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Public policy's bibliography: The use of research in US regulatory impact analyses

Bruce A. Desmarais and John A. Hird

Department of Political Science and College of Social and Behavioral Sciences, University of Massachusetts Amherst, Amherst, MA, USA

Abstract

Major US federal regulatory decisions are developed and justified using regulatory impact analyses (RIAs) mandated by executive order. We examine the scientific citation activity in RIAs, a unique effort that we believe holds significant potential for understanding the use of science in policymaking. This paper reports preliminary findings from collecting and examining scientific citations in 104 RIAs from 2008–2012. We present evidence indicating that some agencies make extensive use of science in RIAs, that there is substantial variation in use across agencies, and show variation across journals and disciplines cited by regulatory agencies. Finally, we present analysis showing that regulatory policymakers make greater use of research published in highly cited scholarly journals. We conclude by outlining several future directions for research using these data.

Keywords: bibliometrics, knowledge utilization, regulatory impact analysis, regulatory policy, scientific expertise.

1. Introduction

The scientific basis of regulatory policymaking plays an important role in maintaining the legitimacy, transparency, and accountability of policymaking by unelected officials. Political support for regulatory agencies rests in large measure on the legitimacy of their public justifications for regulatory action, and regulatory impact analyses (RIAs) are an important expression of regulatory agency policymaking behavior in the US. Executive Order 12866, issued by President Clinton in 1993 and still the basis of regulatory analysis, requires that each agency "base its decisions on the best reasonably obtainable scientific, technical, economic, and other information concerning the need for, and consequences of, the intended regulation" (Federal Register 1993, 1[b][7]). RIAs serve as justification of the agency's proposed regulatory policy, and agencies have considerable latitude in how they support and justify regulatory decisions.

Regulations are increasingly important policy tools, and reliable science is essential to their effectiveness. The importance of science in the regulatory process is underscored in a report from the Bipartisan Policy Center:

> The [conflict over the] use of science in the formulation of regulatory policy . . . has left the US with a system that is plagued by charges that science is being "politicized" and that

Correspondence: Bruce A. Desmarais, College of Social and Behavioral Sciences, University of Massachusetts Amherst, 225 Draper Hall, 40 Campus Center Way, Amherst, MA 01003, USA. Email: desmarais@polsci.umass.edu

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> regulation lacks a solid scientific basis. As a result, needed regulation may be stymied, dubious regulations may be adopted, issues can drag on without conclusion and policy debate is degraded. Moreover, the morale of scientists is weakened, and public faith in both government and science is undermined. (Bipartisan Policy Center 2009, p. 11)

We seek to understand the way policymakers use scientific evidence by examining how US federal regulatory agencies invoke science to justify new regulations through RIAs. We develop and analyze a novel data resource connecting US federal regulatory policies to specific scientific publications. These data permit both a broad-based and precise examination of the connection between science and policymaking, as well as regulatory legitimacy through the quality of science employed. Specifically, we study scientific citation patterns in US federal RIAs, and examine the nature of evidence used by US federal regulatory agencies in justifying new rules. We examine citation patterns in all economically significant federal regulations issued between 2008 and 2012 to better understand the nature of the scientific evidence regulatory agencies use to bolster their rulemaking process. This paper is the first of its kind to document and analyze regulatory citation patterns to understand the use of information across a broad substantive range of policymaking.

2. Background

Post-World War II optimism about using science to advance policymaking led to several institutional innovations in the US, including the National Science Foundation, established in 1950, as well as institutionalized technical advice to the President through the Council of Economic Advisers in 1946 and the Office of Science and Technology Policy in 1976. However, as confidence in social science research waned, scholars pointed to the difficulties of bridging the "two communities" of research and policymaking (Caplan 1979; Hird 2005). Scientists, not to mention policymakers, began to wonder why their research had little impact on policy. Spawning a field of "knowledge utilization," including its own journal,[1] scholarship pointed to the ambiguity of defining "use" and, related, cast doubt on the easy translation of research to policymaking (Meltsner 1976; Lindblom & Cohen 1979; Weiss & Bucuvalas 1980; Szanton 1981).

The contemporary era of research on the use of science in policymaking, assisted by Weiss's (1979) seminal work, adopts a more nuanced approach recognizing that policymakers use research in a variety of ways and under a variety of policy conditions. (Shulock 1999). An established field of social science research, variously understood as knowledge utilization, evidence-based policymaking, and policy learning, investigates the relationships between expert knowledge and policymaking. However, after a thorough review of the literature, a recent US National Research Council (NRC) report notes that ". . . the focus on operationalizing 'use' has not provided an adequate understanding of what happens between science and policy in policy making" (NRC 2012, p. 31) and concludes "the scholarship on use to date is inadequate" (p. 33). Space does not permit an examination of all the research attempting to link science with policymaking, though a burgeoning literature examining theoretical and empirical aspects has emerged (Jasanoff 1994; Cozzens & Woodhouse 1995; Stokes 1997; Morgan & Peha 2003; Bozeman & Sarewitz 2005; Wagner & Steinzor 2006; Pielke 2007; Dudley & Gray 2012).

Studies of the use of research in policymaking tend to focus on early stages of the policy process, and virtually all agency decisionmaking processes take place in "systems characterized by high levels of interdependency and interconnectedness among participants" (Contandriopoulos *et al.* 2010, p. 447). Thus, teasing out the independent influences of

various ideas, political actors, material resources, constituencies, and other factors governing decisionmaking is exceedingly complex. Because of these difficulties, scholars have pursued other lines of inquiry. Many have examined particular aspects of policy, such as congressional committees (e.g. committee use of Office of Technology Assessment studies, Whiteman 1985), agencies (e.g. the Department of the Interior, Farrow 1991; or the Environmental Protection Agency [EPA], Morgenstern 1997), the influence of "boundary organizations" (Guston 2001) (e.g. think tanks, Rich 2004), a policy field (e.g. family policy, Bogenschneider *et al.* 2000), or a specific policy idea (e.g. charter schools, Henig 2008). These studies shed important light on the use of research in these areas, but the results preclude generalizing beyond specific institutions or policy domains. As a result, we know more about how knowledge producers engage the policy process than how knowledge consumers, the policymakers themselves, use scientific research. In contrast, we examine the other end of the policy process, studying the policy outcome, the regulation, and the science that informs it through the justificatory RIAs. By focusing on policy justifications, the RIAs issued by agencies, we avoid the flawed assumption that dissemination of science is sufficient to compel use and instead work to identify "those types of transfer that are worthwhile under varying conditions" (Knott & Wildavsky 1980, p. 538).

3. Why focus on regulatory impact analyses (RIAs)?

As a result of long-standing executive orders requiring RIAs for all major regulations,[2] RIAs have been produced to justify thousands of regulations across dozens of policy areas. Whenever a rule is estimated to have an effect on the economy of $100 million or more, among other criteria, it is deemed "economically significant" by the Office of Information and Regulatory Affairs (OIRA) in the US Office of Management and Budget, and by executive order OIRA must review and approve the RIA before the final rule is issued.

RIAs represent an unusually coherