Agriculture Coalition (NSAC) and Land Stewardship Project (LSP), the main non-state supporters of the CStP, frustrated. Even farm lobbyists argued that the program lacked accountability in selecting watersheds and failed to meet its objective to reward good stewardship (Johnson, 2004; Lenihan and Brasier, 2010). By the 2008 Farm Bill negotiations, the faults in the CStP were seen as too compounded to correct. Instead of reforming the CStP, policymakers chose to redesign and remarket the program as the Conservation Stewardship Program (CSP).

Conservation Stewardship Program (CSP)

The newly authorized Conservation Stewardship Program (CSP) retained its predecessor's acronym and two key policy objectives: comprehensive conservation planning and payments for both existing stewardship and new activities. The 2008 Farm Bill included language that mandated the NRCS to use conservation measurement tools 'to the maximum extent practicable' to rank the level of existing and proposed conservation treatment for every application. The law advocated tying payments to actual benefits but did not provide guidelines on how this would be achieved. While the CSP's legal and administrative commitments reflects rationalistic rhetoric, the principal concern in this paper is how this rationalistic language was translated into practice. The practice questions is important because the law did not specify in much detail how quantification would be organized. Important questions such as, what is meant by environmental benefits, or, what resources are relevant for making these calculations were left unanswered. CSP did offer a vague definition for conservation measurement tools:

> *"procedures to estimate the level of environmental benefit to be achieved by a producer in implementing conservation activities, including indices or other measures developed by the (USDA) Secretary" (110th Congress, 2008).*

The unclear instructions on how to interpret terms such as, 'conservation performance', and, 'environmental benefits', suggests a lack of engagement by Congresspersons on closely supervising policy implementation. The details about the technologies, the relevant scales, and applicable ecosystem services were left to the Secretary of Agriculture (USDA) which oversees the Department of Agriculture and thus also the NRCS, the main implementation agency. Within a year of the 2008 Farm Bill, the NRCS had developed a quantification system called the "Conservation Measurement Tool" (CMT) and enrollments began as early as 2009.

2.5 Conservation Measurement Tool (CMT): Basic Process

The Conservation Measurement Tool (CMT) is a centralized environmental scoring and ranking algorithm. To participate in the CSP, farmers must first complete a questionnaire with the help of the local NRCS officials. In the CMT form, farmers are asked about their current agronomic practices (such as tillage practices, crop rotation, and nutrient management) and current level of conservation treatment. The questions are intended to capture the management practices of the farm and the history of the farmer's conservation efforts. Next, the applicant must select 'enhancements' that they intend to undertake over the contract period. Enhancements are new conservation practices and farmers must choose from a list of over 90 different enhancement options. Once the farmer has written this information on a paper form, they sit with an NRCS employee who inputs all this information into a computerized CMT interface. The CMT model processes the information and produces a single ‘score for each farm based on a weighted aggregation of their existing activities and additional enhancements. After the scores are available, each applicant is ranked against others in the same ranking pool. The state office starts from the top rank and enrolls all the land of the highest-ranking applicants until they exhaust allotted acreage. Final payments are calculated by multiplying the ranking score by the farm acreage and the payment rates. Prior to contracting, local NRCS officials must conduct a field verification to ensure that information provided during the CMT meetings matches the information in the form. This verification is the last hurdle before contracts are signed. Figure 1 captures the structure of the CSP process and the role of the CMT is rationalizing who and where funds are directed.

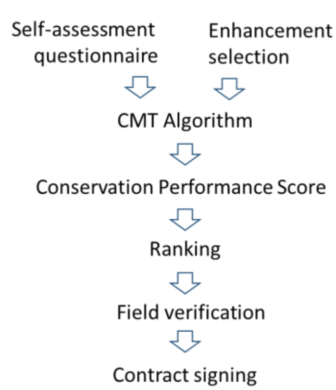

Figure 1: Conservation Measurement Took Enrollment Process; Source: Interviews

The CMT scoring and ranking process is different from other Farm Bill conservation programs which may suggest that the CSP is a departure from the Farm Bill status quo and an embrace of data-driven discipline. Because farmers interact with local officials through the CMT form, it also suggests a potential change in the relationship between farmers and the USDA, one based on performance calculations and legal contracts rather than a disguised subsidy. In theory, the scoring and ranking process is meant to engender competition. Farmers would compete with each other to rank higher, get more money, and in this process they would provide more ecosystem services beneficial to the public.

To participate in the CSP, farmers must also divulge a large amount of farming information such as what crops they grow, how they grow their crops, what chemicals they put on their fields, and the technologies they have on their farm. By taking the CSP incentive and accepting the terms of agreement, farmer also lock themselves into a legal relationship with the government to continue much of what they had written in the contract. The level of questioning and the amount of money supporting the CSP (nearly $1billion every year) prompts asking to what extent the CSP represents a sophisticated technology of disciplinary governmentality. As I discuss below, there are important reasons to be cautious about the disciplining capacity of the CMT.

Counter to the CSP tagline of paying for performance, the CMT does not actually measure outcomes but expected outcomes. The CMT scoring model is fitted with pre-set relationships and does not rely on any pre- or post- measurements that would then be labeled 'additional' environmental benefits. This raises questions about the quality of the model and the data that inform the equations. Moreover, to work, the model requires very basic though extensive information about a farm and fails to include other informational sources that could strengthen the measurement of environmental change without heavy additional costs. For example, the CMT does not take into account the farm's location. No geographic information (except the county) is collected in the interviews and neither is the CMT linked to other spatial databases that could point out whether the given farm is in a particularly sensitive ecological region, such as near to a large water body, on has a high slope, or comprises a soil-type that is less likely to hold nutrients[4]. The CMT does use maps which suggests that the model does contain this information even if the information is not used in the calculation. This omission suggests that technological difficulty or additional transaction costs are not the reasons why such, otherwise useful, information is left out.

In theory the CSP is meant to engage competition in the procurement of ecosystem services from farms but the level of competition generated is questionable. First, farmers do not have access to the CMT model and thus cannot pre-calculate what combination of new activities would optimize their own business goals. Farmers must rely on their back calculation of what is best for them which primarily becomes a decision centered on costs which farmers are quite familiar with. In this sense the CMT undermines its own objective of extracting more conservation from farmers. Moreover, instead of pitting every farmer in the country against another, CMT scores

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[4] Note that some effort at geographic rationalization was attempted in the CStP through the tiered wetland process but was rejected for being too selective and non-transparent.

are only used to rank applicants within state ranking pools. Each state is allocated a total amount of acres they can enroll into the program. The acreage quota is based on the state's share of agricultural land rather than some estimate of ecological risk suggesting that much of the budgetary allocation under the CSP is baked in even before the CMT decides which applicants generate the most benefits. The state NRCS office determines whether to rank all applicants in one pool or create multiple pools within the state. The policy decision to create smaller pools across the country sends mixed signals about rationalization. Rationalization, I argue, exists in the CSP but the policy network controls where and under what conditions allocations are rationalized.

The rationalist promise, I argue, is in tension with the historical commitment toward distributional fairness of Farm Bill payments. Seen through the political historic lens, the weak rationalist structure can be justified as more fair. Geographic targeting of CSP payments may result in some farmlands being preferred over other simply because the farms are located in a more sensitive area. Moreover, asking farmers across the country to compete in a single pool (rather than multiple state pools) could also advantage some regions over others and raise questions about spatial fairness. I do not aim to evaluate the balance of these justifications but to highlight how the policy network's commitment toward equity can frustrate the economic rationalist's interest in the efficiency gains. While in this section I summarized the broader institutional context within which the tool operates, in the next section, I examine how exactly the tool was developed and how different social groups shaped its development.

2.6 Tool Development

In order to understand how the model was developed, I sought official documentation about the process and key actors involved. As I soon discovered, there is no official record of the CMT's development process. This is most clearly evidenced in the following response (Figure 2) to an FOIA request submitted by the author:

> This is a final response letter to your FOIA request, dated October 27, 2015 and submitted to my office via email. You requested documentation related to the development and modification of the Conservation Measurement Tool (CMT) including development reports, presentations, white papers, and/or meeting minutes of CMT development meetings. You also asked for the names of USDA professionals (scientific, administrative, economists etc.) who were a part of the development team in charge of constructing the CMT. Your request was assigned FOIA Number [redacted] Please refer to this number concerning any future inquiries you may have.
>
> After a thorough search of agency records and discussions with several NRCS program leaders, I am informing that we have no records responsive to your request. As you'll recall I did share with you, via email, a five page guide discussing the Conservation Measurement Tool and how it generates conservation performance points to be used for ranking and scoring within the CSP program. This paper is available in the public domain.

Figure 2: FOIA Request response; Source: Email record dated November 2015 from FOIA/PA Officer, United States Department of Agriculture, Natural Resources Conservation Service

The lack of any formal documentation of the CMT (except the five-page note) makes an analysis of the CMT's historical development challenging but, importantly, it also indicates the weak level of accountability faced by actors in charge of the development process. The five-page note briefly explains the CMT's internal structure but gives no details on the actual model, previous models, scientific studies relied upon, expertise commissioned, statistical methods used, or the general thought process that led to its development. To reconstruct the CMT development process and how ideas of rationalization and discipline feature in the process, this paper draws on snowball sampling and semi-structured interviews[5]. We breakdown the analysis across principal social groups, political aides representing lawmakers, subject-matter specialists representing the ecological expertise, and elite bureaucrats responsible for program design, and how these different actor groups explain the narrative of the tool's development.

Policymakers

I asked the political aides and environmental advocates who wrote the 2008 Farm Bill what motivated them to include the mandate for conservation measurement tools in the CSP law and why the mandate was poorly specified. I found that the frustrations with the CStP primed the dialogue. The support for the CSP was led by a prominent Democratic Party Senator who was also at the time the head of the House Agricultural Committee. The political coalition backing the CSP was slim but powerful given that the Democratic Party held a majority in the Senate and controlled the White House. However, to gather enough political support to pass the program and implement it with sufficient funding required more broad-based support from non-environmental groups. Some environmental groups such as the Environmental Working Group were not supportive of the program and advocated for fewer subsidies. The CSP advocates depended on support from outside the environmental lobby community: food companies, commodity organizations, crop insurance, food security groups, and other

[5] The term CMT emerged later but in this essay, we refer to the early stages also as part of the CMT development.

specialty farming groups. The CSP was not directly hostile to their interests, creating an opportunity for negotiation. But the negotiating challenge for CSP advocates was to demonstrate the value of the program and make it fiscally defensible in the tighter budgetary climate of 2008 compared to 2002 and given the fiscal indiscipline associated with the CStP.

When I asked why the law failed to provide more detailed guidelines on what the system of measurement might look like, political staffers referenced the lack of in-house expertise and the time constraint of the Farm Bill negotiations. At the time of writing the 2008 Farm Bill, staffers explained it seemed best to leave specifics about measurement to the USDA. Details were seen as minor and resolvable once the funding and regulatory approvals were in place. While the policy directive to expand rationalization was written ambiguously, in terms of actual budgets, the Farm Bill did not relegate any new money for data collection, modeling or measuring tools. This additional work of measuring would be funded through existing USDA research units and the NRCS bureaucratic structure. The following response by a senior staff member of the Farm Bill negotiating team echoes the rhetorical relevance of including references to quantification in law:

> *"Some of it stems from that [need for rationality] but more of it was to fend off people who didn't see value in the program. So defenders could point to CMT and show this is the value of the program. Now we can track the data".*
> - *Professional Staffer, Interview, 9/27/2016*

The particular professional staffer seems to look at the CMT as a resource to “fend off” critics and demonstrate value. The interviewee’s narrative seems to suggest that the CMT’s main function was to mobilize science not mainly to improve discipline but to perform a sense of rationality to the extent it allowed organizers to defend the program. The interviewee is not denouncing the usefulness of the CMT’s calculative strength but rather the quote highlights the significance of data tracking and measurement as a response to accountability demands. The data production is the end in itself if it suffices to deflect more questioning. This interpretation of the role of data in government may explain the lack of more detailed interest on the part of political aides and by extension legislators in the actual program design and implementation.

Subject-Matter Specialists

Through interviews with USDA technical specialists, I learned that the much of the model underlying the CMT predated the CSP. Technical teams were meeting regularly between 2004 and 2008 to develop evaluative tools that could be used in rationalizing conservation spending. At this early stage, experts were asked to develop screening tools relevant to their expert domain such as water quality, biodiversity, soil erosion, soil quality etc. Experts included an environmental engineer and water and soil scientists. A subject matter expert described the initial mandate 1) must be understandable for self-assessment and 2) implementable easily across the country. He also mentioned that they were told that there would be limited opportunity for subjecting the model to rigorous testing and comparison with actual field data. They were also given the guidance that the model should not be excessively time-consuming for a local NRCS official to operate. The ‘practicable’ measurement system was born out of these constraints: operating time, limited testing possibility, limited administrative capacity, and restricted funding. I probed further about how experts responded to these constraints and how they adapted the CMT model in response. The interviewees did not offer a clear structure to the tool development process. Coupled with the lack of documentation, I am want to conclude that the process was messy and ad hoc. In the absence of a clear timeline, I present a rough chronological structure that could help situate the comments made by subject matter specialists (Figure 3).

Figure 3: Reconstruction of CMT Development Process by the author based on interviews

From the chronology, I draw attention to two main takeaways on how subjective matter specialists positioned themselves in relation to the CMT. First, subject-matter specialists problematized the focus on self-assessment questionnaires. Interviewees explained that the self-assessment reduced the burden of data collection upon the official and shifted it to the applicant. From an accountability perspective, this meant that information would need to be verified later but verification could be done only for applicants who score high enough. While each applicant in the CSP is required to go through a basic verification, a more detailed audit of contracts is also conducted randomly and perhaps adds as a deterrent to information falsification in the CMT form. Subject-matter specialists also problematized that the verification system was weak and did not adequately replace the precision of field-level data collection done using formal screening tools[6]. One subject matter specialist explained how his perspective about the tool and its precision came in direct contrast with the visions of high level program official:

> *"As a wildlife biologist, I go out to a property, assess the property, do grid searches, and do whatever else you need to do to understand what is going on. Then I develop a plan to improve wildlife habitat. I made a presentation to our Chief in early 2004 and late 2003. He stopped me half way through my presentation and said we are not going to the field. He said, we don't have the manpower or the time to go out and look at every field to make the assessment. I told him, I don't know how to do wildlife assessment in an office."*
> - *Subject Matter Specialist, Interview, 9/9/2016*

Second, subject-matter specialists problematized the gradual consolidation of the tools. They explained that the first version of the CMT was a tool mean to screen

[6] Examples of such measuring systems include RUSLE, WEPS, and the Soil Condition Index.

good and bad nutrient management on the farm, primarily an estimation of how much nutrients were leaching into surface and ground water because of nutrients applied on the farm. Later, the water quality eligibility tool was combined with a soil quality assessment tool to become the Soil and Water Eligibility Tool (SWET) (Figure 3). Later still, the SWET was combined with irrigation tools, wildlife assessment tools, and other environmental screening tools. The challenge in consolidating tools, I was told, was to liken good water management with good soil management on the same measurement scale. To make different tools speak to each other, the CMT team used an existing scoring system called the Conservation Practices Physical Effects (CPPE) matrix. The NRCS had previously developed the CPPE as a communication tool to help conservation planners explain the complexity of farm ecology to farmers. The use of the CPPE to score stewardship was a new application of the tool and drew debate. As one subject matter specialist explained:

> *"CPPE was never intended to be use the way it is. It was a training tool - how a practice effects something. Not always positive. Somehow this got used in ranking. At any site, the CPPE can be a 100% wrong. Many technical people have no respect for CPPE."*
>
> – *Subject Matter Specialist, Interview, 9/7/2016*

Despite the problems raised by subject matter specialists, they also communicated how they negotiated their own role in the science-policy process, by emphasizing their singular responsibility to develop science-based tools under the direction of program officials. The following quotes illustrate this position:

> *"They [Program Office] are not scientists, they wanted to rush dollars and contracts… they were pushing me and others to bastardize science – develop binary questions that no scientist is going to ask. People [scientists] felt they don't want to participate. But we are not here to justify the program."*

- *Subject Matter Specialist, Interview, 10/6/2016*

> *"We were focusing on narrative type questions of the producer - to get a general sense of what they were doing within guidelines and not use technical tools. Every technical person would agree it was counterproductive. At my level, we are not allowed to tell Congress or share our thoughts with Congress*
> - *Subject Matter Specialist, Interview, 7/9/2016*

The quotes use strong language to characterize the CMT and suggest that the specialists positioned themselves at some distance to the CMT. To understand the importance of their positioning, we next turn to the role of elite bureaucrats who were charged with implementing the CSP.

<u>Elite Bureaucracy</u>

Unlike the delay in the CStP, the favorable political climate in 2008 for CSP payments led to pressure to roll out the program quickly, with emphasis on 'getting the money out'. This urgency in organizing the CSP appears to be the leading explanation for the structure of accountability in developing the CMT, the lack of documentation of its development, and the specific design choices in the CMT. A senior member of the NRCS - reflected on his own experience in the early days of implementing the CSP:

> *"It (CMT) was all impromptu and situation driven. Not a formal process but a fast-moving train. We were given a concept and we had to make it work"*
> - *NRCS Official, Interview, 12/7/2015*

Officials did often reference the importance of discipline but pointed out the pressure from policymakers and powerful non-state actors to swiftly implement the programs. I asked an official how much statistical testing was the final CMT subject to and where I could find these reports. He responded:

> *"We did a test under the first set of questions before the final CMT was developed. The general tenor of the questions did not change. There was a lot of editing and tweaking but the underlying reasoning is still there. We did tests in a number of states kind of remotely. We asked field offices to go through the ranking tool on a number of farmers that they were familiar with as a professional soil conservationist. We asked them to classify them as: 'this is a good farm and it has good conservation on it'. Based on responses, we asked them to divide farms into three categories. Pick out a farm that is a tier three farm - pinnacle of conservation in your county: pick out one that is average; pick out one that is below average. We used the ranking tool to develop a score for each one of those. We did that across a number of states. We then used that as the basis for checking whether or not our questions were giving us realistic answers. It was like a test run."*
>
> – *NRCS Official, 8/16/2016*

It was not clear that the program office felt any pressure to subject the CMT to further external tests. The test described above was rather rudimentary, did not involve external reviewers, or any major statistical analysis. The lack of robust testing further reinforces the nature of the political arrangement within which officials were negotiating multiple expectations regarding CSP implementation. The political arrangement can be summarized as follows: officials saw their responsibility as one of ensuring funds were actively spent, and that if demanded, the NRCS should be able to produce some quantitative explanation for why funds were allocated the way they were. The nature of the political arrangement also explains the serious lack of procedural documentation of the CMT's development on one hand and the complex multiple decimal point scoring system on the other. The position is expressed more clearly by a senior government official in the following quote:

> *"We had to get a budget out because there was money to be spent … As the timeline moved on, decisions were made that couldn't be backtracked on […] This {CMT} was a huge tension. At some point, <u>you have to punt</u> and say we will get rid of the {CStP} watershed approach. It was a nice idea but we need to work on accountability. There were flaws in that. A national agency like <u>NRCS must show it was spending money properly</u>."*
>
> – *Former Associate Deputy Chief for Programs, NRCS, Interview, 9/12/2016*

The quote demonstrates the importance of bureaucratic rationality in negotiating the multiple demands placed upon the NRCS officials and how the officials worked within rather than against the historical interpretation of AEP as both an environmental and income support policy. Given that achieving scientific consensus would (and did) take longer than the timeline to distribute funds, program officials found themselves as central actors in the science-policy interface and turned to ideas of bureaucratic rationalization to overcome the tensions. Bureaucratic acrobatics or 'punts' would make it possible to meet the dual accountability routines of science/rigor and payment timelines. It is within this dynamic that the algorithm becomes a particularly relevant resource that enables social groups to assemble around the tool while also advancing their strategic interests. The lack of documentation and the black boxing of the tool was able to represent the tool as technically robust but also shielded the tool from political tinkering:

> *"We tried to minimize the politics and maximize the science. [] So we left it {CMT} a little opaque to insulate it from political processes. Simple and transparent means we are open to political questioning. We don't want a Senator to point at the equation and algorithm and say something about the allocation"*
>
> – *NRCS Official, Interview, 12/7/2015*

In the above quote, I understand the official as expressing the benefits of the tool's blackboxed structure as shielding the CSP from political scrutiny. Eventually, when the CMT was operationalized to administer CSP payments, few experts could understand and modify its internal structure.

2.7 Discussion

I argue that environmental accounting emerges in response to certain political demands, and, the extent to which accounting triggers a neoliberal governance regime is heavily shaped by how actors in the policy network position themselves in relation the tools. In the CSP, the political concern that is consistent across the different social groups is a need to strengthen the technical basis to process mass applicants. However, the specific parameters of what is to be measured in the calculation and what would constitute a "strong technical basis" or what would constitute "practicable" was never actively discussed or formally resolved, creating room for what STS scholars call interpretive flexibility. Through interactions across the policy process, the structure of the performance evaluation system was underspecified, allowing the enactment of data-driven governance at the terms of the dominant policy players. In the case study, I highlight the importance of three key groups who played a dominant role in shaping and labeling the CSP a PfP program: policymakers and political aides, subject-matter specialists, and elite bureaucrats. The competing strategic interests of the different groups manifested in the combination of demands placed upon the CSP (Figure 4).

Strategic demands	Constraints	Innovations

Economic rationalism	Operational cross-country, respect political culture of partnering with farmers	Ranking system that is operated by local NRCS official
Ecological foundation	Different models for different ecosystem service	Use a centralized model with scoring to combine multiple existing models
Granular (farm-level) data	Alignment with local bureaucracy	Self-assessment questionnaire, One-time field verification
Validity of model	Deadline	Limit external testing, limit peer-review, modify existing models
Regional equity	Dodge regional claims of differential treatment	Pre-set ranking pools

Figure 4: Analysis of Strategic demands, Constraints, and Innovations

Policymakers wrote into law a need for tools that would comprehensively rank every applicant based on expected environmental outcomes but the law offered no new resources to build the tool or any precise direction on how to develop the tool. I am inclined to believe that the inclusion of measurement tools was not meant primarily to force discipline upon policy implementation but an overture from policymakers to provide a resource to legitimize what the NRCS and USDA was already doing. I also note how elite bureaucrats interpreted their responsibility to implement the CSP in the same historic framework as they have done with other Farm Bill programs: to get the money out quickly, without too much overhead, and in a way that would raise least inspection. The latter is achieved by ensuring the CSP's distribution is not too different from other AEP programs. This is made possible by making the big-picture allocation decisions politically and leaving the scoring model to make decisions within much narrower sub-state pools. I do not suggest that the process was merely politicized, a finding that is already well established in STS, but rather to understand exactly how data was mobilized to negotiate accountability and yet carry out business-as-usual. Absent a strong institutionalized definition of terms such as “practicable” and “strong technical basis” and processes of governing what they mean in practice, the program office was able to control and manage the interpretation of the CSP in a way that allowed them to meet their various strategic interests. While much of the literature in STS and Political Ecology focuses on how environmental quantification enacts a certain kind of neoliberal nature, this study shows that the processes of quantification also enact the meaning of terms such as practical and rigorous quantification. Here we find that the meaning of rigor was understood in relation to historical policy commitments that prioritized supporting farm incomes and not meaning to extract conservation value from farmers. This also explains why the CMT was put through such few external tests, why the program office did not see a need to bring in technical experts, or why a comprehensive peer-review was not carried out.

Finally, the subject matter specialists hinted at the heroic expectations upon them from policymakers and bureaucrats and the rush to develop the model. While subject matter specialists positioned themselves as both in relation to but also outsiders to the political interests of the CSP. Some ecologists communicated their own uneasiness with the CMT development process and choice of both the self-assessment questionnaire and the combining of otherwise separate tools into a single scoring model. But given the organizational hierarchies of the USDA, the scientists’ demand of more rigor in the calculations was considered practically incompatible with the policy goal to get the money out quickly. Environmental performance quantification was less a check on resource allocation and more a resource to be deployed to justify the policy trajectory.

2.8 Conclusion

While new accounting systems emerge in a neoliberal moment in our history, they do not reproduce the neoliberal impulse ex-ante. Outcomes are not pre-determined. Paced change is always ongoing. The incumbency of state-bureaucracies grants them some level of control over the technical tools that are meant to discipline them (Carpenter, 2001; Coleman et al., 1996). The strategies policy networks mobilize to withstand change and yet demonstrate responsiveness to public concerns illuminates the importance of broadening our understanding of the political underpinnings of environmental measurement and accounting. If we consider the polemic that the pathway from accounting to economic rationalism is an empirical question, then we need to explore how accounting practices emerge and mutate in relation to policy networks, and what accountability tests/controls do they face in the process. New technologies and ideas brought into policy debate may transform existing practices and challenge established conventions, and they may even introduce new actors and shift power dynamics, but it is necessary to understand how incumbent power holders respond to the prospects of change and what resources and logics they mobilize to preserve strategic interests. How and to what extent relevant actors are able to respond, learn, and adapt as new technologies, new concerns, and new ideas emerge is an important empirical research question for the study of institutional change.

STS scholars of science-policy argue that technical development or expertise must be subjected to democratic accountability tests rather than treating regulatory science as a blackbox (Guston, 2004; Jasanoff, 2003). Perhaps subjecting tool development projects to more democratic tests may generate informational resources that are cheap to gather and yet prevent any one group to control the infrastructural design. This implies asking questions of funding, the distribution of resources, formal mandates and available mechanisms to question the mandates, different actors involved, and the mechanisms through which external feedback is convoked. However, I also interpret the case to suggest a need for caution in advocating accountability as the central policy lever to stimulate progressive environmental policies. I suggest that centralizing policy debate on accountability risks overlooking how the widespread endorsement given to increasing accountability can backfire and mask rather than expose political interests.

2.9 References

110th Congress, 2008. Food, Conservation, and Energy Act of 2008.

Asdal, K., 2011. The office: The weakness of numbers and the production of non-authority. Accounting, Organizations and Society 36, 1–9. https://doi.org/10.1016/j.aos.2011.01.001

Batie, S.S., 2008. Wicked Problems and Applied Economics. Am J Agric Econ 90, 1176–1191. https://doi.org/10.1111/j.1467-8276.2008.01202.x

Bigger, P., 2015. Environmental Governance in the Carbon Economy: Regulating Greenhouse Gas Emissions in California's Cap-and-Trade Program. Theses and Dissertations--Geography.

Bijker, W.E., 2010. How is Technology Made?-That is the Question! Cambridge Journal of Economics 34, 63–76. https://doi.org/10.1093/cje/bep068

Bijker, W.E., Hughes, T.P., Pinch, T. (Eds.), 2012. The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology, anniversary edition edition. ed. The MIT Press, Cambridge, Mass.

Bowker, G.C., Star, S.L., 2000. Sorting Things Out: Classification and Its Consequences. MIT Press.

Bybee-Finley, K., Ryan, M., Bybee-Finley, K.A., Ryan, M.R., 2018. Advancing Intercropping Research and Practices in Industrialized Agricultural Landscapes. Agriculture 8, 80. https://doi.org/10.3390/agriculture8060080

Carpenter, D.P., 2001. The Forging of Bureaucratic Autonomy: Reputations, Networks, and Policy Innovation in Executive Agencies, 1862-1928. Princeton University Press.

Choe, C., Fraser, I., 1999. Compliance Monitoring and Agri-Environmental Policy. Journal of Agricultural Economics 50, 468–487. https://doi.org/10.1111/j.1477-9552.1999.tb00894.x

Coleman, W.D., Skogstad, G.D., Atkinson, M.M., 1996. Paradigm Shifts and Policy Networks: Cumulative Change in Agriculture. Journal of Public Policy 16, 273–301.

Considine, M., Lewis, J.M., Alexander, D., 2009. Networks, Innovation and Public Policy: Politicians, Bureaucrats and the Pathways to Change inside Government. Springer.

Doering, I., Otto C., Lawrence, D.J., Helms, J.D., 2013. Agricultural Conservation & Environmental Programs: The Challenge of Data-Driven Conservation. Choices Quarter 2.

Espeland, W.N., Sauder, M., 2007. Rankings and Reactivity: How Public Measures Recreate Social Worlds. American Journal of Sociology 113, 1–40. https://doi.org/10.1086/517897

Ferguson, J., 1990. The Anti-Politics Machine: "Development", Depoliticization and Bureaucratic Power in Lesotho. CUP Archive.

Freidberg, S., 2017. Big Food and Little Data: The Slow Harvest of Corporate Food Supply Chain Sustainability Initiatives. Annals of the American Association of Geographers 107, 1547–1547. https://doi.org/10.1080/24694452.2017.1349522

GAO, 2006. Conservation Securuty Program: Despite Cost Controls, Improved USDA

Management Is Needed to Ensure Proper Payments and Reduce Duplication with Other Programs (No. GAO-06-312). United States Government Accountability Office.
Gupta, A., 1998. Postcolonial Developments: Agriculture in the Making of Modern India. Duke University Press.
Guston, D.H., 2004. Forget Politicizing Science. Let's Democratize Science! Issues in Science and Technology XXI.
Hall, P.A., 1993. Policy Paradigms, Social Learning, and the State: The Case of Economic Policymaking in Britain. Comparative Politics 25, 275–296. https://doi.org/10.2307/422246
Jasanoff, S., 2003. (No?) Accounting for expertise. Science and Public Policy 30, 157–162. https://doi.org/10.3152/147154303781780542
Johnson, B.A., 2004. Implementing the Conservation Security Program (CRS Report for Congress No. RS21740). Congressional Research Service.
Kenis, P., Schneider, V., 1991. Policy Networks and Policy Analysis: Scrutinizing a New Analytical Toolbox, Schriften aus dem Max-Planck-Institut für Gesellschaftsforschung. Campus Verlag, Frankfurt a. M.
Le Galès, P., 2016. Performance measurement as a policy instrument. Policy Studies 37, 508–520. https://doi.org/10.1080/01442872.2016.1213803
Lehrer, N., 2010. U.S. Farm Bills and Policy Reforms: Ideological Conflicts Over World Trade, Renewable Energy, and Sustainable Agriculture. Cambria Press.
Lehrer, N., Becker, D.R., 2010. Shifting paths to conservation: policy change discourses and the 2008 US farm bill. Journal of Environmental Planning and Management 53, 639–655. https://doi.org/10.1080/09640561003730007
Lenihan, M.H., Brasier, K.J., 2010. Ecological modernization and the US Farm Bill: The case of the Conservation Security Program. Journal of Rural Studies 26, 219–227. https://doi.org/10.1016/j.jrurstud.2009.12.004
Lippert, I., 2015. Environment as datascape: Enacting emission realities in corporate carbon accounting. Geoforum 66, 126–135. https://doi.org/10.1016/j.geoforum.2014.09.009
Muniesa, F., 2014. The Provoked Economy: Economic Reality and the Performative Turn, 1st Edition. ed. Routledge.
Potter, C.A., Wolf, S.A., 2014. Payments for ecosystem services in relation to US and UK agri-environmental policy: disruptive neoliberal innovation or hybrid policy adaptation? Agric Hum Values 31, 397–408. https://doi.org/10.1007/s10460-014-9518-2
Robertson, M., 2012. Measurement and alienation: making a world of ecosystem services. Transactions of the Institute of British Geographers 37, 386–401. https://doi.org/10.1111/j.1475-5661.2011.00476.x
Scott, J.C., 1999. Seeing like a State: How Certain Schemes to Improve the Human Condition Have Failed. Yale University Press.
Star, S.L., 1999. The Ethnography of Infrastructure. American Behavioral Scientist 43, 377–391. https://doi.org/10.1177/00027649921955326
Wolf, S.A., 2017. Accountability, Rationality, and Politics: Critical Analysis of Agri-environmental Policy Reform in USA, in: Bonanno, A., Wolf, S.A. (Eds.),

Resistance to the Neoliberal Agri-Food Regime: A Critical Analysis. Routledge.

CHAPTER 3: APPETITE FOR IMPRECISION: THE ROLE OF BUREAUCRACY IN IMPLEMENTING A PAY-FOR-PERFORMANCE PROGRAM

3.1 Introduction

In April 2016, I was sitting beside a District Conservationist (DC) in a county Natural Resource Conservation Service (NRCS) office in North Dakota, US. A farmer seated in front of the DC was asking him questions about an environmental payment program - the Conservation Stewardship Program (CSP). The CSP is a federal agri-environmental policy (AEP) that incentivizes farmers anywhere in the country to adopt conservation practices on their farms. As of 2017, the CSP is the largest private land conservation program in the US; the state of North Dakota – a major agricultural state - is the fourth largest recipient of CSP funding. The county mentioned above received \$12.5 million between 2010 and 2017, and is the highest CSP recipient county in the entire country. Over the same period, the US Department of Agriculture (USDA) spent \$2.2 billion to enroll 20% US farmland into the CSP. The deadline for the CSP application was fast approaching this May; the meeting between the farmer and the DC would result in a conservation performance score for the farmer, a rank, and the possibility of federal financial assistance.

Unlike other USDA conservation programs, the CSP is explicitly designed to be outcome/results-based, echoed in CSP's promotion as a pay-for-performance (PfP) program. The PfP governance model like similar payments for ecosystem services (PES) programs is guided by the economic logic that providing incentives and engendering competition is the most cost-effective policy to produce public goods from private lands (Büscher, 2012). What differentiates the PfP from existing PES projects is an emphasis on basing a part or the entirety of payments on measureable conservation outcomes. Much of the social science literature on PES and metrics discuss which performance metrics or standards should be included in evaluating outcomes and organizing payments (Birch et al., 2011; Doering et al., 2013). In contrast, critical social scientists – scholars committed to disentangling how relations of power shape knowledge production – highlight the depoliticizing function of data in governance (Barry, 2002; Bryant, 2016). To the extent environmental governance is transformed into an apolitical project of enhancing efficiency, managerial forms of expertise are privileged; the scope for deliberation and debate is overlaid by a seemingly consensual process of data-driven governance (Backstrand et al., 2010). Data, its collection, storage, categorization, analysis, and then more collection, becomes the primary substance of government. The critical studies of data in environmental governance situate initiatives like the CSP within a political economy of conservation (O'Connor, 1988), referencing consequences such as financialization, commodification, and accumulation (Bumpus and Liverman, 2008; Robertson, 2012; Sullivan, 2013a). An overlapping research trajectory has illuminated the role of science and technology (or techno-science) – models, metrics, accounting protocols, and standards (Cooper, 2015; Lansing, 2010; Nost, 2015; Robertson, 2007) – in laying the foundations for enacting economic solutions for conservation challenges.

There is, however, little geographic research on the role of the bureaucracy in shaping the structure and outcomes of a data-driven governance project. The research gap persists despite a long tradition in geography and anthropology to study state-centered conservation programs from the perspective of bureaucratic encounters (for a recent analysis, see: Mathews, 2011). At the same time, scholars of PES illustrate how economic rationality is reproduced, interrupted, and resisted through local institutional actors like community groups and NGOs (e.g. Osborne and Shapiro-Garza, 2018). Yet, few studies have looked at the role of bureaucrats and their routines in shaping conservation payment projects. In this paper, I look toward the bureaucracy to analyze how promises of economic rationalization through data-intensive technologies are realized from the ground-up. I study how bureaucratic rules and routines are reformed (or not) to create PfP initiatives and how organizational changes (or lack of changes) shape the performances of rationalized governance.

The grounded nature of this study follows a long tradition within human geography to study economic practices (as opposed to policies, rules, and norms) (Gibson-Graham, 2008). A turn to practice is particularly useful in studying how the adoption of data-driven technologies produce uncertainties and coordination challenges that cannot be resolved by referencing rules or precedents and thus require improvisation (Wolf and Ghosh, forthcoming). Espeland and Stevens (2008) argue that the impulse to quantify, while supported by ecological modeling and field experimentation, needs to be coordinated by multiple human actors, rules, technologies, and moral perspectives within situated practical constraints such as deadlines, funding, and personnel resources. A large amount of information gathering and management work, such as the meeting outlined in the beginning of the paper, underscore the everyday informational work of rationalizing environmental governance (Ghosh, 2017; Lippert, 2015). In state-lead programs, the institutional actor most often tasked with the responsibility to transform qualitative observations into quantitative data are the frontline bureaucrats or what Lipsky (2010) called “street-level bureaucrats”. Applying critical insights on data-infrastructures from Science and Technology Studies (STS) (Bowker and Star, 2000; Gitelman, 2013), I scope out how and in what ways the street-level bureaucracy interprets, probes, and adapts to a PfP model and the consequence of bureaucratic work for the performance of accountability relations in outcome-based payments program.

The paper draws on a five-month ethnographic study of bureaucratic work in North Dakota. Data was collected in bureaucratic offices through in-person semi-structured interviews with District Conservationists (DCs) and through participant observation of meetings between DCs and farmers like the one mentioned earlier. While the study is specific to US AEP and the USDA bureaucracy, inferences will be relevant to the use of data and algorithms in environmental governance more broadly.

In the following section, I discuss key elements of bureaucratic organization and the performance of mechanical objectivity. In Section 3, I summarize historic developments in US AEP and set up the backdrop within which the CSP emerged as a policy solution. I also lay out my research methodology. In Section 4, I introduce the CSP and explain how the performance quantification model functions. In Section 5, I address how bureaucrats interpret the policy directive, the contingencies they face in completing their tasks, and how they work around the contingencies. In Section 6, I present how bureaucrats justify their work and perform objective, fair, and accountable decision-making. In the Discussion section, I argue a need to consider the limits of quantification as advancing rationalized governance and layout future research directions. I offer final thoughts on the political implications of embracing PfP ideas in the Conclusion.

3.2 Street-level Bureaucrats

Critical social scientists speak of bureaucracy as the manifestation of state power (Ferguson, 1990; Gupta, 1998; Scott, 1999). Bureaucracies are often studied in terms of their hierarchical organization, but in this paper, I am to understand the specific role of street-level bureaucrats (Lipsky, 2010) who perform the day-to-day work of creating, maintaining, and/or transforming institutions. In this section, I review key themes in bureaucratic politics in relation to environmental governance and focus on the different ways street-level bureaucrats extend or undermine policy goals.

According to Weber (2007), the essence of the bureaucracy lies in the depersonalization of employees who constitute the bureaucracy. The process of depersonalization is necessary for the bureaucracy to garner legitimacy, impart a sense of "internal coherence", and function as an objective and "disciplined machine" that is in service of the public good (Bourdieu et al., 1994). However, when the work of bureaucratic knowledge production is examined closely, we find that officials often ignore high-level directives and carry out "rituals of accent" (Li, 2005) which can undercut regulatory visions of change (Gupta, 2012).

In his study of forestry bureaucrats in Mexico, Mathews (2011) points out that the state's production of knowledge is often improvised and performed before skeptical audiences. Mathews' observed local officials acrobatically juggling national regulatory shifts in relation to localized politics and situated norms. For example, some regulations, like fire risk management, were selectively enforced in order for the street-level official to maintain connections and trust among local forestry communities. Although officials were aware of violations, they would turn a blind eye, effectively acknowledging that their decision to overlook due process would eventually misinform higher bureaucrats. A similar argument has been made in the context of China's forest governance in terms of what the authors call "accommodative buffering" of information at the level of street-level bureaucrats (Zinda and Zhang, 2018). Similarly, Juntti and Potter's (2002) comparison of street-level bureaucrats tasked with implementing AEP in England and Finland reinforce a similar finding - the identity of officials is an important albeit overlooked variable in how polices was implemented.

The ability of the State to "see" (Scott, 1999) and rationalize its policies based on data is a result of many street-level bureaucratic encounters. It is tempting to see situated encounters of knowledge production as a shift toward a democratization of knowledge (Backstrand et al., 2010; Guston, 2004) or a deflation of the rigid intellectualism associated with bureaucratic knowledge gathering (Murphy, 1994; Weber, 1978), but as Lave (2015) points outs such shifts reflect deeply contradictory practices that do not necessarily fit any single political momentum, let alone a progressive one. A need arises for analytical care in deconstructing situated bureaucratic encounters and to identify the conditions that shape how outcomes advance institutional changes.

3.3 Political Economy of Agri-Environmental Policies (AEP)

Agriculture is not only a source of food, fuel, and fiber but also negative ecological consequences: groundwater pollution, soil erosion, greenhouse gas (GHG) emissions, and loss of biodiversity (Crosson and Brubaker, 2016; Reay et al., 2012; Swinton et al., 2007). Many of these consequences are experienced far beyond the farm and create a public good problem. Despite the evident environmental concerns, the agricultural industry is not policed in the same way industrial polluters are regulated (Shortle et al., 2012). Part of the explanation lies in the difficulty to account for agricultural non-point source pollution (Ribaudo, 2015). Unlike the smokestacks in a factory, it is technically and administratively difficult to measure non-point pollution from a specific farm.

However, a more critical explanation lies in the political history and power dynamics of the agri-food system (Wolf, 2013). AEP rely almost exclusively on voluntary incentive payments rather than coercive regulatory policies. (Claassen et al., 2014). The USDA spends as much as US $5.5 billion/year through a variety of programs to incentivize conservation on private farmlands and the trend looks to continue (Claassen, 2014). Depending on the type of program, farmers either set aside parts of their farmland as uncultivated land or modify their farm management by incorporating conservation practices such as cover cropping, increasing crop diversity, and reducing tillage. Despite experimenting with voluntary conservation incentives since 1985, the success of USDA voluntary approaches has been piecemeal and fragmented (Ribaudo, 2015). Scholars argue that the distribution of payments are not optimized to meet agri-environmental problems (Claassen et al., 2014; Ribaudo, 2015).

In light of the growing critique of AEP as ineffective, USDA economists diagnose the weak success of AEP as a technical problem and advocate more outcome-based targeting (Babcock et al., 1997; Doering et al., 2013; Feather et al., 1999; Hansen and Hellerstein, 2006). Social science discussion on outcome-based strategies focus primarily on what to measure, what metrics to use, and/or what kinds of standards or thresholds would maximize benefits (Babcock et al., 1997; Birch et al., 2011; Hellerstein, 2017). Scholars also document how the momentum toward expanding outcome-based targeting has manifested in different ways in US and Europe; EU AEP adopt a broader idea of rural development within targeting initiatives while US AEP discuss targeting more narrowly in terms of environmental benefits (Baylis et al., 2008; Hansen and Hellerstein, 2006; Moxey and White, 2014). However, despite the growing conversations about more rationalized approaches, empirical evidence suggests that policy interest in rationalization is weak (Potter and Wolf, 2014). The lack of optimization in spending is a political and structural problem, not a technical one. The political limits to rationalization are evident when we consider the historical negotiations that authorize AEP. During negotiations, expanding funding rather than expanding efficiency or returns dominate policy debate. The increase in funding made available for agricultural conservation after the 1996 Farm Bill has, to some extent, added pressure on AEP to rationalize spending. When the NRCS was audited for the first time in 2008, the auditors flagged a lack of rigor in how AEP funds were distributed. Around the same time, two Government Accountability Office (GAO) reports in 2006 and 2008 noted that payments were not sufficiently designed to optimize environmental benefits.

The CSP can be understood as a response to growing demands placed upon AEP to rationalize spending. The 2008 Farm Bill that created the CSP, wrote into law a mandate for the NRCS to use conservation measurement tools to rank farms based on expected environmental benefits and use these ranks to determine payments. This is an explicit reference to more outcome-based controls and within this reference is the potential for triggering policy reform through data and measurement. In the rule-making stage, NRCS directly engaged the economic rationalist discourse, promoting the CSP as a pay-for-performance initiative. This placed emphasis on calculating expected conservation benefits and linking payments to these calculations. Given CSP's commitment toward comprehensive farm-level conservation, the term "conservation benefits" did not directly correspond with any pre-existing ecological assessment metric or standard, effectively requiring the USDA to create a whole new set of quantification tools with potential implications.

The tool developed was called the Conservation Measurement Tool (CMT) and is a scoring and ranking algorithm that is applied across the country. Using models for decision-making could both complement and threaten the autonomy of the "disciplined machine" like bureaucracy. How and in what ways the bureaucracy adapts to change and performs data-driven governance at its own terms is the empirical question at the core of this analysis.

Research Design

This paper relies on five months of ethnographic research stretched across two years with discontinuous field visits to North Dakota and USDA headquarters in

Washington, DC. Interview requests were sent to over 30 field offices resulting in 18 interviews with District Conservationists (DC) located in 17 different counties. 10 months from the original interviews and at a time coinciding with the CSP application period, follow-up interviews were conducted with 10 of the 17 DCs. DCs are federal government officials who implement farm bill policies at the local level and provide technical assistance to farmers. Given the practical and financial constraints of going from county to county to conduct interviews, the sampling strategy reflects a combination of theoretical sampling and an opportunistic sampling (Creswell, 2013). Sampling was driven by balancing two considerations: which regional CSP pool the county fell in (there are three geographic pools within which CSP ranking is carried out) and the number of farms contracted in the county. The approach helped capture a balanced picture of CSP related encounters across North Dakota. The interview script was based on Patton's (2002) classification of questions in terms of experience, opinion, knowledge, and background. I asked officials about a) the different rules and routines they used to perform data-collection, b) instances where the rules were insufficient or inapplicable, and c) how they were able to ensure that information was precise despite uncertainties and constraints.

North Dakota was selected as the primary research site for the following reasons:

i) <u>The state's share of federal CSP spending</u>: North Dakota is among the top-five state recipients of CSP funds and an important player in agricultural conservation. The county mentioned in the beginning of the paper was the highest CSP recipient county in the country over the period 2010 to 2017 (Data received by author from NRCS).

ii) Importance of the agricultural economy for the state economy: Agriculture sector contributes over 25% to the state income and indirectly supports other industries such as transportation, communication, and food processing (USDA, 2014).

iii) Importance of state's agriculture for the rest of the country: North Dakota is a leading supplier of a food staples, producing 18% of the US wheat, 24% of US dry beans, 40% of US dry peas, 38% of US lentils, 16% of sugar beets and 12.5% of the country's oats (USDA, 2014).

iv) Geographic diversity of cropping systems: Travelling from east to west, soil types, rainfall diversity, and environmental conditions change from highly fertile soils near the Red River Valley to more arid landscapes near the Badlands. The diversity offers a glimpse into the geographic complexity of realizing a federal scale PfP program.

I also observed eight CSP Interviews between NRCS employees and farmer/s as they together fed data into the scoring algorithm. My positionality as a participant observer was indirect (Bryman, 2015), i.e. I was not directly working with the NRCS but was negotiating my own access to every meeting. Interactions were possible only by invitation as NRCS-farmer interactions are protected by privacy laws. Officials consulted with the farmers before inviting me. All farmers were well aware of my researcher status and informed that I was not interested in the specific details of their property but in documenting the process. I also attended other events: soil health workshops, farm talks, and NRCS field experiments. While most interviews were conducted in government offices, many ideas were shared on rides in pickup trucks, walking along fields, and in harvesting combines. My observations of these interactions are presented in the form of field notes in this paper. A focus group discussion was also conducted with the State Ecological Science Team, composed of the Team Head, Rangeland Specialist, Biologist, and Agronomist in Bismarck, N.D. Two pilot interviews were conducted with the DC in the county near the author's university. Interviews lasted, on average, one and a half hours. Most interviews were audio recorded and transcribed. I roughly followed the model of open coding from grounded theory (Corbin and Strauss, 2007; Glaser and Strauss, 2009) noting the points of tension, the resources/rules referenced to overcome tensions, and the overall strategies in how DCs approached the interviews.

3.4 Conservation Stewardship Program

Background

The CSP was authorized under the 2008 Farm Bill to enroll 12.8 million acres per year, later reduced to 10 million in the 2012 Farm Bill. All enrollments were processed through a centralized scoring algorithm called the Conservation Measurement Tool (CMT). The CMT quantifies "expected environmental benefits" generated for a given set of conservation practices in a given location. The CMT does not measure actual performance but is a proxy. The CMT scores refer to the benefits across an applicant's entire farm, not specific fields and is thus meant to be size neutral. Once conservation performance points are calculated, funding is distributed beginning with the highest ranking applicant and continuing until the assigned acreage is exhausted. Acreage is allocated to each state based on the level of agricultural land in the state. Farmers who ranked high enough enter into contracts with the NRCS. By signing contracts, farmers are legally obliged to continue their existing conservation practices and also adopt new ones for the 5 year contractual duration.

Conservation Stewardship Program

Conservation Performance Summary Report

Application Number:	Applicant:	Date:	
Geographic Area Ranking Pool:	Ag Lands-Beginning Farmer-Agricultural Lands-Beginning Farmer	Signup Number:	CSP-2015-1

Application NInformation for Payment Calcuulations:

	Acres	Existing Activity Points	Additional Activity Points
Cropland	909.3	289.20	94.79

Cropland - Does not include the Resource Conserving Crop Rotation Conservation Performance Points

Conservation Performance Ranking Score	
Ranking Factor 1	14.26
Ranking Factor 2	288.87
Ranking Factor 3	99.44
Ranking Factor 4	94.05
Ranking Factor 5	0
Final Ranking Score	496.62

Application Ranking Information:

	Cropland, Patureland, Rangeland
Total Acres	909.3
Conservation Performance Ranking Score	496.62

Stewardship Threshold Requirements Met:

Priority Resource Concerns	Applicabl e Priority	Cropland		Pastureland		Rangleland	
		Time of Application	End of Contract	Time of Application	End of Contract	Time of Application	End of Contract
Air Quality		Yes	Yes	NA	NA	NA	NA
Animal	X	Yes	Yes	NA	NA	NA	NA
Energy		Yes	Yes	NA	NA	NA	NA
Plants	X	No	No	NA	NA	NA	NA
Soil Erosion	X	Yes	Yes	NA	NA	NA	NA
Soil Quality	X	No	No	NA	NA	NA	NA
Water Quality	X	Yes	Yes	NA	NA	NA	NA
Water Quantity		No	No	NA	NA	NA	NA

Existing Activities			
Conservation Performance Levels			
	Cropland	Pastureland	Rangleland
Air Quality	27.8393	0.00	0.00
Animal	45.6716	0.00	0.00
Energy	13.5037	0.00	0.00
Plants	24.5037	0.00	0.00
Soil Erosion	34.0000	0.00	0.00
Soil Quality	37.0074	0.00	0.00
Water Quality	97.1753	0.00	0.00
Water Quantity	9.5000	0.00	0.00
Existing Activity Points	289.20	0.00	0.00

Additional Activities			
Conservation Performance Levels			
	Cropland	Pastureland	Rangleland
Air Quality	14.6863	0.00	0.00
Animal	6.8795	0.00	0.00
Energy	12.2000	0.00	0.00
Plants	16.9056	0.00	0.00
Soil Erosion	8.5612	0.00	0.00
Soil Quality	17.7460	0.00	0.00
Water Quality	17.4167	0.00	0.00
Water Quantity	0.3941	0.00	0.00
Additional Activity Points	94.79	0.00	0.00

Figure 1: A Sample CMT summary sheet; Source: District Conservationist, redrafted by Author for clarity.

Figure 1 illustrates the information generated by the CMT. The applicant has 909.3 acres of cropland and received a score of 496.62 conservation points (A and C). The points are subdivided into existing and additional activity points (A), or as ranking factors (B); the existing and additional activity points are further broken down by the different resource concerns (E). At the beginning of the contract, this farmer only meets the requirements for three resource concerns (D) – animal, soil erosion, and water quality, but he/she is expected to meet plant and soil quality by the end of their term. To understand how these numbers are produced, I summarize the basic structure of the CMT model below.

Conservation Measurement Tool

The CMT model scores answers based on the effects of management practices on 28 ecosystem services. However, much of the inner model is blackboxed and local NRCS officials have limited knowledge of the relationship between model input and model outcome. To complete a CSP application, a DC sits down with an applicant and goes through multiple-choice and numerical questions about an applicant's farming history, farm ecology, and future plans. This is an officially documented meeting called the "CSP Interview" – a prerequisite for CSP applications. During the meeting, the DCs ask farmers questions from the CMT questionnaire which is available to the farmer in printed form and to the DC as an online software. A farmer first responds to three general questions about their farm and nine questions about waterways. Next, depending on their land use, they must answer either eighteen cropland questions, eleven pasture questions, ten rangeland questions, or fourteen forestland questions or a combination of these if they have multiple farm types. The last step in the CSP application process is a selection of over 90 possible enhancements. Enhancements in the CSP refer to the set of additional farm management practices, technological changes, or changes in cropping practices that a farmer must adopt to fulfill contractual obligations. For croplands, these include cover cropping, reducing tillage, or performing precision nutrient management. Some farmers might already be applying some of these practices to part of their farm and would expand the scope of their activities through the enhancement. This is assessed through an Operations Baseline Data (OBD) form. If an applicant selects a practice, e.g., cover cropping, they will be scored on both the existing extent of their cover cropping and any additional commitments with all data inputs, including existing activities and enhancements, are input and processed through the CMT algorithm.

As shown in Figure 1, the detailed score breakdown and the four decimal point scoring system represents commitments of rigorous and comprehensive calculation, and transparency in the decision making. Yet paradoxically, the scoring technology – the CMT – is blackboxed not only to the public but also to the street-level bureaucrats who handle the CMT on an everyday basis.

3.5 Policy Interpretations by Street-Level Bureaucrats

During an interview, a DC explained that the CMT presented him a mechanical foundation to justify the taxpayer dollars that passed through his office. The CMT was time-consuming but did not significantly disrupt his other duties. DCs would regularly explain that their primary role was to promote conservation and provide synthesized technical support. Because CSP contracts could reach as much as $40,000 for a single applicant, the stakes for objectivity and public accountability was higher. On further probing, he explained:

> "*My farming ranch background allows me to associate with a farmer-rancher. I know their language. I know small rural communities, sensitivities, and clichés. I wear a conservation hat when I am explaining science-based technical things. […] This is a people's department. I need to use common sense but within the realm of program delivery. […] I use the DC hat to tell a guy why they are not eligible. I wear DC hat to approve CSP payment and I wear DC hat to make them return payments when they don't do what they said. I wear student hat too because this is a classroom."*
>
> – *District Conservationist, North Dakota, Interview, 2015*

The DC's quote conveys how the multiple social responsibilities faced by street-level bureaucrats become resources in carrying out their work. His status as a government official allows him to exercise authority when denying an applicant funds or asking them to return payments when they fail to complete obligations. But his position as a former rancher allowed him to engage as a peer, a much less hierarchical position. As a peer, he focused on building relations and getting a sense of current farmer-rancher conversations. He acknowledged that his own strategy in how he approaches interactions is shaped by "common sense", i.e. not simply by official rules but by employing rules differently in different situations for specific strategic purposes.

Realizing that "common sense" or what we might call tacit knowledge (Collins, 2010) is important but often overlooked in the social science of data-driven governance, I asked my interviewees the key challenges they faced in using "common sense" while working with the CMT algorithm and how they overcame these challenges. Based on a grounded theory approach, I categorize the responses as:

i. Producing a "normal" set of farming practices
ii. Preparing for future contingencies
iii. Speaking the language of policy subjects.

Producing the norm

CMT questions require generalized responses; asking applicants to respond as if their entire farming operation was a single field. Much of the CMT followed a multiple-choice format that did not afford opportunity to enter complex responses. For example, the first question in the cropland questionnaire of the CMT asks farmers to input their typical crop rotations. A crop rotation refers to the temporal pattern of growing different crops in the same area. The CMT does not ask what the farmer planted in the last three years but a more abstract query about the crops they plant and the order they plant them in, even if they do not have a set routine. This may be a tricky question for many farmers who often change their crop rotations annually to adjust with market prices of inputs and outcomes or may change rotations on some fields and not others. The question is answerable in multiple ways as described by an interviewee:

> *"Many stumble on the rotation questions. No one has an exactly defined rotation. Markets drive what to plant. Still, I would say farmers do have a 'typical rotation'. Something like wheat-canola-wheat-corn. This might be considered normal management. Some substitute canola for buckwheat or flax."*
> *- District Conservationist, North Dakota, Interview, 2016*

As the DC explains, a farmer's cropping decision changes with shifting market prices, seed prices and availability, soil tests, and other exogenous variables, as well as, knowledge gleaned in coffee talks and other peer interactions. But, the CMT is not constructed to account for such level of complexity. To input a crop rotation is not a simple mechanical task of feeding existing information into the form but an act of interpretation. DC's, in their own situated ways, developed informal routines to identify the answer they were "most comfortable" with. For instance, the following official explained:

> *"Basically it's like a conversation. 'Tell me how you seed, tell me what crops you are growing.' They give me a breakdown. I make a picture in my head. We go through the questions and I talk them through them."*
> – *District Conservationist, North Dakota, Interview, 2015*

In the CSP Interview, a DC reads a specific question, the applicant selects an answer and the DC reports the exact answers back to the computer. Applicants may ask clarifying questions to the DC and the DC offers clarity about the intent of the question. But DC's are not allowed to coach the farmer and they made this amply clear to me, repeatedly mentioning that they were not coaching. However, DCs were quite willing to stretch the definition of coaching and it was not evident what mechanisms of accountability they faced in interpreting the technical questions. Their practical skills and imaginations were not necessarily contrasting the official instructions but were in fact necessary to effectively organize and relay complex ecological information. Consider a seemingly basic question of counting total acres of a farm, a seemingly obvious question which would also have other official records to back it up. Below, I draw on my field notes of a meeting between a DC and a farmer as they sit down with maps to classify and aggregate the farmer's land.

> *Because part of the farmer's fields are center-pivot irrigated, some of his fields are circular with edges at the corners that don't receive irrigated water. In the main fields, he plants potatoes but in the field edges, he plants wheat. In the edges, he follows a slightly different rotation. He explained that though the yields are lower in the edges without irrigation, he still plants them. But he can't plant potatoes like he plants in the rest of the field. Potatoes, he explained, don't do well without the additional water. But wheat is great. He plants and harvests wheat before he starts harvesting the potatoes. The 30 or so corners add up to 115.97 acres*
> *The farmer and the DC work through the numbers but when they input the numbers into the CMT, it outputs an error. The numbers are not adding up. There are many corners over his fields – like narrow areas of only 4-5 acres. They recalculate multiple times. Eventually, their number is off by an acre. At this, the DC points to thin bands on a few fields. He explains that the mapping software doesn't catch these bands. He says he has done many applications and is used to these mapping problems. He apologizes for not bringing this up earlier. At no point did the DC or the farmer use any measuring tools but simply ballparked the sizes of the different strips and edges.*
> - *Author field notes, 2016*

The above farmer presented a complex farming operation with multiple types of crop rotations, irrigated land, and oddly shaped fields. Together the farmer and the official sifted through A4 sized maps of the farmer's different fields. The official eyeballed the maps, asked questions, and entered acreage data. To close the discussion, the official said: "*I am comfortable with that*". The term "comfort" constituted a closure to the negotiated nature of the CSP Interview. In stark contrast to the highly precise answers of the CSP, the observation illuminates how data, in its physicality as a number in the CMT form, achieves an objective status through informal and situated seals of approval. The CSP Interviews are not simply about discovering data that was preexisting the interaction. Rather it is through the interaction between the official, the farmer, the paper documents, and the computer screen that an ideal-type representation of a farmer's operation is realized in such a way that would conform to the CSP data requirements.

Preparing for future needs

To meet their audit and documentation responsibilities, officials explained that they would prioritize certain parts of the data collection and recording. They would be more careful and disciplined in filling some parts of the CMT, while saving time on others. There were some patterns in how they went about adapting their workloads.

As mentioned earlier, every applicant completes an OBD form. Among its many questions, the OBD asks for information on the portion of the farm currently under cover crops or existing length of riparian buffers. Each of these calculations can be time-consuming depending on the size and complexity of the applicant's farm. Instead of rigorously calculating each answer, DCs were selective in how much time they spent on the OBD. For example, the term "riparian buffers" is broadly understood as a reference to vegetative strips adjacent to water streams that absorb excess nutrients as they leach from the field. When an applicant commits to adding riparian buffers as an enhancement, the algorithm evaluates how many feet of buffers are already recorded in the OBD. Depending on what is existing, say 10% of all water streams have buffers, the CMT then calculates the value of how much more buffer the farmer commits. The precision in answering the question, a DC explained, was based on whether the farmer was committing to the corresponding enhancement. If not, then DCs often ballpark the number and do not revisit the calculation. Multiple DCs explained that they would invest more time and effort in ensuring accurate data collection about selected enhancements. The rationale for this form of prioritized precision was to avoid legal challenges if in the future a farmer is found to be in violation of their contractual obligations. In such situations, the farmer is under scrutiny, but to some degree, so is the DC.

The CSP Interviews served needs beyond the CSP such as conservation outreach and extension. In an interview, the North Dakota Assistant State Conservationist explained how he encourages DCs to think about the CSP Interviews as an opportunity to build relationships for future conservation projects. He said that the CSP Interviews were not an end-in-themselves but a "foot-in-the-door" to establish new partnerships. According to the Assistant State Conservationist, it was a missed opportunity to approach the CSP Interviews strictly as a process of "nailing facts". To follow the "foot-in-the-door" metaphor meant approaching CSP Interviews, not only as the CSP pre-requisite, but also to actively foster trust and interdependence moving forward.

Many DCs actively leveraged the CSP Interviews to "sell" conservation ideas, representing themselves to me as "conservation salespersons". This meant using the CSP Interviews as a way to ask more questions about the farmer's operation, discuss technological innovations, and engage with the farmer as peers with shared interests. While the alliance of data-gathering and the bureaucracy suggest dull impersonal exchanges about numbers, rules, and protocols – the work of nailing facts, I found that during the meetings repeatedly extended beyond the CSP to subjects such as new technologies, chemical companies, commodity prices, evidence-based policy, importance of community, and even global trade negotiations. These discussions were seemingly tangential to the CSP's scoring system but essential to building the social capital necessary at the ground level to operationalize top-down directives.

<u>Speaking the language</u>

Since the CMT is meant for all CSP applicants nationwide, the questions are framed broadly. Many DCs mentioned a need to translate the language of the CMT to communicate the *intent* of questions. The language of intent was repeatedly mentioned in interviews suggesting some official circulation of the term. Below, I summarize a conversation between a farmer and a DC to determine how many wetlands have a buffer on the farmer's fields.

> *DC: When I look at your map, these red-dots are your wetlands. What they want to know is what type of buffer zone you have around them.*
>
> *Farmer: Yeah.*
>
> *Claire: Do you farm right to it? What percentage of these areas have 33 ft wide buffer? It's a first reaction type thing. You need to think about this. That's where the question starts to lead.*
>
> - *Author field notes, 2016*

In the exchange, the DC translates "wetlands" as "red-dots on the map". Red-dots are point-marks on the official Farm Service Agency (FSA) maps that designate areas officially deemed wetlands based on a 1986 mapping effort. Farmers are, by regulation, not allowed to fill these areas and dry them out. The CSP rewards farmers who have left uncultivated areas, buffer zones, around wetlands. The detailed question about how much of their wetlands have 33 ft or more grassed buffers is translated into one about "first reactions" to how farmers farm around the red dots. Such contradictions between "rigorous" data-collection and "first-reaction" sort of answers was common in CSP Interviews and crucial for the DCs to complete the questionnaire.

In another question, a DC used the term "odd areas" to refer to a "pollinator habitat". I learnt that odd areas in farmer vernaculars refer to parts of the farm that are difficult to till such as roadsides or fence corners. Because they remain uncultivated, these become habitats for wild birds, insects, and other wildlife (Rodgers and Wooley, 1983). A DC explained the confusion:

> *"Average width of pollinator habitat - They are going to look at you and say "Ah what does that mean?". So what I would say is, this is odd areas. This can be shelterbelts, cattails outside wetlands, grass habitat adjacent or within crop field. When talking to farmers, I would say this question means odd areas."*
> *- District Conservationist, North Dakota, Interview, 2015*

In a basic sense, DCs explained their responsibility as interpreting the question for farmers. This work of translation was more than just a one-to-one conversion. It was a mechanism adopted by DCs to provoke farmers to think differently about their land, an occasion for DCs to share their knowledge and expertise with the farmer, a resource to build new relationships and re-engage old ones, and an opportunity to draw farmers deeper into a conversation about conservation. In a way, translation served as a way for DCs to make the CSP more coherent to localized understandings and agri-environmental concerns.

The vignettes illuminate the interpretive work of collecting farm information. CMT questions, I noted, regularly failed to present enough guidance to complete the form and bureaucratic improvisation was necessary. The role of interpretation contrasts the CMT promotion as a comprehensive data-collection and calculation project. It also contrasts the bureaucracy's image as a disciplined machine. In the following section, I explore how existing structures of demonstrating accountability were strategically mobilized as resources to justify interpretation.

3.6 Justifying (Im)Precision

I probed interviewees on how they ensured their work conformed to agency protocols and with interpretations performed in other offices. I was seeking to understand what forms of accountability relations DCs saw themselves enmeshed in and how they justified their improvised work by turning to these accountability relations when needed. In response, I was redirected to many formal NRCS resources. These rules and resources were useful in addressing two main accountability challenges:

i) Answering questions consistently across local offices, contexts, and farming systems.

ii) Ensuring questions were calibrated to local agri-environmental concerns.

I treat these concerns as two sides to the problem of commensuration: a) justifying equivalence and b) justifying calibration (Cooper, 2015; Schinkel, 2016).

Justifying equivalence

When possible, CMT questions are linked to existing NRCS practice standards which contain information on how a practice should be applied and the quality criteria to evaluate whether the application of the practice achieves its intended purpose(s)".

NRCS practice standards are state-based and available to DCs through the Field Office Technical Guides (FOTG). For example, to ensure that different field offices were consistent in recording the quality of riparian buffers, the ND office defined riparian buffers as having a minimum 33 ft. of vegetation around a water body.

However, these standards and models are relevant for only a handful of CMT questions. In other situations, officials rely on quasi-standardized references. Visual aids such as the residue chart help DCs make a quick judgment of the level of crop residue left on a field after harvest (Figure 2). More residue has been determined to be a best management practice for increasing the organic matter in the soil and reducing soil erosion risks. The CMT rewards higher points for more residue. Because the judgment about the level of residue must be made quickly and without reference to any technical measuring device, the chart serves as a rough but primary guide to organize consistency across offices. However, exactly how DCs used the rubric was unclear to me as it was not mobilized during CSP interviews. Many DCs also mentioned that they do not carry the chart when they visit fields. Based on experience and rainfall, they were able to estimate the level of residue without the chart. Yet, the residue charts were often on display on the walls of local NRCS offices.

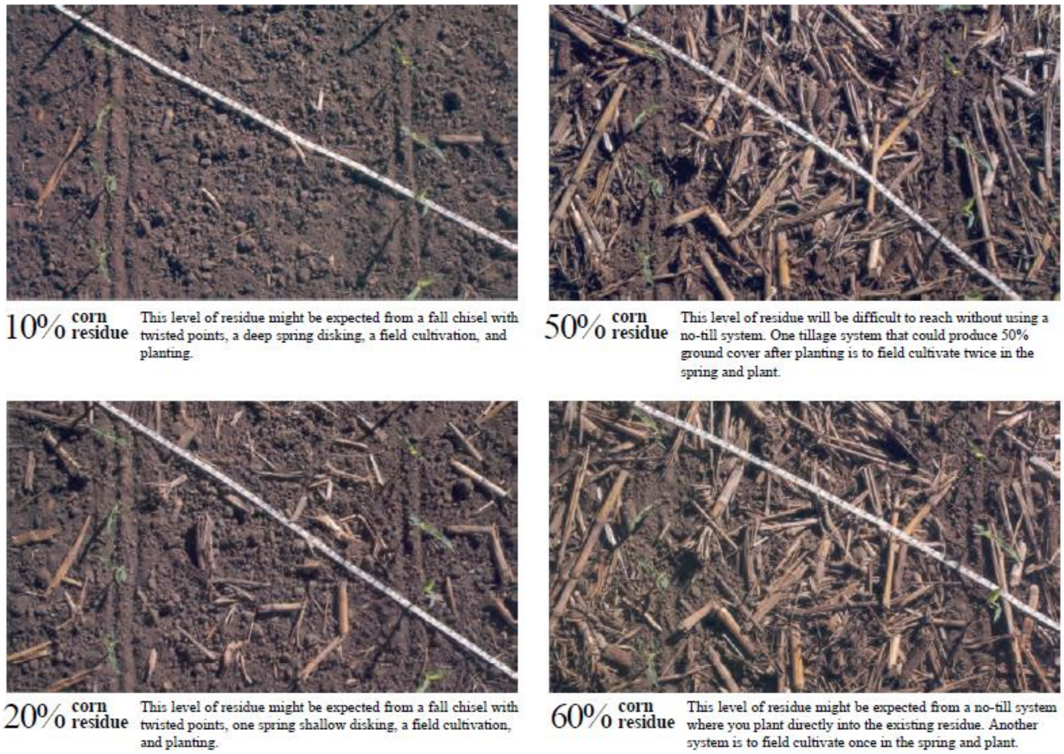

Figure 2: Residue Management Chart; Source: Crop Residue Management Guide, USDA

When information aids are unavailable, interviewees said they reached out to peers or supervisors. A field official could message, email, or call their peers and senior officials. As with much of bureaucratic organizing, the credibility of answers depended upon rank and expertise. Eventually, questions and their responses were collected into an FAQ-like document that served as a formal reference for DCs. However, the precision of language in the FAQ document was often ambiguous. The FAQ exchange below illustrates the nature of ambiguities in answering CMT questions:

> *"Q: CMT Cropland Question 8 – What if the producer leaves unharvested acres but it's not 50-75% or more of the field, how should they answer?*

> *A: The producer should choose whichever answer a-d that best fits his operation… if c, or d do not work, he may need to evaluate a or b."*
> - *Official Sharepoint FAQs, NRCS*

Ambiguous answers such as the one above were common in the FAQ. The FAQ document recognized contingencies as a recurring part of the CMT scoring process. It is an example of a formal effort to document the actual challenges that arise in the practice of CMT scoring.

The residue chart, the practice standards, and the FAQ represent resources available to the DCs when confronted with difficult decisions in quantifying farm data. But despite the references to these resources, it was unclear how they were used in practice or how, when, or how often officials sought them out. Moreover, while these documentation trails suggest precision and consistency in calculations, the correspondence with the reality of the farm field is tenuous.

Justifying calibration

The 2008 Farm Bill mandated applicants meet or exceed stewardship thresholds for at least one priority resource concern. Priority resource concerns are a set of ecosystem service issues that are established as important for the region or state. Thresholds refer to some baseline score that applicants must meet to be eligible for the program. Points scored toward enhancing priority resource concerns are weighted higher on the CMT. The selection of which resource concerns are prioritized for the given region are made at the state level. Each state must identify three to five priority resource concerns for each CSP pool. While states cannot change the CMT questionnaire or the internal model, the priority resource concerns offer an opportunity for states to (re)calibrate the CMT to be more applicable for the ecological issues at the level of their state or sub-state. Priority resource concerns in ND include: animal, plants, soil erosion, soil quality, and water quality. The resources concerns as is evident from their names, such as animal and plants, are broadly defined.

Another way state offices modify the CSP application process is by including additional information for each enhancement. Before the CSP is opened for applications each year, the ND Ecological Science develops a version of the CMT questionnaire with additional information relevant to ND in the margins. These "sideboards" (Figure 3) provide supplementary instructions to farmers and officials on how to answer questions and legally comply with the CSP contractual obligations. The sideboards include references to specific practice standards, details on chemicals permitted for certain enhancements, and even harvest dates given the growing season in ND. The sideboards contain information the ND office sees as important for filling out the CMT that is not mentioned in the national form.

Select Activities that interest you	Actual or System with Amount Acres or Number**	NRCS Code	Eligible Land Use				Enhancement Name	Enhancement Criteria	ND Implementation Sideboards	May Be Applicable on Land Adjacent to Eligible Land
			Crop	Pasture	Range	Forest				
	System Acres	SQL05	X				Use deep rooted crops to breakup soil compaction	Use deep rooted crops to break up pans in the soil to improve internal drainage.	See ND list of deep rooted cover crop mixes.	No
	Actual Acres	SQL06	X				Conversion of cropped land to grass-based agriculture	acres of cropland	Grassland will be **mechanically** harvested only. Need to meet 512 standards and specifications, refer to 512, Pasture and Hayland Planting, for acceptable species mixtures. For Option A: No haying allowed from April 15 to August 1: 8" stubble height.	No
	System Acres	SQL07				X	Forest Stand Improvement for Soil Quality	Management of forest activities (planting, thinning, harvesting) to minimize impact of forest soils to improve soil quality.	Applicable to all forest stands in North Dakota, excluding windbreaks and shelterbelts. Forest management plan required.	No
	System Acres	WQL01		X	X		Biological suppression and other non-chemical techniques to manage brush, herbaceous weeds or invasive species	Removal, reduction or manipulation of non-herbaceous plants with biological suppression methods.	Goats, sheep and/or beneficial insects only; no mechanical treatment; does not apply to native shrubs; does not need to meet 528.	No
	System Acres	WQL03		X	X	X	Rotation of supplement and feeding areas	Rotation of Supplementation and Feeding Areas to manage areas of concentrated livestock use to improve livestock distribution and reduce localized areas of disturbances.		No
	System Acres	WQL04	X				Stalk or leaf tissue tests for N application	Use corn stalk and/or leaf tissue tests to adjust nitrogen application rates.	**Corn only.** Refer to ND guidelines for implementation requirements.	No
	System Acres	WQL05	X				Apply nutrients no more than 30 days prior to planned planting date	Apply nutrients (fertilizer, manure, etc.) no more than 30 days prior to the planned planting date of the crop.		No
	System Acres	WQL07	X	X			Split nitrogen applications 50% after crop emergence	Apply 50% or more of the total nitrogen needs after crop emergence.		No
	System Acres	WQL08	X				Apply split applications of nitrogen based on a pre-sidedress nitrogen test on cropland	Use of a Pre-Sidedress Nitrogen Test (PSNT) to determine the need and/or rate of additional nitrogen to be applied during a sidedress application.	**PSNT is not available in North Dakota.** Use plant tissue testing or properly calibrated chlorophyll meters to determine need for split application of **nitrogen** in the growing season. **For corn only.** Producer must currently apply all nitrogen fertilizer pre-plant in their cropping system. Contact NDSU Extension for further information regarding these two tests.	No

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Figure 3: 2011 CSP Enhancement listing with ND Sideboards; Source: NRCS, Retrieved from ND NRCS Website on 10th July 2017

A final component of the CSP application process is the field visit. Before formal contracts are signed, DCs must carry out field visits to verify information input into the CMT. Some field offices relied more on GIS and LIDAR maps to verify farm information while sitting in the NRCS office. Others preferred spending more time in field visits. Some DCs included photographs in their documentation while others wrote observations in an official log. However, the precise details required in populating the CMT and the ambiguity of questions meant that only parts of the answers could be verified in a field visit. Moreover, given the level of detail asked in the CSP questions, DCs explained that a single short visit was not enough to precisely verify all the information. Any significant verification process would require a larger team and complex measurements. For example, to calculate the precise width of buffers on every stream in every field of a farm would require hours of painstaking measurements either on a map or on the ground. Time, personnel, and budgetary constraints limit verification procedures to acts such as collecting existing farmer records or verifying what is visible from a pick-up truck as it drives past fields. The process is less an act of inspection and more a ritual that every now and then will find errors in the data. That the ritual did occasionally produce errors was important to maintaining its legitimacy but I argue here that verification visits, along with the accountability resources mentioned above, did more than standardize information or identify errors, they are important socio-technical interactions that built trust toward the CMT calculations. The value of these documents, procedures, and rituals lie not in their use but in their very existence.

In Callon's (1998b) terms, these artifacts and practices cool debates over scores and measurements by creating formal structures to respond to accountability demands, much in the same way DCs rely on the CMT to attribute accountability when farmers must be denied a contract. Yet paradoxically, the transparency and accountability are enacted not through more information but by shifting decision making toward a blackboxed algorithm. The material act of coming to the office and answering questions while a DC sat on the other side of the desk filling out a computerized form performs, in a very material sense, the practice of data-driven governance. Yet, beneath the performance of precision lies a less attended world of bureaucratic encounters that shapes the actual work of transforming qualitative negotiations into quantitative representations.

3.7 Discussion

The case study demonstrates the importance of bureaucratic performances of accountability and objectivity in incorporating more data-driven technologies in environmental governance. The rationalist promises of mobilizing data-driven technologies to enhance economic efficiency of PES projects sharply contrasts the situated improvisations and bricolage that shape the grounded work of collecting and processing data. The contrast expands upon the contradictions geographers have come to associate with incentive programs in other environmental domains such as forestry, finance, wetland governance, and carbon markets (Bryant, 2016; McAfee, 2012; Robertson, 2012).

The case study prompts asking to what extent PfP reinforces managerial policy solutions and depoliticizes conservation (McCarthy, 2013; Robertson and Wainwright, 2013). To some extent, the CMT is able to shift the AEP political debate to a question of appropriate models and measurements. But behind the veneer of managerial and depoliticized approaches, we find bureaucrats and farmers working together in situated settings to build new relations and share ideas while also populating models. The quantification of environmental performance might carry within it a promise of disciplining politics and red tape by increasing procedural controls, but in the CSP, powers of accountability and transparency were marshalled in combination with powers of situated relationships and ignorance.

The case goes beyond highlighting the messiness of practice to argue that data-driven governance in the CSP was designed with a considerable appetite for imprecision. I argue that this appetite for imprecision is not simply an upshot of the practical challenges of implementing abstract economic theory to real-world situations (Muradian et al., 2013) but a structural problem conditioned by the interaction of economic rationality with: a) technical innovation: the nature and structure of the models mobilized, embodied in the design of the CMT as a questionnaire-based scoring system; b) administrative rationalities: the bureaucratic architecture required to enact policies, exemplified in the case study through the hierarchical and extensive county-level NRCS network; and c) political opportunism: the political economic backdrop of US AEP, understood in relation a historic balance struck to service multiple funding demands through USDA conservation budgets.

The emphasis on the performativity of computation, calculation, and rigor (Asdal, 2008) risks overlooking how the strategic mobilization of transparency and accountability as an endpoint may function to undermine the goals of more calculative decision making. The scoring and ranking technology – CMT - was a technically innovative solution when studied within the mandate to develop a system of quantifying environmental benefits across all US farmlands, across all major ecosystem services, applicable to any farm types, and for multiple conservation practices. Precision was not only secondary to the DC but also to law and politics. This is reflected in the design of the model with its need for expansive applicability and workability under low transaction costs. To ensure some flexibility, the scoring system was made somewhat modular by allowing alterations to weights. But the final CMT model and the overall scoring process shows that instead of a highly exact and transparent performance evaluation technology, the CMT is a blackboxed algorithm that relies on coarse answers to multiple choice questions.

The technical innovations led to a blackboxed algorithm and payment process. Instead of paying farmers for a specific practice such as installing riparian buffers or precision agriculture, CSP farmers are paid based on abstract scores that are used to compare across farmers. The turn to outcome based approaches, in theory, is a promising policy innovation that may or may not risk a shift toward more economization, but in practice, the use of the tool lead to much of the same set of interactions. In contrast to the critique of capital enlisting techno-science to commodify nature (Castree, 2003; Kosoy and Corbera, 2010; Robertson, 2007), it is not clear whether the use of the models changed much and thus, whether anything can be called out as commodified. In theory, farmers are cold-bloodedly competing with one another to produce ecosystem services through higher scores for higher payouts but in practice, farmers and DCs are struggling to make sense of policy shifts, the algorithmic process, and the meaning of the scores. Faced with uncertainties, they are adapting to policy changes in ways that preserve their positions and advance their strategic interests.

Operationalizing a PfP program meant not only assembling techno-science - models, experts, databases, and measuring/testing centers - but also leveraging administrative rationalities - existing bureaucratic rules, documents, infrastructures, and a network of trained professionals. The CMT’s design as a desktop-based data-collection process is partially explained by the availability of over 3600 NRCS offices across the country that were already on NRCS payroll, possessed technical expertise, and had available computers other materials. This extensive NRCS network could be enrolled into a data-collection project, without much disruption to everyday practices. The grounded work of street-level bureaucrats through their interpretations and improvisations helped populate the CMT. Much like the CMT, bureaucrat-farmer interactions are also blackboxed. Ironically, their blackboxed nature is not because they are highly technical but because they were non-technical and highly informal. The secrecy is also supported by a historical political commitment to preserve the privacy of voluntary farmer data (Stubbs, 2017). At times, these grounded interactions probed and undermined the PfP agenda and at other times, they generated farmer support for the agenda. Despite the interpretive work in street-level bureaucratic offices, the rule-bound structure of the bureaucracy, its protocols, knowledge resources, and hierarchies generated assurances that arbitrariness was under control.

Finally, I argue a need to analyze how political actors position themselves in relation to conversations about data-driven governance. While the 2008 Farm Bill wrote into law a need for NRCS to use conservation measurement tools, the same law offered little detail on what constituted environmental benefits, did not allocate any new administrative and technical resources in organizing the large quantification project, and signaled only a feeble interest in verifying data quality. The commitment toward PfP unlocked an opportunity for principal stakeholders – Congress, USDA, farm lobbyists, environmentalists, trade negotiators etc. - to frame their funding needs in terms of rationalization, managerialism, and outcome-based accountability (Wolf, 2017). Similar political analysis of agri-environmental policies (AEP) in the US and Europe show that economic rationality is often secondary to other policy objectives, resulting in complex institutional arrangements that, nonetheless, masquerade as economic solutions (Dibden et al., 2009; Potter and Burney, 2002; Wynne-Jones, 2013). Instead of disrupting and relinquishing deeply rooted political relations, the PfP adequately performed rigor and created the conditions to avoid radical political reform.

I have argued that the contradictions of PfP governance are not intrinsic to the construction of techno-science, bureaucracy, or political fields but lie at the interface. The CMT generated rough estimates that permit new ways to compare environmental performance across farms but when the conservation scores were mobilized to justify fine-scaled resource allocation decisions, the contradiction of data-driven governance becomes most evident. Wolf (2017) has argued that when incumbent state-capital actors confront a critique of accountability, they adapt by performing non-threatening learning and transparency with the hope of gaining legitimation. Such newly forged relations may often mobilize data and calculation but how and in what ways these data-driven initiatives advance a high-modernist vision for control and efficiency (Scott, 1999) is an empirical question that can be understood in reference not only to the expansion of economic rationality in public policy but also the technical compromises, administrative structures, and political opportunism that enact economic ideas like pay-for-performance. The analysis calls upon geographers to consider the dynamic and incomplete ways data is mobilized in practice and what efforts to be more transparent eventually conceal.

3.8 Conclusion

At the time of writing, the CSP has already undergone significant policy changes in the 2014 Farm Bill and is currently under negotiation for the 2018/19 Farm Bill. The 2014 Farm Bill reduced CSP acreage and also removed regulatory references to conservation measurement tools without much change in the rest of the Act or resistance from policy actors. However, the USDA continued to use the CMT to enroll farmers until 2017 as the law did not proscribe the use of the CMT either. The current Farm Bill negotiations are consistent with the paper's meta-arguments: policy debates continue to focus primarily on negotiations over the level of payments rather than debating ways to strengthen targeting and discipline. At the same time, the framing of the policy problem remains engrained in terms of the financial difficulties at the level of the farmer that constrain adoption of conservation practices. The framing lends itself to solutions that directly pay farmers to encourage conservation practices at the level of the farm. Alternate policy framing such as regulation (Rundquist and Cox, 2016) or lessening the power of agro-chemical companies (Kanter, 2018) remain at the margins of policy debate.

Renewed interest in precision agriculture, combined with potential applications of big data, drone technologies, sensors, and internet-of-things in agricultural management (Stubbs, 2017) suggest that conversations around data will be a recurring theme in environmental governance. The political curiosity around data is explicit in the recently introduced Senate bill titled "Agriculture Data Act of 2018" by Senator Klobuchar. The bill seeks to increase the knowledge of how conservation practices impact farm and ranch profitability, and advances legal frameworks to standardize data collection, review, and analysis (Klobuchar, 2018). Given the momentum to expand data-driven technologies in agricultural conservation, critical social science must continue updating the repertoire of analytical resources that help understand what role information, metrics, and infrastructures play in producing public goods. We must consider how information resources create opportunities but also new challenges in addressing ecological risks and social inequities associated with agriculture. The diversity of US farming practices and localized histories will require illuminating the multiple-narratives of data-driven governance and identifying patterns and emergent themes. The political outcome of mobilizing data to ostensibly resolve ecological problems is not pre-given and will invariably transform as rationalist ideas come to terms with existing social networks, histories, and institutions. The conversation on the role of data in restructuring economic and political relations is only beginning and critical social scientists are well positioned to contest dominant policies, narratives, and practices.

3.9 References

110th Congress, 2008. Food, Conservation, and Energy Act of 2008.

Antal, A.B., Hutter, M., Stark, D., 2015. Pragmatist Perspectives on Valuation: An Introduction. Oxford University Press.

Asdal, K., 2011. The office: The weakness of numbers and the production of non-authority. Accounting, Organizations and Society 36, 1–9. https://doi.org/10.1016/j.aos.2011.01.001

Asdal, K., 2008. Enacting things through numbers: Taking nature into account/ing. Geoforum, Environmental Economic Geography 39, 123–132. https://doi.org/10.1016/j.geoforum.2006.11.004

Babcock, B.A., Lakshminarayan, P.G., Wu, J., Zilberman, D., 1997. Targeting Tools for the Purchase of Environmental Amenities. Land Economics 73, 325–339. https://doi.org/10.2307/3147171

Backstrand, K., Khan, J., Kronsell, A., Lövbrand, E., 2010. Environmental Politics and Deliberative Democracy: Examining the Promise of New Modes of Governance. Edward Elgar Publishing, Cheltenham ; Northampton, MA.

Barry, A., 2002. The anti-political economy. Economy and Society 31, 268–284. https://doi.org/10.1080/03085140220123162

Batie, S.S., 2009. Green payments and the US Farm Bill: information and policy challenges. Frontiers in Ecology and the Environment 7, 380–388. https://doi.org/10.1890/080004

Batie, S.S., 2008. Wicked Problems and Applied Economics. Am J Agric Econ 90, 1176–1191. https://doi.org/10.1111/j.1467-8276.2008.01202.x

Batie, S.S., 2005. The Demand for Economic Policy Analysis: Is Anyone Listening? Agricultural and Resource Economics Review 34, 123–130. https://doi.org/10.1017/S1068280500008303

Baumgartner, F.R., Jones, B.D., 2010. Agendas and Instability in American Politics, Second Edition. University of Chicago Press.

Baylis, K., Peplow, S., Rausser, G., Simon, L., 2008. Agri-environmental policies in the EU and United States: A comparison. Ecological Economics, Payments for Environmental Services in Developing and Developed Countries 65, 753–764. https://doi.org/10.1016/j.ecolecon.2007.07.034

Bigger, P., 2017. Hybridity, possibility: Degrees of marketization in tradeable permit systems. Environ Plan A 0308518X17737786. https://doi.org/10.1177/0308518X17737786

Bigger, P., 2015. Environmental Governance in the Carbon Economy: Regulating Greenhouse Gas Emissions in California’s Cap-and-Trade Program. Theses and Dissertations--Geography.

Bigger, P., Dempsey, J., 2018. The ins and outs of neoliberal natures. Environment and Planning E: Nature and Space 1, 58.

Bigger, P., Robertson, M., 2017. Value is Simple. Valuation is Complex. Capitalism Nature Socialism 28, 68–77. https://doi.org/10.1080/10455752.2016.1273962

Bijker, W.E., 2010. How is Technology Made?-That is the Question! Cambridge Journal of Economics 34, 63–76. https://doi.org/10.1093/cje/bep068

Bijker, W.E., Hughes, T.P., Pinch, T. (Eds.), 2012. The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology, anniversary edition edition. ed. The MIT Press, Cambridge, Mass.
Birch, M.B.L., Gramig, B.M., Moomaw, W.R., Doering, I., Otto C., Reeling, C.J., 2011. Why Metrics Matter: Evaluating Policy Choices for Reactive Nitrogen in the Chesapeake Bay Watershed. Environ. Sci. Technol. 45, 168–174. https://doi.org/10.1021/es101472z
Blesh, J., Drinkwater, L.E., 2013. The impact of nitrogen source and crop rotation on nitrogen mass balances in the Mississippi River Basin. Ecological Applications 23, 1017–1035. https://doi.org/10.1890/12-0132.1
Blok, A., Nakazora, M., Winthereik, B.R., 2016. Infrastructuring Environments. Science as Culture 25, 1–22. https://doi.org/10.1080/09505431.2015.1081500
Boisvert, V., Méral, P., Froger, G., 2013. Market-Based Instruments for Ecosystem Services: Institutional Innovation or Renovation? Society & Natural Resources 26, 1122–1136. https://doi.org/10.1080/08941920.2013.820815
Boldyrev, I., Svetlova, E. (Eds.), 2016. Enacting Dismal Science - New Perspectives on the Performativity of Economics | | Palgrave Macmillan, Perspectives from Social Economics. Palgrave Macmillan US.
Bourdieu, P., Wacquant, L.J.D., Farage, S., 1994. Rethinking the State: Genesis and Structure of the Bureaucratic Field. Sociological Theory 12, 1–18. https://doi.org/10.2307/202032
Bowker, G.C., Star, S.L., 2000. Sorting Things Out: Classification and Its Consequences. MIT Press.
Bryant, G., 2016. The Politics of Carbon Market Design: Rethinking the Techno-politics and Post-politics of Climate Change. Antipode 48, 877–898. https://doi.org/10.1111/anti.12237
Bryman, A., 2015. Social Research Methods. Oxford University Press.
Bumpus, A.G., Liverman, D.M., 2008. Accumulation by Decarbonization and the Governance of Carbon Offsets. Economic Geography 84, 127–155. https://doi.org/10.1111/j.1944-8287.2008.tb00401.x
Busch, L., 2007. Performing the economy, performing science: from neoclassical to supply chain models in the agrifood sector. Economy and Society 36, 437–466. https://doi.org/10.1080/03085140701428399
Büscher, B., 2012. Payments for ecosystem services as neoliberal conservation: (Reinterpreting) evidence from the Maloti-Drakensberg, South Africa. Conservation and Society 10, 29. https://doi.org/10.4103/0972-4923.92190
Bybee-Finley, K., Ryan, M., Bybee-Finley, K.A., Ryan, M.R., 2018. Advancing Intercropping Research and Practices in Industrialized Agricultural Landscapes. Agriculture 8, 80. https://doi.org/10.3390/agriculture8060080
Callon, M., 1998a. Laws of the Markets. Wiley.
Callon, M., 1998b. An Essay on framing and overflowing: economic externalities revisited by sociology, in: The Laws of the Markets. Blackwell, Oxford, UK, p. 244.

Callon, M., Muniesa, F., 2005. Peripheral Vision: Economic Markets as Calculative Collective Devices. Organization Studies 26, 1229–1250. https://doi.org/10.1177/0170840605056393

Carpenter, D.P., 2001. The Forging of Bureaucratic Autonomy: Reputations, Networks, and Policy Innovation in Executive Agencies, 1862-1928. Princeton University Press.

Carwardine, J., Klein, C.J., Wilson, K.A., Pressey, R.L., Possingham, H.P., 2009. Hitting the target and missing the point: target-based conservation planning in context. Conservation Letters 2, 4–11. https://doi.org/10.1111/j.1755-263X.2008.00042.x

Castree, N., 2008. Neoliberalising nature: the logics of deregulation and reregulation. Environment and Planning A 40, 131–152.

Castree, N., 2003. Commodifying what nature? Prog Hum Geogr 27, 273–297. https://doi.org/10.1191/0309132503ph428oa

Choe, C., Fraser, I., 1999. Compliance Monitoring and Agri-Environmental Policy. Journal of Agricultural Economics 50, 468–487. https://doi.org/10.1111/j.1477-9552.1999.tb00894.x

Claassen, R., 2014. 2014 Farm Act Continues Most Previous Trends In Conservation. Amber Waves; Washington 1A,2A,3A,4A,5A,6A,7A,8A,9A,10A.

Claassen, R., Cattaneo, A., Johansson, R., 2008. Cost-effective design of agri-environmental payment programs: U.S. experience in theory and practice. Ecological Economics, Payments for Environmental Services in Developing and Developed Countries 65, 737–752. https://doi.org/10.1016/j.ecolecon.2007.07.032

Claassen, R., Cooper, J., Salvioni, C., Veronesi, M., 2014. Agri-Environmental Policies. The Oxford Handbook of Land Economics. https://doi.org/10.1093/oxfordhb/9780199763740.013.020

Cleaver, F., 2012. Development Through Bricolage: Rethinking Institutions for Natural Resource Management, 1 edition. ed. Routledge, Abingdon, Oxon ; New York, NY.

Coase, R.H., 1960. Problem of Social Cost, The. J.L. & Econ. 3, 1.

Coleman, W.D., Skogstad, G.D., Atkinson, M.M., 1996. Paradigm Shifts and Policy Networks: Cumulative Change in Agriculture. Journal of Public Policy 16, 273–301.

Collins, H., 2010. Tacit and Explicit Knowledge, Reprint edition. ed. University Of Chicago Press.

Cooper, M.H., 2015. Measure for measure? Commensuration, commodification, and metrology in emissions markets and beyond. Environment and Planning A 47, 1787–1804. https://doi.org/10.1068/a130275p

Corbin, J., Strauss, A., 2007. Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory, 3rd edition. ed. SAGE Publications, Inc, Los Angeles, Calif.

Creswell, J.W., 2013. Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. SAGE Publications.

Crosson, P.R., Brubaker, S., 2016. Resource and Environmental Effects of U.S. Agriculture. Routledge.
David, P.A., 2001. Path dependence, its critics and the quest for “historical economics,” in: Garrouste, P., Ioannides, S. (Eds.), Evolution and Path Dependence in Economic Ideas: Past and Present. Edward Elgar Publishing.
David, P.A., 1985. Clio and the Economics of QWERTY. The American Economic Review 75, 332–337.
Dempsey, J., Suarez, D.C., 2016. Arrested Development? The Promises and Paradoxes of “Selling Nature to Save It.” Annals of the American Association of Geographers 106, 653–671. https://doi.org/10.1080/24694452.2016.1140018
Diaz, R.J., Rosenberg, R., 2008. Spreading Dead Zones and Consequences for Marine Ecosystems. Science 321, 926–929. https://doi.org/10.1126/science.1156401
Dibden, J., Potter, C., Cocklin, C., 2009. Contesting the neoliberal project for agriculture: Productivist and multifunctional trajectories in the European Union and Australia. Journal of Rural Studies 25, 299–308. https://doi.org/10.1016/j.jrurstud.2008.12.003
Doering, I., Otto C., Lawrence, D.J., Helms, J.D., 2013. Agricultural Conservation & Environmental Programs: The Challenge of Data-Driven Conservation. Choices Quarter 2.
Edwards, P.N., 2013. A Vast Machine: Computer Models, Climate Data, and the Politics of Global Warming. The MIT Press, Cambridge, Massachusetts London, England.
Espeland, W.N., Sauder, M., 2007. Rankings and Reactivity: How Public Measures Recreate Social Worlds. American Journal of Sociology 113, 1–40. https://doi.org/10.1086/517897
Espeland, W.N., Stevens, M.L., 2008. A Sociology of Quantification. European Journal of Sociology / Archives Européennes de Sociologie 49, 401–436. https://doi.org/10.1017/S0003975609000150
Farley, J., 2012. Ecosystem services: The economics debate. Ecosystem Services 1, 40–49. https://doi.org/10.1016/j.ecoser.2012.07.002
Feather, P., Hellerstein, D., Hansen, L., 1999. Economic Valuation of Environmental Benefits and the Targeting of Conservation Programs: The Case of the CRP (SSRN Scholarly Paper No. ID 2735093). Social Science Research Network, Rochester, NY.
Ferguson, J., 1990. The Anti-Politics Machine: “Development”, Depoliticization and Bureaucratic Power in Lesotho. CUP Archive.
Fisher, K.A., Winsten, J.R., Spratt, E., Anderson, R., Smith, R., 2016. Pay-for-performance Conservation: A How-To Guide. Winrock International.
Freidberg, S., 2017. Big Food and Little Data: The Slow Harvest of Corporate Food Supply Chain Sustainability Initiatives. Annals of the American Association of Geographers 107, 1547–1547. https://doi.org/10.1080/24694452.2017.1349522
GAO, 2006. Conservation Securuty Program: Despite Cost Controls, Improved USDA Management Is Needed to Ensure Proper Payments and Reduce Duplication

with Other Programs (No. GAO-06-312). United States Government Accountability Office.
Ghosh, R., 2019. Appetite for Imprecision: The Role of Bureaucracy in Implementing a Pay-for-Performance Program. Annals of the American Association of Geographers.
Ghosh, R., 2017. Supplying the supply curve: an ethnography of environmental reverse auctions. Journal of Cultural Economy 0, 1–16. https://doi.org/10.1080/17530350.2017.1393444
Ghosh, R., Forthcoming. Environmental models and economic rationalization: a critical analysis. Forthcoming.
Gibson-Graham, J.K., 2008. Diverse economies: performative practices for `other worlds'. Prog Hum Geogr 32, 613–632. https://doi.org/10.1177/0309132508090821
Gitelman, L. (Ed.), 2013. "Raw Data" Is an Oxymoron. The MIT Press, Cambridge, Massachusetts ; London, England.
Glaser, B.G., Strauss, A.L., 2009. The Discovery of Grounded Theory: Strategies for Qualitative Research. Transaction Publishers.
Good, A.G., Beatty, P.H., 2011. Fertilizing Nature: A Tragedy of Excess in the Commons. PLOS Biology 9, e1001124. https://doi.org/10.1371/journal.pbio.1001124
GPO, 2016. Hearings before a subcommittee of the committee on appropriations house of representatives one hundred fourteenth congress second session. Government Publishing Office.
Greif, A., Kingston, C., 2011. Institutions: rules or equilibria?, in: Political Economy of Institutions, Democracy and Voting. Springer, pp. 13–43.
Gupta, A., 2012. Red tape: Bureaucracy, structural violence, and poverty in India. Duke University Press.
Gupta, A., 1998. Postcolonial Developments: Agriculture in the Making of Modern India. Duke University Press.
Guston, D.H., 2004. Forget Politicizing Science. Let's Democratize Science! Issues in Science and Technology XXI.
Hall, P.A., 1993. Policy Paradigms, Social Learning, and the State: The Case of Economic Policymaking in Britain. Comparative Politics 25, 275–296. https://doi.org/10.2307/422246
Hansen, L., Hellerstein, D., 2006. Better Targeting, Better Outcomes (SSRN Scholarly Paper No. ID 2736544). Social Science Research Network, Rochester, NY.
Hellerstein, D.M., 2017. The US Conservation Reserve Program: The evolution of an enrollment mechanism. Land Use Policy 63, 601–610. https://doi.org/10.1016/j.landusepol.2015.07.017
Heynen, N., McCarthy, J., Prudham, S., Robbins, P., 2007. Neoliberal Environments: False Promises and Unnatural Consequences, 1 edition. ed. Routledge, London ; New York.
Jackson, S.J., 2014. Rethinking Repair, in: Gillespie, T., Boczkowski, P., Foot, K. (Eds.), Media Technologies: Essays on Communication, Materiality and Society. The MIT Press, Cambridge, Mass.

Jarzabkowski, P., Pinch, T., 2013. Sociomateriality is 'the New Black'': accomplishing repurposing, reinscripting and repairing in context.' M@n@gement Vol. 16, 579–592. https://doi.org/10.3917/mana.165.0579
Jasanoff, S., 2003. (No?) Accounting for expertise. Science and Public Policy 30, 157–162. https://doi.org/10.3152/147154303781780542
Johnson, B.A., 2004. Implementing the Conservation Security Program (CRS Report for Congress No. RS21740). Congressional Research Service.
Juntti, M., Potter, C., 2002. Interpreting and Reinterpreting Agri-Environmental Policy: Communication, Trust and Knowledge in the Implementation Process. Sociologia Ruralis 42, 215–232. https://doi.org/10.1111/1467-9523.00212
Kanter, D.R., 2018. Nitrogen pollution: a key building block for addressing climate change. Climatic Change 147, 11–21. https://doi.org/10.1007/s10584-017-2126-6
Klobuchar, A., 2018. Agriculture Data Act of 2018, S.2487.
König, T., Bräuninger, T., 1998. The Formation of Policy Networks: Preferences, Institutions and Actors' Choice of Information and Exchange Relations. Journal of Theoretical Politics 10, 445–471. https://doi.org/10.1177/0951692898010004004
Kosoy, N., Corbera, E., 2010. Payments for ecosystem services as commodity fetishism. Ecological Economics, Special Section - Payments for Environmental Services: Reconciling Theory and Practice 69, 1228–1236. https://doi.org/10.1016/j.ecolecon.2009.11.002
Lampland, M., 2010. False numbers as formalizing practices. Social Studies of Science. https://doi.org/10.1177/0306312709359963
Lansing, D.M., 2010. Carbon's Calculatory Spaces: The Emergence of Carbon Offsets in Costa Rica. Environ Plan D 28, 710–725. https://doi.org/10.1068/d13208
Lave, R., 2015. The Future of Environmental Expertise. Annals of the Association of American Geographers 105, 244–252. https://doi.org/10.1080/00045608.2014.988099
Lave, R., 2012. Fields and streams: Stream restoration, neoliberalism, and the future of environmental science. University of Georgia Press.
Lawrence, T.B., Suddaby, R., Leca, B. (Eds.), 2009. Institutional Work: Actors and Agency in Institutional Studies of Organizations, 1 edition. ed. Cambridge University Press, Cambridge, UK ; New York.
Lehrer, N., 2010. U.S. Farm Bills and Policy Reforms: Ideological Conflicts Over World Trade, Renewable Energy, and Sustainable Agriculture. Cambria Press.
Lehrer, N., Becker, D.R., 2010. Shifting paths to conservation: policy change discourses and the 2008 US farm bill. Journal of Environmental Planning and Management 53, 639–655. https://doi.org/10.1080/09640561003730007
Lenihan, M.H., Brasier, K.J., 2010. Ecological modernization and the US Farm Bill: The case of the Conservation Security Program. Journal of Rural Studies 26, 219–227. https://doi.org/10.1016/j.jrurstud.2009.12.004
Li, T., 2005. Transforming the Indonesian Uplands. Routledge.

Lippert, I., 2015. Environment as datascape: Enacting emission realities in corporate carbon accounting. Geoforum 66, 126–135. https://doi.org/10.1016/j.geoforum.2014.09.009
Lipsky, M., 2010. Street-Level Bureaucracy, 30th Ann. Ed.: Dilemmas of the Individual in Public Service. Russell Sage Foundation.
Lohmann, L., 2011. The Endless Algebra of Climate Markets. Capitalism Nature Socialism 22, 93–116. https://doi.org/10.1080/10455752.2011.617507
Lounsbury, M., Glynn, M.A., 2001. Cultural entrepreneurship: stories, legitimacy, and the acquisition of resources. Strat. Mgmt. J. 22, 545–564. https://doi.org/10.1002/smj.188
Mäki, U., 2013. Performativity: Saving Austin from MacKenzie, in: Karakostas, V., Dieks, D. (Eds.), EPSA11 Perspectives and Foundational Problems in Philosophy of Science, The European Philosophy of Science Association Proceedings. Springer International Publishing, pp. 443–453.
Martin, A., Lynch, M., 2009. Counting Things and People: The Practices and Politics of Counting. Soc Probl 56, 243–266. https://doi.org/10.1525/sp.2009.56.2.243
Mathews, A.S., 2011. Instituting Nature: Authority, Expertise, and Power in Mexican Forests. MIT Press.
McAfee, K., 2012. The Contradictory Logic of Global Ecosystem Services Markets. Development and Change 43, 105–131. https://doi.org/10.1111/j.1467-7660.2011.01745.x
McCarthy, J., 2013. We Have Never been "Post-political." Capitalism Nature Socialism 24, 19–25. https://doi.org/10.1080/10455752.2012.759251
McCarthy, J., Prudham, S., 2004. Neoliberal nature and the nature of neoliberalism. Geoforum 35, 275–283. https://doi.org/10.1016/j.geoforum.2003.07.003
Mol, A., 2002. The Body Multiple: Ontology in Medical Practice. Duke University Press.
Moxey, A., White, B., 2014. Result-oriented agri-environmental schemes in Europe: A comment. Land Use Policy 39, 397–399. https://doi.org/10.1016/j.landusepol.2014.04.008
Muller, J.Z., 2017. The Tyranny of Metrics. Princeton University Press, Princeton, N. J.
Munck af Rosenschöld, J., Rozema, J.G., Frye-Levine, L.A., 2014. Institutional inertia and climate change: a review of the new institutionalist literature. Wiley Interdisciplinary Reviews: Climate Change 5, 639–648. https://doi.org/10.1002/wcc.292
Muniesa, F., 2014. The Provoked Economy: Economic Reality and the Performative Turn, 1st Edition. ed. Routledge.
Muradian, R., Arsel, M., Pellegrini, L., Adaman, F., Aguilar, B., Agarwal, B., Corbera, E., Ezzine de Blas, D., Farley, J., Froger, G., Garcia-Frapolli, E., Gómez-Baggethun, E., Gowdy, J., Kosoy, N., Le Coq, J. f., Leroy, P., May, P., Méral, P., Mibielli, P., Norgaard, R., Ozkaynak, B., Pascual, U., Pengue, W., Perez, M., Pesche, D., Pirard, R., Ramos-Martin, J., Rival, L., Saenz, F., Van Hecken, G., Vatn, A., Vira, B., Urama, K., 2013. Payments for ecosystem

services and the fatal attraction of win-win solutions. Conservation Letters 6, 274–279. https://doi.org/10.1111/j.1755-263X.2012.00309.x
Murphy, R., 1994. Rationality And Nature: A Sociological Inquiry Into A Changing Relationship: Raymond, 1st Edition. ed. Westview Press, New York.
North, D.C., 1990. Institutions, Institutional Change and Economic Performance. Cambridge University Press.
Nost, E., 2015. Performing nature's value: software and the making of Oregon's ecosystem services markets. Environ Plan A 47, 2573–2590. https://doi.org/10.1177/0308518X15616631
NSAC, 2017. Agenda for the 2018 Farm Bill. National Sustainable Agriculture Coalition, Washington, D.C.
O'Connor, J., 1988. Capitalism, nature, socialism a theoretical introduction. Capitalism Nature Socialism 1, 11–38. https://doi.org/10.1080/10455758809358356
Osborne, T., Shapiro-Garza, E., 2018. Embedding Carbon Markets: Complicating Commodification of Ecosystem Services in Mexico's Forests. Annals of the American Association of Geographers 108, 88–105. https://doi.org/10.1080/24694452.2017.1343657
Patton, M.Q., 2002. Qualitative interviewing. Qualitative research and evaluation methods 3, 344–347.
Pierson, P., 2000. Increasing Returns, Path Dependence, and the Study of Politics. The American Political Science Review 94, 251–267. https://doi.org/10.2307/2586011
Pierson, P., 1994. Dismantling the Welfare State? by Paul Pierson [WWW Document]. Cambridge Core. https://doi.org/10.1017/CBO9780511805288
Polasky, S., Tallis, H., Reyers, B., 2015. Setting the bar: Standards for ecosystem services. PNAS 112, 7356–7361. https://doi.org/10.1073/pnas.1406490112
Porter, T.M., 1996. Trust in Numbers: The Pursuit of Objectivity in Science and Public Life. Princeton University Press.
Potter, C., Burney, J., 2002. Agricultural multifunctionality in the WTO—legitimate non-trade concern or disguised protectionism? Journal of Rural Studies 18, 35–47. https://doi.org/10.1016/S0743-0167(01)00031-6
Potter, C., Cook, H., Norman, C., 1993. The targeting of rural environmental policies: an assessment of agri-environmental schemes in the UK. Journal of Environmental Planning and Management 36, 199–216. https://doi.org/10.1080/09640569308711939
Potter, C.A., Wolf, S.A., 2014. Payments for ecosystem services in relation to US and UK agri-environmental policy: disruptive neoliberal innovation or hybrid policy adaptation? Agric Hum Values 31, 397–408. https://doi.org/10.1007/s10460-014-9518-2
Potter, P., Ramankutty, N., Bennett, E.M., Donner, S.D., 2010. Characterizing the Spatial Patterns of Global Fertilizer Application and Manure Production. Earth Interact. 14, 1–22. https://doi.org/10.1175/2009EI288.1

Reay, D.S., Davidson, E.A., Smith, K.A., Smith, P., Melillo, J.M., Dentener, F., Crutzen, P.J., 2012. Global agriculture and nitrous oxide emissions. Nature Clim. Change 2, 410–416. https://doi.org/10.1038/nclimate1458

Ribaudo, M., 2015. The Limits of Voluntary Conservation Programs. Choices 30, 1–5.

Robertson, M., 2012. Measurement and alienation: making a world of ecosystem services. Transactions of the Institute of British Geographers 37, 386–401. https://doi.org/10.1111/j.1475-5661.2011.00476.x

Robertson, M., 2007. Discovering Price in All the Wrong Places: The Work of Commodity Definition and Price under Neoliberal Environmental Policy. Antipode 39, 500–526. https://doi.org/10.1111/j.1467-8330.2007.00537.x

Robertson, M., Wainwright, J.D., 2013. The Value of Nature to the State. Annals of the Association of American Geographers 103, 890–905. https://doi.org/10.1080/00045608.2013.765772

Rodgers, R.D., Wooley, J.B., 1983. Conservation tillage impacts on wildlife. Journal of Soil and Water Conservation 38, 212–213.

Rundquist, S., Cox, C., 2016. Fooling Ourselves: Voluntary Programs Fail to Clean Up Dirty Water. Environmental Working Group, Washington, D.C.

Schinkel, W., 2016. Making climates comparable: Comparison in paleoclimatology. Social Studies of Science 46, 374–395. https://doi.org/10.1177/0306312716633537

Scott, J.C., 1999. Seeing like a State: How Certain Schemes to Improve the Human Condition Have Failed. Yale University Press.

Shortle, J.S., Ribaudo, M., Horan, R.D., Blandford, D., 2012. Reforming Agricultural Nonpoint Pollution Policy in an Increasingly Budget-Constrained Environment. Environ. Sci. Technol. 46, 1316–1325. https://doi.org/10.1021/es2020499

Singh, R., Jackson, S.J., 2017. From Margins to Seams: Imbrication, Inclusion, and Torque in the Aadhaar Identification Project, in: Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems, CHI '17. ACM, New York, NY, USA, pp. 4776–4824. https://doi.org/10.1145/3025453.3025910

Star, S.L., 1999. The Ethnography of Infrastructure. American Behavioral Scientist 43, 377–391. https://doi.org/10.1177/00027649921955326

Stubbs, M., 2018. Agricultural Conservation: A Guide to Programs (CRS Report for Congress No. R40763). Congressional Research Service, Washington, D.C.

Stubbs, M., 2017. Big Data in U.S. Agriculture (CRS Report No. R44331). Congressional Research Service, Washington, D.C.

Stubbs, M., 2016. Agricultural Conservation: A Guide to Programs (No. 7–5700). Congressional Research Service, Washington, D.C.

Sullivan, S., 2013a. After the green rush? Biodiversity offsets, uranium power and the 'calculus of casualties' in greening growth. Human Geography 6, 80–101.

Sullivan, S., 2013b. Banking Nature? The Spectacular Financialisation of Environmental Conservation. Antipode 45, 198–217. https://doi.org/10.1111/j.1467-8330.2012.00989.x

Sullivan, S., 2010. "Ecosystem Service Commodities" - A New Imperial Ecology? Implications for Animist Immanent Ecologies, with Deleuze and Guattari. New Formations 69, 111–128. https://doi.org/10.3898/NEWF.69.06.2010
Swinton, S.M., Lupi, F., Robertson, G.P., Hamilton, S.K., 2007. Ecosystem services and agriculture: Cultivating agricultural ecosystems for diverse benefits. Ecological Economics, Special Section - Ecosystem Services and Agriculture 64, 245–252. https://doi.org/10.1016/j.ecolecon.2007.09.020
Torfing, J., 2009. Rethinking path dependence in public policy research. Critical Policy Studies 3, 70–83. https://doi.org/10.1080/19460170903158149
USDA, 2014. Census of Agriculture: Farms and Farmland. National Agricultural Statistics Service, United States Department of Agriculture.
Van Hecken, G., Kolinjivadi, V., Windey, C., McElwee, P., Shapiro-Garza, E., Huybrechs, F., Bastiaensen, J., 2018. Silencing Agency in Payments for Ecosystem Services (PES) by Essentializing a Neoliberal 'Monster' Into Being: A Response to Fletcher & Büscher's 'PES Conceit.' Ecological Economics 144, 314–318. https://doi.org/10.1016/j.ecolecon.2017.10.023
Vilain, G., Garnier, J., Tallec, G., Cellier, P., 2010. Effect of slope position and land use on nitrous oxide (N2O) emissions (Seine Basin, France). Agricultural and Forest Meteorology 150, 1192–1202. https://doi.org/10.1016/j.agrformet.2010.05.004
Ward, M.H., deKok, T.M., Levallois, P., Brender, J., Gulis, G., Nolan, B.T., VanDerslice, J., 2005. Workgroup Report: Drinking-Water Nitrate and Health-Recent Findings and Research Needs. Environmental Health Perspectives 113, 1607–1614.
Weber, M., 2007. The Development of Bureaucracy and its Relation to Law, in: Runciman, W.G. (Ed.), Weber: Selections in Translation. Cambridge University Press, New York.
Weber, M., 1978. Economy and Society: An Outline of Interpretive Sociology. University of California Press.
Winders, B., 2009. The Politics of Food Supply: U.S. Agricultural Policy in the World Economy. Yale University Press.
Wolf, S.A., 2017. Accountability, Rationality, and Politics: Critical Analysis of Agri-environmental Policy Reform in USA, in: Bonanno, A., Wolf, S.A. (Eds.), Resistance to the Neoliberal Agri-Food Regime: A Critical Analysis. Routledge.
Wolf, S.A., 2013. US Agr-environmental Policy: Neoliberalization of Nature Meets Old Public Management, in: The Neoliberal Regime in the Agri-Food Sector: Crisis, Resilience, and Restructuring. Routledge, p. 191.
Wolf, S.A., Ghosh, R., 2019. A practice-centered analysis of environmental accounting: Integrating agriculture into carbon governance. Land Use Policy.
Wünscher, T., Engel, S., Wunder, S., 2008. Spatial targeting of payments for environmental services: A tool for boosting conservation benefits. Ecological Economics, Payments for Environmental Services in Developing and Developed Countries 65, 822–833. https://doi.org/10.1016/j.ecolecon.2007.11.014

Wynne-Jones, S., 2013. Connecting payments for ecosystem services and agri-environment regulation: An analysis of the Welsh Glastir Scheme. Journal of Rural Studies 31, 77–86. https://doi.org/10.1016/j.jrurstud.2013.01.004

Zinda, J.A., Zhang, Z., 2018. Stabilizing Forests and Communities: Accommodative Buffering within China's Collective Forest Tenure Reform. The China Quarterly 235, 828–848. https://doi.org/10.1017/S0305741018000905

CHAPTER 4: CAN DATA-DRIVEN APPROACHES OVERCOME INSTITUTIONAL INERTIA?

4.1 Introduction

In the field of environmental governance, a case has emerged to mobilize economic principles of efficiency and market coordination to rationalize the use of public authority and taxpayer funds. While these proposals have met with strong resistance particularly within critical environmental studies (Lohmann, 2011; Sullivan, 2013b), recent social science literature draws our attention not only to political discourse or actors as the change agent but to the role of data, expertise, and technical innovations in shaping institutional change. Orthodox economic approaches to institutional change focus on using data, specifically environmental performance metrics, to restructure incentives in favor of environmental targeting (Babcock et al., 1997; Wünscher et al., 2008). Such new policy arrangements are promoted as innovative, market-based, and data-driven. Proposals are often framed in terms of modest and incremental changes to public policy. Nevertheless, the emphasis to treat environmental concerns as problems of economic efficiency, asset or service loss, and returns on investment is a radically different paradigm compared to moral and regulatory strategies for organizing environmental governance.

In contrast to the orthodox economics perspective, institutional economics adopts a more historicized and socially embedded perspective of technology and institutional change (North, 1990). It is argued that institutions at any point in time are in part the outcome not only of present-day technological changes, but also of previous day politics and technology (David, 2001, 1985). This concept is widely referenced as *institutional inertia* and is captured by Pierson's phrase "history matters" for how institutions change (Pierson, 2000). Adopting an institutional perspective toward data-driven conservation, I examine how public spending patterns change under a so called data-driven conservation approach in the context of US agriculture and environmental policy (AEP). By examining how recent spending relates to historical spending, I reflect on what changed and failed to in the policy structure given the technological change.

I examine a high stakes policy experiment with data-driven conservation in the US, the Conservation Stewardship Program (CSP). As of 2016, the CSP is the largest agricultural conservation program in the US and it relies on directly paying farmers across the country to adopt conservation practices on their farms. The idea of using incentives is not new to the field of environmental governance or to the political domain of US AEP. However, what makes the CSP unique is a 2008 legal mandate to use conservation measurement tools to select contracts and to determine how much to pay each farmer. In the period 2010 to 2015, the CSP used an ecological model, the Conservation Measurement Tool (CMT), to quantify environmental benefits generated from each potential contract. In this five-year period, the CSP spent over $4 billion to finance conservation on farms, leading to the adoption of over 286,000 conservation practices across 90 million acres of farmland (approx. the size of Montana). The CSP presents an illustration of the challenges and messiness of data-driven conservation and thus an opportunity to study the practice of mobilizing environmental data resources to rationalize public spending earmarked for environmental protection.

While existing policies may already be targeting environmental outcomes to some extent, data-driven conservations promises more precise targeting and thus more productive use of taxpayer funds, measured in terms of environmental outcomes.

I evaluate CSP spending on over 55,000 contracts signed between 2010 and 2015 and compare spending with historical conservation spending records and ecological risk indicators. To capture historical spending I rely on county-level US Agricultural Census data on government conservation receipts. I use data collated in the 2007 and 2002 census to estimate historical conservation spending. Ecological risk is estimated using an indicator of nitrogen pollution - fertilizer receipts per farm. Surveys show that farmers apply more fertilizer than scientifically prescribed best practices, and it is then possible to reduce fertilizer application without a fall in yields (Good and Beatty, 2011; Potter et al., 2010). Using fertilizer spending allows the model to approximate the off-farm risks associated with agricultural production. Excess fertilizer application is considered the cause of pollution in over 5,000 US waterways which are now listed as heavily polluted (Ribaudo, 2015). Water and air pollution caused by excess fertilizer application raise public concerns such as the availability of safe drinking water (Ward et al., 2005), biodiversity loss (Diaz and Rosenberg, 2008), and greenhouse gas emissions (Blesh and Drinkwater, 2013). Nitrogen pollution presents a complex and important environmental problem that captures to some extent the larger set of off-farm environmental problems caused by agricultural production.

Studying the CSP as a case of data-driven conservation that can potentially advance more rationalized policies could offer unique insights for the study of institutional inertia in environmental governance. The primary contribution of this chapter lies in the use of econometric methods to evaluate the changes emanating from automating resource allocation decisions, a topic that has mostly be studied through discursive and qualitative methods.

4.2 Institutional Inertia in US Agri-Environmental Policy (AEP)

Off-farm environmental concerns entered the agricultural policy agenda in 1985. Previously, to the extent environmental concerns were addressed through US agricultural policy, the focus was on on-farm concerns such as soil erosion and soil quality. Through the 1985 Farm Bill, the main legal vehicle to authorize agricultural policies, the US government introduced policies to directly contract farmers for environmental protection on their private lands that would address off-farm concerns such as water quality. Since the 1980s the number of direct payment programs have expanded significantly. As of 2014, the US government spends almost $5 billion every year to support conservation treatment on private lands (Stubbs, 2016). Growing budgets have also been accompanied by questions of accountability (GAO, 2006). Economists within and outside the USDA repeatedly question whether programs are adequately targeted to address environmental concerns (Babcock et al., 1997; Carwardine et al., 2009; Feather et al., 1999; Hansen and Hellerstein, 2006; Potter et al., 1993). Critics argue that programs are poorly optimized to produce ecosystem services and instead support a host of other policy objectives such as supply control, rural development, and income-support.

Institutional and political economists argue that the lack of change in US AEP reflects a case of institutional inertia (Batie, 2009; Potter and Wolf, 2014). The term institutional inertia references the enduring technical, political, administrative, and cognitive structures that shape institutional change (Torfing, 2009). Greif and Kingston (2011, p. 39) argue "Past institutional elements are the raw material on which new institutions are based". The metaphor of inertia is useful for theorizing the sluggish political responses to a growing set of environmental problems like climate change (Munck af Rosenschöld et al., 2014). Applied to US AEP, the idea of institutional inertia could help explain why and how policy actors in AEP has resisted the incorporation of data-driven and market-based approaches. Potter and Wolf (2014) argue that inertia is located in the knowledge, justifications, and relations of the policy domain. US AEP is governed by an extensive state-bureaucratic complex that is well-positioned to accept, reject, or interpret market ideas at its own terms. By identifying the policy structure in terms of a state-bureaucratic complex, Potter and Wolf (2014, ibid) draw attention to the network of administrative rules and organizational controls that coordinate policy design and implementation. This is a highly hierarchical mode of governance which is to some degree anathema to the more decentralized market project. Thus, while the lack of policy change may partly be explained by a lack of high quality data, such a diagnosis overlooks a deeper structural problems that limit change.

The state-bureaucratic structure of US AEP has emerged and grown over time. Historians and sociologists of US AEP show that when conservation entered the agricultural policy agenda in the 1980s, it was brokered by negotiations among both environmental and non-environmental groups, each with differing strategic interests in sanctioning direct payments to farmers (for more see: Lehrer, 2010; Winders, 2009). Rather than a very niche environmental lobby that supports AEP, the policy coalition underwriting AEP is characterized by a large coalition of diverse political actors who see value in using taxpayer funds to directly compensate farmers but for many different reasons. This limits rationalizing policy spending toward only one outcome: environmental efficiency.

This coalition persists today and may explain the continued resistance toward rationalization. However, institutions do change and evolve with time, sometimes from the ground up and at other times through deliberate actions (Greif and Kingston, 2011; North, 1990). It is possible that the increased sophistication and ubiquity in digital agriculture and environmental information infrastructures could loosen the coalition's control over the decision-making process, introduce new actors, trigger policy innovations, and flip the policy field to a new paradigm that is better suited to progressive environmental interests (Baumgartner and Jones, 2010). I assess this possibility by advancing an econometric analysis of the Conservation Stewardship Program (CSP) and evaluate how and to what extent final spending allocations present a significant shift from historical trajectories of spending and how spending under the CSP is better aligned with ecological risk.

4.3 Case Study: Conservation Stewardship Program

The CSP presents the most explicit reference among AEP toward data-driven conservation and performance-based conditionality. The CSP relies on a complex environmental scoring and ranking algorithm called the Conservation Measurement

Tool (CMT) to calculate conservation benefits from every applying farm. To apply for the CSP, farmers must work with their local NRCS official to provide their farm information to an online CMT form and also choose from a set of new practices they will do over the 5 year contract period. Farmers cannot alter their land management history but they can certainly compete to score higher through selection of new practices. There are over 90 different practices (or enhancements as officially termed) to choose from, creating flexibility for the applicant who can choose different combinations that fit their economy and ecology. The CMT algorithm outputs an individual score for each applicant which is then used to rank all applicants. Enrollment starts from the farmer with the highest score and moves downwards until acreage budgets are exhausted. Farm acreage becomes a factor only after ranking to ensure that the competition is size neutral. Scores are then used to calculate individual payments by multiplying the score with acreage and a pre-set payment rate. By making it possible to compare farms across the country, across multiple ecosystem services, and across multiple conservation practices, the CMT is an important innovation that conditions policy innovations. The availability of the CMT makes it possible for the CSP to incorporate important market-based innovations in policy design: flexibility for the ecosystem service provider (the farmer), payments conditional on results or performance, algorithm-based decision making, and a ranking process to engender competition in service provision. The CSP is advertised and actively promoted with the tagline: ‘pay-for-performance’. Based on the above narrative, the technological innovation of the CSP suggests possibilities to unlock policy innovation, potentially dirupt the state-bureaucratic complex of US AEP.

However, there are important reasons to be cautious about the innovative potential of the CSP. First, stakeholders point out that the CMT is difficult to use. Congressman David Young (R-Iowa) remarked in a hearing at the House of Representatives in 2016:

> *"the Conservation Measurement Tool basically gives you points, and it is at the end of the day too opaque and too complex to understand really what is happening" (GPO, 2016, p. 772).*

Second, given the difficulty in understanding the inner working of the tool, it important to maintain critical distance toward the confidence attached to the algorithm as an effective scientific tool to predict environmental benefits (Ghosh, Forthcoming). The final scores are difficult to interpret or compare in terms of environmental well-being. Contracts can be compared with each other through the scores but what the scores mean for say water quality is not interpretable through the CMT. Moreover, the formal process and expertise that shaped the algorithm were poorly documented and is not available in the public domain (Ghosh, Forthcoming).

Lastly, even when assuming the algorithm is an artefact of best available science, the algorithm does not pool all applicants together and rank them based on expected outcomes. Instead, the NRCS created smaller pools across the country at the state or sub-state level within which applicants compete. Nonetheless, the CSP presents an important experiment with outcome-based policy made possible by a complex environmental scoring algorithm. To what extent does the CMT overcome the inertia of the state-bureaucratic complex is the subject of the rest of this paper.

Data Sources

I combine CSP contract data (n~55,000) with county-level (n~2900) datasets from the 2012 Agricultural Census. Data, units, description of data, and sources are summarized in Table 1.

The dependent variable is the actual CSP contract data sourced from the Natural Resource Conservation Service (NRCS). The original data comprises obligations on all CSP contracts, 68,805 contracts between 2000 and 2015. In this study I only use data on the 48 contiguous states which reduces the total number of contracts to ~55,000. A Federal Information Processing Standard (FIPS) code identifies each contract to a county but no further geo-spatial information was provided by the NRCS so as to maintain farmer privacy. Each contract includes information on the set of new practices and total acreage committed for the five year contractual period.

Table 1: Data and sources

Variable	Unit	Source	Description
CSP	$	NRCS REAP	CSP Obligations from 2010-2015
Fertilizer spending (per farm)	$	2012 Census (NASS)	Total Fertilizer Expense, Incl Lime & Soil Conditioners - Measured In $ divided by number of operations in the county with fertilizer use
Govt Spending 2002	$	2007 Census (NASS)	Govt programs, federal - receipts, measured in $ per operation Government payments to farmers include conservation payments, direct payments, loan deficiency payments, disaster payments, and payments from various other federal programs. The 2007 Census collected data based on programs in effect under the 2002 farm bill. An operation in this case, is defined as any farm that sells more than $1,000 worth of products.
Govt Spending 1996	$	2002 Census (NASS)	Same as above but for the 1996 Farm Bill
Farm Income	$	2012 Census (NASS)	Income, farm-related - receipts, measured in $ / operation Farm-related income refers to payments received for rent, custom work on other farms, forest product sales, recreational services provided, patronage dividends, crop and livestock insurance payments, and other activities and services closely related to the agricultural operation.
fy	Year	NRCS	Categorical variable corresponding to years 2010:2015
Shapefiles	N/A	MAF/TIGER	US Census Bureau Topologically Integrated Geographic Encoding and Referencing (MAF/TIGER) Database.

To capture historical policy inertia, the study uses county-wise government conservation spending records as reported through the Census, and made publically accessible in the NASS database. Two time periods are used: 2007 and 2002 which correspond to spending between 1996-2002 and 2002-2007. To evaluate ecological risk, I use data on county-wise fertilizer spending receipts per farm sourced from the 2012 Agricultural Census. The fertilizer expense indicator serves as a proxy for current-levels of nutrients added to a farms in the county. Important to note that the Ag Census data is self-reported. At the time of writing, no other environmental risk indicator was available to compare cross-county ecological risk. Other variables considered were slope and precipitation however, the relationship between slope and risk and precipitation and risk are inconclusive (Vilain et al., 2010). Fertilizer application presents a strong approximation of environmental risk in US agriculture.

Farm income and year of spending are included as control variables. Given the suggestion that conservation spending functions both for income support and ecosystem service provision, we would expect an inverse relationship between CSP spending and farm incomes. This would suggest that farm with relatively lower income receive more CSP funding. I include a categorical variable for Year, which will work as a dummy for each of the five years of the data (2010-2015). This is helpful as the CSP acreage cap (and thus the budget) changed over the years. Total CSP acreage cap was reduced from 12.769 million acres in the first two years to 10 million in later years. Given that the payment rates are preset, i.e. they do not change with the reduced supply, we would expect that CSP payments would fall in subsequent years.

Methods

To analyze the change dynamic of the CSP, I examine how CSP spending patterns align or break with historic patterns and to what extent CSP spending reflects ecological risk concerns. A multi-variate regression model is used to model the contract-level CSP spending, historic spending, and ecological risk.

$$CSP\ Spending = Historical\ spending\ proxy + Ecological\ risk\ proxy + Control\ variables + error\ term$$

The analysis proceeds in three parts. First, I develop two different models: one with the historical variable and one without. The models are compared using R^2 and the Bayesian Information Criterion (BIC) to assess goodness of fit. Because the BIC score provides a large-sample approximation, it is particularly applicable as a goodness-of-fit measure given the large number of observations and the relatively low number of explanatory variables for the present study. The BIC is an increasing function of the error variance and an increasing function of the number of variables. Unexplained variation in the dependent and the number of explanatory variables increase the value of the BIC indicator. Thus, while the R^2 increases with every additional explanatory variable, the BIC introduces a penalty for the number of parameters in the model. A lower BIC then either means better explanation of the variance, fewer variables, or a combination.

Second, I analyzed the substantive contribution of the included historical spending variable and assessed the p-statistic to compare significance levels. Significance is considered at 0.1% and 1% confidence intervals. I compare the substantive explanatory power of the historical spending variable with the substantive power of the environmental risk variable. I also consider how the predictive strength of the environmental risk variable changes with the inclusion of the historical spending variable. The historical spending proxy will help assess the extent of business as usual or inertia effect on the CSP. On the other hand, a higher value for the ecological risk coefficient compared to the government spending coefficient indicates more rationalized and better targeted spending, and the prospect of disruptive innovation.

Third, I subset all counties along four quartiles (715 counties in each) based on historical spending. This allows us to distinguish counties where the farm sector is more dependent on government support for either income or conservation. The objective here is to capture whether counties with previously high levels of spending continue to reflect strong spending under the more calculative targeting approach.

An OLS estimator with robust standard errors was used to model the relationship. I also tested other multiple generalized linear models including Ordinary Least Squares (OLS), Tobit, and Maximum Likelihood. The modeling outcomes were similar and given the consistency of outcomes and the ease of interpretation, the paper uses an OLS model. Important to note that the CSP contract data has a relatively low mean compared to its variance. The high variance is addressed by combing the OLS with Eicker–Huber–White standard or robust standard errors. Robust standard errors are more sensitive to outliers but define a linear relationship that will allow us to maintain a simple interpretation of coefficients. Given that the structure of the potential heteroscedasticity is unknown, using a model with robust standard errors is more useful than correcting for heteroscedasticity post-estimation. An OLS combined with robust standard errors does not affect the coefficients.

4.4 Results

4.1 Spatial Allocation

The CSP pays $12.23 per enrolled acre and enrolls approximately 17,945 acres per county. At the contract level, the mean and median spending per contract was $25,540 and $13,800. The CSP payment mean is far below the variance. This is caused by the high number of contracts at the lower end of the distribution. The wide difference between the mean and the variance presents certain challenges for the modeling exercise and explain the preference for an OLS model with robust standard errors.

Through Figure 1 to 4 we develop an initial graphic understanding of CSP spending in relation to fertilizer receipts and historic government conservation spending. Beside Oklahoma (10.0% of total CPS acreage), we note a heavy concentration of CSP spending in the Prairie Pothole regions of Montana (9.7%), Nebraska (8.7%), South Dakota (8.7%), and North Dakota (6.0%), receiving over $500 million in CSP funds over 2010 to 2015 (Figure 1a). A third concentration of CSP funds appear to be targeted to the Columbia River Basin region. We also note pockets in California and Florida. In contrast to CSP spending, fertilizer spending in concentrated primarily in the mid-western regions or Mississippi River Basin (Figure 1b). We also note a high concentration of fertilizer spending in Eastern California and in the Oregon Region. We notice that CSP spending is far more concentrated than the spatial distribution of fertilizer expenses. In Figures 1c and Figure 1d we notice little change in government spending from 1996 to 2007. There is also a high concentration of historical conservation spending in the Prairie Pothole Region which has changed little over the two farm bill periods (1996 to ~2008). Observationally, historical spending aligns to some degree with fertilizer spending, primarily in the Texas and Oklahoma region but also in the Colombia River Basin, and to some extent with California. However, we also notice that historically conservation spending has not been as high in the mid-western regions which feature prominently as high fertilizer use areas in Figure 1b.

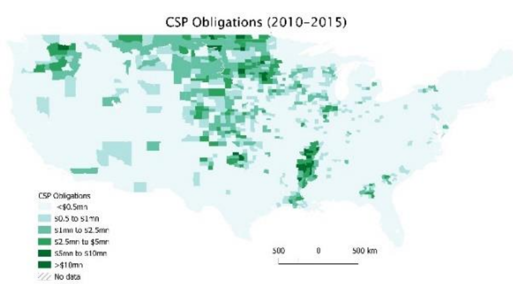

Figure 1a

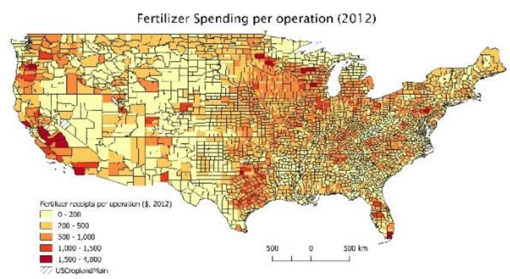

Figure 1b

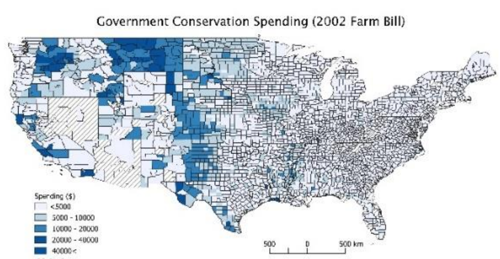

Figure 1c

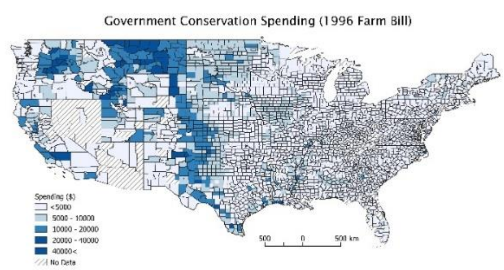

Figure 1d

Figure 1: Spatial Distribution of CSP Spending, Ecological Risk, and Historical Government Conservation Spending

Sources: Adapted by Author using NRCS and CENSUS data. Shapefiles from TIGER database.

4.2 Model Comparison

When the historical spending proxy is excluded, ecological risk is both a significant and substantive predictor of CSP spending (Model 1: W/o Govt). Every increase of $1,000 in fertilizer spending per farm is predicted to increase CSP payout by $613. In contrast to expectations about income, farms with higher income tend to capture more CSP funding. The model has a low goodness of fit but this might be expected with high variance in CSP spending. Independent variables, ecological risk and farm income, explain about 13% of the variance on the dependent variable: CSP spending. In comparison, the goodness of fit increases to 25% in Model 2 when the historical spending is included. Improved goodness of fit is corroborated with a lower BIC (1,502,871 to 1,376,579).

Table 2: Model Comparison

	Model 1 b/se	Model 2 b/se
Dependent variable: CSP Spending per contract (2010-2015)		
Fertilizer spending	0.613***	0.570***
	(0.01)	(0.01)
Farm Income	0.242***	0.072**
	(0.02)	(0.02)
Year=2010	0.000	0.000
	(.)	(.)
Year=2011	16925.796***	15368.900***
	(1705.24)	(1052.05)
Year=2012	-9165.323***	-9206.686***
	(962.90)	(908.51)
Year=2013	-29205.037***	-30243.904***
	(902.61)	(818.78)
Year=2014	-46640.273***	-47726.925***
	(747.47)	(704.15)
Year=2015	-63058.480***	-64115.572***
	(699.88)	(664.65)
Govt Spending (2002)		1.405***
		(0.18)
Govt Spending (2007)		1.636***
		(0.19)
Constant	47284.461***	38139.536***
	(766.09)	(684.89)

R-sqr	0.133	0.245
dfres	58695	55043
BIC	1502871.7	1376579.6

* p<0.05, ** p<0.01, *** p<0.001

Sources: NRCS, NASS

4.3 Predictive strength of history

The historic spending variable in Model 2 is both significant at a 1% confidence interval and makes a substantive contribution to predicting CSP spending. We find that data from both the 2007 and the 2002 Census make similarly predictions for CSP spending. Counties that received $1,000 more from the 2002 farm bill would be expected to receive $1,405 more through the CSP mechanism, and farms that received $1,000 in the 2007 farm would expect to receive as much as $1,636 more in CSP payments. The income variable was no longer significant in the 1% confidence interval when historical variable, perhaps because of a high degree of correlation between income and government spending.

4.4 Comparison across historic spending subsets

2,863 counties were divided into four classes based on the quartiles of historical conservation payments at the farm level. The four classes break at $3,440, $5,518, and $9,572 historic spending per farm per year. When compared with CSP data, we find that counties in Q4 capture the most contracts (22,566 contracts) while counties in Q1 contract the least CSP contracts (6,711 contracts) (Table 3). The mean contractual obligations also follows a similar upward pattern from Q1 ($33,247 per contract) to Q4 ($85,961 per contract). Counties at the two extremes (Q1 and Q4) based on historic spending also have a higher standard deviation compared to the quartiles around the mean (Q2 and Q3).

Table 3: Summary statistics of CSP contract payments under different classes

Class	*n*	*Mean*	*Std. Dev.*	*Min*	*Max*
Q1	6,771	33,247	120,803	78	8,244,020
Q2	12,574	45,257	59,078	76	412,390
Q3	17,370	63,862	76,743	44	2,832,932
Q4	22,566	85,961	112,468	21	9,064,075

Sources: NRCS, NASS

In Table 4, the regression analysis for all four quartiles is summarized. Across all quartiles, the ecological risk is a significant predictor of CSP spending. Every additional $1,000 in fertilizer receipts increases CSP spending by $640, $433, $578, and $534 across Q1, Q2, Q3, and Q4 counties respectively.

However, the goodness of the model worsens with increase in quartiles from Q 1 to Q4. The highest goodness of fit for the model is recorded for counties in Q4 where the model explains as much as 23% of the variance of CSP spending. Yet, the substantive contribution of historical spending is strongest for Q3 (counties with historical spending between $5,518, and $9,572 per contract) and not Q4 (counties with spending upwards of $9,572 per contract). In Q3 counties, every additional $1,000 of historical spending predicts an increase of $3,305 in CSP spending compared to an increase of only $1,289 for contracts in Q4 counties. Historical spending fails to be significant at a 0.1% or a 1% confidence interval for contracts in both Q1 and Q2 counties.

Farm income is a significant predictor of CSP spending in Q1 and Q2 counties.

The coefficient of farm income weakens and turns negative as we progress from Q1 to Q4. For contracts in Q1 and Q2 counties, every additional $1,000 in farm income predicts an increase in CSP payout by $708 and $378 respectively. The farm income variable is not significant at either 0.1% or 1% confidence interval for contracts in counties with average historical spending over $5,518 per farm, i.e. in Q3 and Q4 counties. Farm income is not significant predictor of CSP spending for counties with average historical spending over $5,518 per farm. The findings from the subset suggest that the explanatory strength of farm income and historical spending differ across different classes of historical conservation spending.

Table 4: Comparison across quartiles of counties based on historic government spending data

	Model 1: Q1	Model 2: Q2	Model 3: Q3	Model 4: Q4
	b/se	b/se	b/se	b/se
Dependent variable: CSP Spending per contract (2010-2015)				
Fertilizer spending	0.640***	0.433***	0.579***	0.534***
	(0.08)	(0.03)	(0.02)	(0.02)
Farm Income	0.708***	0.378***	-0.046	-0.085*
	(0.15)	(0.05)	(0.04)	(0.04)
Govt spending (96&02)	-5.848*	1.597*	3.305***	1.289***
	(2.89)	(0.81)	(0.43)	(0.06)
Year=2010	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)
Year=2011	10312.797	10139.056***	16455.834***	19250.128***
	(7616.18)	(1873.47)	(1855.21)	(1929.06)
Year=2012	-5115.859*	-10127.438***	-7346.347***	-12997.666***
	(2300.89)	(1559.06)	(1575.75)	(1691.75)
Year=2013	-13740.786***	-21936.812***	-29247.554***	-40079.560***
	(3076.23)	(1422.07)	(1410.33)	(1522.59)
Year=2014	-23727.957***	-32857.724***	-44947.382***	-64019.630***
	(1969.12)	(1157.57)	(1203.71)	(1306.70)
Year=2015	-30733.805***	-43286.887***	-61769.006***	-87772.780***
	(2028.85)	(1032.89)	(1094.22)	(1239.67)
constant	35451.903***	28037.186***	30815.052***	55998.981***
	(5969.43)	(3648.29)	(3246.27)	(1614.08)
R-sqr	0.029	0.157	0.183	0.236
dfres	6644	12509	17305	21320
BIC	174556.0	308513.6	431950.3	538921.3

* p<0.05, ** p<0.01, *** p<0.001

Sources: NRCS, NASS

4.5 Discussion

In both the federal-level model and the subset model based on quartiles of historical conservation spending per farm, the high correlation with purchased fertilizer inputs is consistent, substantive, and a significant predictor of CSP spending. In the subset analysis, we also note that even when other independent variables change in significance, substance, and signage, there is a consistency across the significance and substantive contribution of ecological risk. The finding reinforces claims that CSP is organized toward ecological concerns and payments are directed to address ecological risk.

However, while the CSP spending does indeed align with ecological risk concerns, it is unclear whether it is optimized to produce environmental outcomes. While ecological risk is a significant explanatory variable, in terms of the substantive contribution it is multiple magnitudes lower than historic spending. In the federal-level analysis, the inclusion of historical spending improved the total fitness of the model significantly and the historical spending was both a significant and substantive predictor of CSP spending. In the subset analysis, the relevance of government spending is more pronounced for counties with historically higher levels of government spending. This suggests that the inertia effect is stronger for counties where historical spending was already high and lower for counties which historically received less government conservation funding. Counties with historically high government spending maintain a strong lock-in toward new conservation financing opportunities. In corollary, in counties where government conservation spending has been historically low, the state-bureaucratic complex has a weaker hold over spending patterns. Overall, the findings are broadly consistent with the political economy of US agriculture and support both the policy inertia hypothesis and the data-driven efficiency gains argument.

The critique of CSP as servicing an income support function is not entirely defensible based on our analysis. This is reflected in the lack of significance of farm income in predicting CSP spending in Q3 and Q4 counties. For counties where government spending has been historically low (Q1 and Q2), we observe a positive relationship between CSP spending and farm income, suggesting that richer farmer are likely to receive more CSP funding. We may infer that the CSP is structured in a way that richer farmers in historically low spending counties are more competitive and thus more likely to receive CSP funding. This suggests that CSP does not act to supplement farm income in historically low spending counties and is irrelevant to counties with higher historical spending. This suggests that if CSP is meant to serve as an implicit income support project, it may be ineffective in half the country and failing in the other half. The inference suggests the possibility that CSP largely supports large/rich farms, a finding that is repeated by studies at the Environmental Working Group (Rundquist and Cox, 2016).

While the CSP does indeed address ecological concerns, there is no strong evidentiary base to suggest that the program is designed in any new way to maximize ecosystem services. But, the analysis also does not comprehensively answer whether the use of the data-driven technologies and the innovative CSP policy design creates more precise targeting of payments toward ecological risks. The relevance of historical spending in predicting CSP spending may suggest that the “history matters” position has been validated, but it does not necessarily suggest that CSP spending is weakly targeted. It may be argued that conservation spending prior to the CSP was already well-aligned with ecological risks and thus while history matters that does not necessarily reflect inefficiency. In such a situation, change may even loosen the alignment of public spending and ecological risk. However, when we consider the questions raised about the lack of AEP effectiveness within the USDA and the growing demands for reform (Claassen et al., 2008; Ribaudo, 2015), I think it is safe to argue that the continuity of historical spending reflected in the CSP reproduces the similarly weak targeting of payments. If CSP spending continues to follow the path of historical spending, the environmental outcomes from CSP will replicate the same problems now associated with other AEP programs.

Putting aside the question of whether or not the CSP generated efficiency gains, the results do raise a larger policy question about the usefulness of investing in and adopting data-driven technologies to change public policies. In following the work of Potter and Wolf (2014) and similar arguments about the lack of economic rationalization in AEP made by Batie (2009) and Doering (2013), this analysis suggests that the data-tools can be a relatively powerless resource for triggering policy change. As other scholars point out, instead of focusing on the possible gains from more technical measurement, students of policy reform may direct attention to the more intractable problem of a change-resistant policy structure. Rationalizing AEP is not limited by the lack of quality information but by the policy structure and the coalition of actors controlling policy structure. As Batie (2005) argues, economic tools and analysis for rationalization have been available for decades but there is little interest among policy actors to seriously consider these options. In the CSP, while we find a switch toward introducing more data when contracting farmers, we also find that the net for data-driven decision-making was cast very narrowly. Even as data-driven approaches are embraced, they operate within the dominant policy interests and the historical structure of the largely untouched state-bureaucratic complex.

Finally, there are important ways future scholars could expand upon the analysis. First, it is possible that because CSP spending addresses a range of ecological risks, fertilizer spending as a proxy incompletely captures total risk. Future research may consider examining other ecological concerns such as changes in wildlife, soil erosion, and air quality. Our federal-level study limited the use of other datasets to approximate ecological risk. More regionalized studies could use other risk indicators though they will be limited by the format of CSP spending data. The CSP is a comprehensive agricultural program and thus, by law, it addresses comprehensive conservation on farms. This renders impossible the ability to evaluate the program's impact given only one ecological concern. As mentioned earlier, the model is blackboxed and the scores cannot be disaggregated for different resource concerns, at least given the current data format. Second, this paper relies on self-reported data for both fertilizer expenses, government spending, and farm income. Self-reported information may misrepresent actual fertilizer application or farm income. This can be overcome by using data from other sources to estimate fertilizer applications and farm income. Actual historic government spending can also be used by aggregating historical USDA datasets. Lastly, there might be useful comparative insights on quantifying policy inertia by studying CSP in relation to major conservation programs such as the Environmental Quality Incentives Program (EQIP) and the Conservation Reserve Program (CRP).

4.6 Conclusion

The limits of relying on science and technology to trigger institutional changes is well established in critical social science literature. Yet the balance of economics literature has focused on developing new information tools and advocating idealistic market-based ideas such as pay-for performance. I argue that this perspective conceptualizes reform narrowly and overlooks the larger structural shifts needed to deliver progressive environmental reforms. Hall (1993, p. 280) has previously argued that "the process whereby one policy paradigm comes to replace another is likely to be more sociological than scientific". On the other hand, Pierson (2000, 1994) argues that change is rarely radical but rather incremental. To study any one event such as the introduction of data-driven approaches in the CSP, one must not only evaluate short term changes but also the set of chain-reactions that may accumulate to create a different equilibrium state for the role of technology and the state-bureaucracy (also see Coleman et al., 1996). This position raises questions toward whether the partialness of this analysis and urges us to consider whether longitudinal datasets when studying institutional change. I do not deny that it is possible that over time data-driven approaches could undermine the intellectual coherence of the original policy coalition and thus force change. However, here too, recent events suggest that the policy coalition faces little accountability for policy experiments and will likely preserve continuity. In 2012, the new CSP law removed any references to conservation measuring tools and eliminated the legal instrument to data-driven conservation. The new law has shifted to a simpler and less comprehensive tool. The new tool is more transparent but it is no longer calculating outcomes. While the benefits of the CSP are clearly mixed, the findings support thinking about successor programs not only in terms of building more information or evidence-based calculations but in terms of realigning data-driven technologies with accountability dynamics and historical political structures.

4.7 References

Babcock, B.A., Lakshminarayan, P.G., Wu, J., Zilberman, D., 1997. Targeting Tools for the Purchase of Environmental Amenities. Land Econ. 73, 325–339. https://doi.org/10.2307/3147171

Batie, S.S., 2009. Green payments and the US Farm Bill: information and policy challenges. Front. Ecol. Environ. 7, 380–388. https://doi.org/10.1890/080004

Batie, S.S., 2005. The Demand for Economic Policy Analysis: Is Anyone Listening? Agric. Resour. Econ. Rev. 34, 123–130. https://doi.org/10.1017/S1068280500008303

Baumgartner, F.R., Jones, B.D., 2010. Agendas and Instability in American Politics, Second Edition. University of Chicago Press.

Blesh, J., Drinkwater, L.E., 2013. The impact of nitrogen source and crop rotation on nitrogen mass balances in the Mississippi River Basin. Ecol. Appl. 23, 1017–1035. https://doi.org/10.1890/12-0132.1

Carwardine, J., Klein, C.J., Wilson, K.A., Pressey, R.L., Possingham, H.P., 2009. Hitting the target and missing the point: target-based conservation planning in context. Conserv. Lett. 2, 4–11. https://doi.org/10.1111/j.1755-263X.2008.00042.x

Claassen, R., Cattaneo, A., Johansson, R., 2008. Cost-effective design of agri-environmental payment programs: U.S. experience in theory and practice. Ecol. Econ., Payments for Environmental Services in Developing and Developed Countries 65, 737–752. https://doi.org/10.1016/j.ecolecon.2007.07.032

Coleman, W.D., Skogstad, G.D., Atkinson, M.M., 1996. Paradigm Shifts and Policy Networks: Cumulative Change in Agriculture. J. Public Policy 16, 273–301.

David, P.A., 2001. Path dependence, its critics and the quest for “historical economics,” in: Garrouste, P., Ioannides, S. (Eds.), Evolution and Path Dependence in Economic Ideas: Past and Present. Edward Elgar Publishing.

David, P.A., 1985. Clio and the Economics of QWERTY. Am. Econ. Rev. 75, 332–337.

Diaz, R.J., Rosenberg, R., 2008. Spreading Dead Zones and Consequences for Marine Ecosystems. Science 321, 926–929. https://doi.org/10.1126/science.1156401

Doering, I., Otto C., Lawrence, D.J., Helms, J.D., 2013. Agricultural Conservation & Environmental Programs: The Challenge of Data-Driven Conservation. Choices Quarter 2.

Feather, P., Hellerstein, D., Hansen, L., 1999. Economic Valuation of Environmental Benefits and the Targeting of Conservation Programs: The Case of the CRP (SSRN Scholarly Paper No. ID 2735093). Social Science Research Network, Rochester, NY.

GAO, 2006. Conservation Securuty Program: Despite Cost Controls, Improved USDA Management Is Needed to Ensure Proper Payments and Reduce Duplication with Other Programs (No. GAO-06-312). United States Government Accountability Office.

Ghosh, R., Forthcoming. Environmental models and economic rationalization: a critical analysis. Forthcoming.

Good, A.G., Beatty, P.H., 2011. Fertilizing Nature: A Tragedy of Excess in the Commons. PLOS Biol. 9, e1001124. https://doi.org/10.1371/journal.pbio.1001124
GPO, 2016. Hearings before a subcommittee of the committee on appropriations house of representatives one hundred fourteenth congress second session. Government Publishing Office.
Greif, A., Kingston, C., 2011. Institutions: rules or equilibria?, in: Political Economy of Institutions, Democracy and Voting. Springer, pp. 13–43.
Hall, P.A., 1993. Policy Paradigms, Social Learning, and the State: The Case of Economic Policymaking in Britain. Comp. Polit. 25, 275–296. https://doi.org/10.2307/422246
Hansen, L., Hellerstein, D., 2006. Better Targeting, Better Outcomes (SSRN Scholarly Paper No. ID 2736544). Social Science Research Network, Rochester, NY.
Lehrer, N., 2010. U.S. Farm Bills and Policy Reforms: Ideological Conflicts Over World Trade, Renewable Energy, and Sustainable Agriculture. Cambria Press.
Lohmann, L., 2011. The Endless Algebra of Climate Markets. Capital. Nat. Social. 22, 93–116. https://doi.org/10.1080/10455752.2011.617507
Munck af Rosenschöld, J., Rozema, J.G., Frye-Levine, L.A., 2014. Institutional inertia and climate change: a review of the new institutionalist literature. Wiley Interdiscip. Rev. Clim. Change 5, 639–648. https://doi.org/10.1002/wcc.292
North, D.C., 1990. Institutions, Institutional Change and Economic Performance. Cambridge University Press.
Pierson, P., 2000. Increasing Returns, Path Dependence, and the Study of Politics. Am. Polit. Sci. Rev. 94, 251–267. https://doi.org/10.2307/2586011
Pierson, P., 1994. Dismantling the Welfare State? by Paul Pierson [WWW Document]. Camb. Core. https://doi.org/10.1017/CBO9780511805288
Potter, C., Cook, H., Norman, C., 1993. The targeting of rural environmental policies: an assessment of agri-environmental schemes in the UK. J. Environ. Plan. Manag. 36, 199–216. https://doi.org/10.1080/09640569308711939
Potter, C.A., Wolf, S.A., 2014. Payments for ecosystem services in relation to US and UK agri-environmental policy: disruptive neoliberal innovation or hybrid policy adaptation? Agric. Hum. Values 31, 397–408. https://doi.org/10.1007/s10460-014-9518-2
Potter, P., Ramankutty, N., Bennett, E.M., Donner, S.D., 2010. Characterizing the Spatial Patterns of Global Fertilizer Application and Manure Production. Earth Interact. 14, 1–22. https://doi.org/10.1175/2009EI288.1
Ribaudo, M., 2015. The Limits of Voluntary Conservation Programs. Choices 30, 1–5.
Stubbs, M., 2016. Agricultural Conservation: A Guide to Programs (No. 7–5700). Congressional Research Service, Washington, D.C.
Sullivan, S., 2013. Banking Nature? The Spectacular Financialisation of Environmental Conservation. Antipode 45, 198–217. https://doi.org/10.1111/j.1467-8330.2012.00989.x
Torfing, J., 2009. Rethinking path dependence in public policy research. Crit. Policy Stud. 3, 70–83. https://doi.org/10.1080/19460170903158149

Vilain, G., Garnier, J., Tallec, G., Cellier, P., 2010. Effect of slope position and land use on nitrous oxide (N2O) emissions (Seine Basin, France). Agric. For. Meteorol. 150, 1192–1202. https://doi.org/10.1016/j.agrformet.2010.05.004

Ward, M.H., deKok, T.M., Levallois, P., Brender, J., Gulis, G., Nolan, B.T., VanDerslice, J., 2005. Workgroup Report: Drinking-Water Nitrate and Health-Recent Findings and Research Needs. Environ. Health Perspect. 113, 1607–1614.

Winders, B., 2009. The Politics of Food Supply: U.S. Agricultural Policy in the World Economy. Yale University Press.

Wünscher, T., Engel, S., Wunder, S., 2008. Spatial targeting of payments for environmental services: A tool for boosting conservation benefits. Ecol. Econ., Payments for Environmental Services in Developing and Developed Countries 65, 822–833. https://doi.org/10.1016/j.ecolecon.2007.11.014

CHAPTER 5: CONCLUSION

5.1 Summary of Argument

I began the dissertation by asking how public institutions harness the power of information to advance sustainability. Over the course of the dissertation, I problematize two main elements of the original question. First, I show that governmental actions encompass a larger institutional bloc than public sectors actors itself. This observation is reflected in the use of the term “policy network”, drawn from policy theory (König and Bräuninger, 1998), to identify the actors, interests, and resources shaping how new ideas and technologies are incorporated into policy routines. Second, I speak of information in terms of the resources and infrastructures that are developed to carry out repeated quantification of environmental benefits. The focus on infrastructure draws attention, not only to the innovations in modeling, but also in organizational rules and routines, and the imbrication of new systems with old ones. Based on the empirical research, I conclude that the production of more detailed and precise environmental information does not mechanically produce more policy rationalization. I further argue, in some contrast to critical environmental studies that practices of measuring and modeling ecosystems are also not at complete odds with sustainability efforts.

The dissertation focuses on the Conservation Measurement Tool (CMT), an algorithm used to score and rank conservation applications in the Conservation Stewardship Program (CSP). The CSP is an agri-environmental policy (AEP) framed within the language of performance-based, data-driven, and targeted approaches. By studying the role of information infrastructures in triggering changes in agri-environmental governance, this work resides within a larger array of political economy research on state efforts to use science and measurement to expand political control (Busch, 2007; Scott, 1999). I contribute to this body of knowledge by showing how governments, not only mobilize science to actively shape market-based social regulations, but also leverage ideas of markets, rationality, and information to avoid enacting market reform. I show that the dominant policy network in US agricultural policy creatively adapted itself and the technology to perform economic rationalization at its own terms.

The dissertation calls into question the analytical tools for studying institutional changes. I show that it is equally possible to point to the CSP and argue that discipline was both advanced and thwarted. Indeed, under the CSP, the CMT ranked all applications on an estimation of their conservation returns and the scores and ranks determined all resource allocation decisions. While the big picture allocations were politically negotiated, it is also accurate to say that the centralized data-intensive decision-making process effectively constrained political discretion--officials at the local level. Local officials could not overrule the ranking scores or privilege some applicants over others without inviting some serious legal scrutiny. Seen in this light, the CMT afforded a certain set of behavioral and organizational outcomes and closed out other options. The ability of technologies to create such affordances has been an important line of inquiry in organizational studies and STS (Jarzabkowski and Pinch, 2013). We could take the above observation to mean that technology was productively applied toward constraining political discretion and increasing efficiency by building new science-based environmental institutions.

However, such a narrative would be incomplete without examining the technical, organizational, and localized work that support the program. Parameters for quantifying environmental benefits was not definitive and the interpretive flexibility permitted a host of different projects to align themselves to the conservation cause. This openness created room for actors in powerful positions to set policy agendas and oversee what counts as rigorous quantification. It also allowed local bureaucrats to work directly with farmers, build relations, and often undercut the objective of extracting environmental returns from farmers. The narrowly constructed CMT ranking pools, the use of abstract self-reported questionnaires, a simplified scoring system, a black-boxed algorithm, and the lack of robust verification mechanisms are some examples of how the policy network performed economic rationality throughout the CMT-ranking process. This presents a story of policy inertia.

If we were seeking to identify institutional change, I think both narratives of policy transformation and policy inertia hold water. The varied agendas of different actors invested in the future of US agricultural policy, the multifaceted nature of ecological concerns in agriculture, and a large bureaucratic structure conflate any simplistic explanation for what changed. This indecisive conclusion suggests the weaknesses of an analytical framework to identify whether policies are now more or less neoliberal, market-driven and economically rational. A more productive engagement for scholars of political economy is to conceptualize the significance of data-driven governance through focus on the performances of rationalization. I argue that the dynamics of change can be productively gleaned using a practice-centered approach: observing how policy networks embrace quantification ideas, create information tools, and shift routines.

In Chapter 2, I found that the information infrastructure in the CSP was a product of negotiations across bureaucrats, subject matter specialists, and political aides. I develop the argument through primary research with the scientists involved in producing the algorithm. The scientists identified the CMT algorithm as innovative but also pointed out constraints of time and limited scope, which in their view would have strengthen the calculations. The final model was a unique and powerful technical artefact in itself but the development process was subjected to little external review, few statistical tests, and was wholly undocumented. The findings point to the lack interest within and beyond the policy network to hold the tool development process accountable to conventional norms of scientific inquiry or democratic transparency.

In Chapter 3, I examine the systems of coordinating data-collection and process across government offices around the country, with empirical analysis in North Dakota. I show that the CMT shifts decision-making to the algorithm in an evident way but it also requires local officials to interpret questions and top-down rules, thus inserting a degree of localized professional discretion to the rationalist project. To the extent that the CMT enacted rationalization, it was not the only outcome of the process. The long-standing bureaucratic cultures and routines were not abandoned but leveraged as resources to claim objectivity in the process of improvisation. The technology surely acts but not only in controlling subjects but also in loosening control.

Finally, in Chapter 4, I complement the qualitative analysis with a traditional quantitative policy analysis of over 55,000 public conservation contracts. I show that spending under the CSP does indeed align with ecological risk concerns, indicating that the program is structured to produce environmental returns, but largely in a similar structure to historical conservation spending. This illustrates that the data-driven technology is not transformative in its own right though such technologies do not foreclose potential for shifts in the future. It does, however, highlight that information technologies alone have limited impact in shifting policies if the network of actors are able to bound and control informational infrastructures to serve their interests. New technologies and ideas brought into policy debate may transform existing practices and challenge established conventions, and they may even introduce new actors and shift power dynamics, but it is necessary to understand how incumbent power holders respond to the prospects of change and what resources and logics they mobilize to preserve strategic interests.

5.2 Updates on Conservation Stewardship Program (CSP)

Over the last five years, the AEP policy structure has undergone changes that weigh deeply on the message of this dissertation. First, while much of my work on the CSP legislation focuses on the 2008 Farm Bill, the subsequent Farm Bill in 2014 removed references to conservation measurement tools. During my interviews with people who wrote the legislation, I asked why the language changed. Although all were aware of the change, curiously few offered any coherent account of why the change took place. I conclude that both the inclusion and the later exclusion of references to conservation measurement tools were not particularly contentions and is best described as an after-thought. Even after the change in the 2014 Farm Bill, the implementing agency, Natural Resource Conservation Service (NRCS), continued to use the tool for a further two years until the 2017 CSP funding cycle, arguing that the new law does not require measurement tools but neither does it prohibit them. I am inclined to believe that the inclusion of measurement tools was not meant to force discipline upon the NRCS but an overture from policymakers to support existing strategies adopted by the NRCS by giving them new resources to work with. Thus, as the CMT was being challenged for its blackboxed nature, its usefulness in demonstrating legitimacy was diminishing. In 2017 funding cycle, a relatively more transparent tool with a more decentralized calculation has replaced the CMT. Moreover, the new tool has clarified the CSP as an activity-based, rather than an outcome-based, program. Payments are not based on scores that capture expected outcomes but on a payment schedule that links every adopted activity to a certain payment range. The changes bring the CSP closer to a similar and competing agri-environmental program, the Environmental Quality Incentive Program (EQIP) (see Stubbs (2018) for a review of different conservation programs). The activity-based payment system has created greater transparency for farmers to understand why they received a certain level of payment, but it eliminates the pretense of a pay-for-performance initiative. The change may suggest the challenges of advancing more outcome-based discipline or it may suggest that the usefulness of performing legitimacy through the language of the pay-for-performance framework was no longer useful for the policy network.

Second, at the time of writing the conclusion, the 2018-19 Farm Bill remains under negotiation and the longevity of CSP is uncertain. The Senate and the House of

Representatives have each passed versions of the Farm Bill, which now must be reconciled. Part of the reconciliation challenge is differing approaches toward the CSP. While the Senate Farm Bill cuts CSP funding, the House Bill completely eliminates the CSP and reallocates savings to the EQIP. Given that the EQIP and the CSP are somewhat similar, the argument to collapse the programs into one consolidated effort has some merit (see the NSAC (2017) proposal). The uncertain future of the CSP highlights the contentious politics of AEP. It illustrates the entangled politics of experimenting with new policy models and the challenges of organizing change through an existing network of powerful actors who do not necessarily benefit from change. It is possible that this is a period of uncertainty that will produce a new equilibrium. Baumgartner and Jones (2010) theorize policy change follows long periods of calm and stability and sudden bursts of activity and confusion that shift paradigms. Interestingly, while there have been important challenges raised toward the CSP, the alternate no major calls for reform EQIP exist. The selective focus on eliminating the CSP rather than reforming the CSP and EQIP raises useful future research question on some programs and policy innovations outlive their usefulness to the policy network.

5.3 Updates on Theoretical Developments

Over the course of the dissertation, the environmental social science engagement with STS theories of metrics has advanced in important ways that are not all captured in this dissertation. I briefly summarize three key intellectual dialogues that this dissertation is directly engaging.

First, the academic references to the theory of economic performativity have grown considerably in economic sociology and in studying neoliberal environmental changes. New journals, like the Journal of Cultural Economy and the Journal of Economic Anthropology, are testimony to the growing interest in economic practices. Economic sociologists debate the original concepts of economic performativity, and have pointed to a lack of clarity in what is exactly being performed and who or how the performance is being carried out (Mäki, 2013). The problematization is perhaps important as the theory has such widespread acceptance in contemporary economic sociology literature. An example of a review of the performativity literature is coalesced in an edited volume by Boldyrev and Svetlova (2016). The authors offer updates on the concept and respond to critics, primarily Maki. They argue (ibid, p10):

> *"Now, a critical task is to reveal the genealogy of economization, to stop treating particular social structures as pre-given, to see them being constantly produced and reproduced, and sometimes to reveal a hypocrisy of certain practices—claiming to involve naturalistic or laissez-faire attitudes but actually doing otherwise"*

The arguments about performance metrics made in this paper resonate strongly with Muniesa (2014) work on the Provoked Economy. Of particular attention is his chapter on government performance targets and indicators. He looks at a specific French budgetary reform called LOFT (Loi organique relative aux lois de finances) which was meant to radically rationalize federal budgetary allocations. Similar to the questions pursued in this paper, Muniesa wants to identify the ways in which the LOFL was shaped by political interests and to what extent it promoted neoliberal/rationalist policies. He concludes that the LOFL "*could be understood by* *some as a plea for an economization of the state and by others as a defense of its politicization.*" There is no clear answer to the question, primarily because the project of rationalization must unfold within specific institutional fields. But this very question gets at a larger question of what the state is and what people within the state do. For Muniesa, "performance targets and indicators constitute a semiotic haze which envelops the state as a colossal attempt at accounting for the performance of its action, that is, of its agency" (ibid, 109). This haze refers to the endless work of coordinating civil servants, consultants, politicians, and specialists of all kinds. Every effort to make visible a state's managerial actions visible can help reveal the "state's penchant for the elliptical" (ibid, 110). Nevertheless, the mobilization of data to make things less visible is not a capacity limited to the state. Economic and political geographers make a similar argument in the context of green bonds and conservation finance (see Bigger, 2015). They are showing that the promise of market-driven governance and the failure for these new ideas to take off in a meaningful way is part of a larger effort to create metrics and standards to claim that change is happening or that we are at the precipice of a radical change.

Second, I also find a growing interest in studying valuation as a pragmatic project. While valuation is often understood in terms of monetary valuation, the sub-field of valuation studies are expanding the scope of debate conceptualizing valuation as an everyday practice of negotiation. The sub-field draws extensively from economic sociology and takes a leaf from pragmatic philosophy and the ontological turn in STS (see Mol, 2002). An example of prominent work on the subject include Antal, Hutter, and Stark's (2015) book on pragmatics of valuation. The idea of "dissonance" developed through the length of the book has useful insights relevant to this study of calculation and institutional change. They argue:

> *"The challenge is to understand in greater detail the dynamics of social innovation, in their trajectories from situations of initial dissonance to the moments of valuation during which the new is confronted with the value scales of the established world"*

When different approaches to evaluate some action or outcome confront each other, we find dissonance and dissonance leads to new ways of valuing actions and outcomes. I would contend the focus on newness of innovation might distract us from the stickiness of old valuation techniques and the stickiness of older valuation systems may reveal useful questions of who benefits from various valuation regimes. The debates are unlikely to be settled in any universal way but we can take-away that valuation is a useful scaffolding to understand all sorts of social and institutional interactions. environmental social science, valuation has received some recent attention with Bigger and Robertson (2017) making a case for studying valuation because studying values is too easy while studying valuation is hard and important.

Finally, the subfield of infrastructures studies has been growing significantly across STS, anthropology, information science, and more recently in environmental social sciences. Studies of infrastructures have provided an important new analytical approach to the role of information, classifications, and standards in formatting social regulation. There have been useful insights toward understanding how much invisible work and coordination it takes to produce datasets as legitimate informational resources (Bowker and Star, 2000; Gitelman, 2013). There is important research into the implications of new infrastructural innovations for social equity (Singh and

Jackson, 2017) and more relevant to environmental governance, there is now a proliferation of research into environmental models that purport to predict environmental changes (Blok et al., 2016; Edwards, 2013). These new ways to conceptualize environmental futures have implications for how policy makers plan for changes

Discussions about the power and relevance of data-driven governance and outcome-based has not gone unnoticed in the conventional social sciences. Public policy scholars and economists debate the conditions where performance metrics are most applicable, as demonstrated in Muller's (2017) book on the Tyranny of Metrics. Muller questions policy models such as pay-for-performance and alerts the more mainstream economic audience toward the pitfalls of acritical approaches to policy innovation. The book lacks sufficient engagement with neoliberal debates but it is a much needed step within economics to discuss the pitfalls of rationalist principles in state planning.

5.4 Final remarks

Overall, my dissertation supports caution toward postulating the power inherent to data, algorithms, standards, and all sorts of metrics in holding public actors accountable or for triggering change. Despite development of all sort of new technologies in US agriculture, the policy principles remain stuck in the 1980s when conservation incentive policies were introduced for the first time. The weakness of technological systems to produce desired institutional change raises important questions for a progressive environmental movement whose core purpose is to provide detailed environmental datasets and informational resources. Such a movement is ineffectual when the provisioning of data-driven technologies produce little policy change but the movement is thoroughly counter-productive when it produces opportunities for incumbent policy actors to claim legitimacy through the same resources and avoid change. Political actors leverage the political language of the progressive agenda such as valuation, quantification, and performance-metrics to perform efficiency and responsiveness, all the while obfuscating accountability. Information can speak truth to power but it is also a political resource to manage critique.

5.5 References

Antal, A.B., Hutter, M., Stark, D., 2015. Pragmatist Perspectives on Valuation: An Introduction. Oxford University Press.

Baumgartner, F.R., Jones, B.D., 2010. Agendas and Instability in American Politics, Second Edition. University of Chicago Press.

Bigger, P., 2015. Environmental Governance in the Carbon Economy: Regulating Greenhouse Gas Emissions in California's Cap-and-Trade Program. Theses Diss.--Geogr.

Bigger, P., Robertson, M., 2017. Value is Simple. Valuation is Complex. Capital. Nat. Social. 28, 68–77. https://doi.org/10.1080/10455752.2016.1273962

Blok, A., Nakazora, M., Winthereik, B.R., 2016. Infrastructuring Environments. Sci. Cult. 25, 1–22. https://doi.org/10.1080/09505431.2015.1081500

Boldyrev, I., Svetlova, E. (Eds.), 2016. Enacting Dismal Science - New Perspectives on the Performativity of Economics | | Palgrave Macmillan, Perspectives from Social Economics. Palgrave Macmillan US.

Bowker, G.C., Star, S.L., 2000. Sorting Things Out: Classification and Its Consequences. MIT Press.

Busch, L., 2007. Performing the economy, performing science: from neoclassical to supply chain models in the agrifood sector. Econ. Soc. 36, 437–466. https://doi.org/10.1080/03085140701428399

Edwards, P.N., 2013. A Vast Machine: Computer Models, Climate Data, and the Politics of Global Warming. The MIT Press, Cambridge, Massachusetts London, England.

Gitelman, L. (Ed.), 2013. "Raw Data" Is an Oxymoron. The MIT Press, Cambridge, Massachusetts ; London, England.

Jarzabkowski, P., Pinch, T., 2013. Sociomateriality is 'the New Black'': accomplishing repurposing, reinscripting and repairing in context.' M@n@gement Vol. 16, 579–592. https://doi.org/10.3917/mana.165.0579

König, T., Bräuninger, T., 1998. The Formation of Policy Networks: Preferences, Institutions and Actors' Choice of Information and Exchange Relations. J. Theor. Polit. 10, 445–471. https://doi.org/10.1177/0951692898010004004

Mäki, U., 2013. Performativity: Saving Austin from MacKenzie, in: Karakostas, V., Dieks, D. (Eds.), EPSA11 Perspectives and Foundational Problems in Philosophy of Science, The European Philosophy of Science Association Proceedings. Springer International Publishing, pp. 443–453.

Mol, A., 2002. The Body Multiple: Ontology in Medical Practice. Duke University Press.

Muller, J.Z., 2017. The Tyranny of Metrics. Princeton University Press, Princeton, N. J.

Muniesa, F., 2014. The Provoked Economy: Economic Reality and the Performative Turn, 1st Edition. ed. Routledge.

NSAC, 2017. Agenda for the 2018 Farm Bill. National Sustainable Agriculture Coalition, Washington, D.C.

Scott, J.C., 1999. Seeing like a State: How Certain Schemes to Improve the Human Condition Have Failed. Yale University Press.

Singh, R., Jackson, S.J., 2017. From Margins to Seams: Imbrication, Inclusion, and Torque in the Aadhaar Identification Project, in: Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems, CHI '17. ACM, New York, NY, USA, pp. 4776–4824. https://doi.org/10.1145/3025453.3025910

Stubbs, M., 2018. Agricultural Conservation: A Guide to Programs (CRS Report for Congress No. R40763). Congressional Research Service, Washington, D.C.

Tyfield, D., Lave, R., Randalls, S., Thorpe, C. (Eds.), 2017. The Routledge Handbook of the Political Economy of Science, 1 edition. ed. Routledge, Abingdon, Oxon ; New York, NY.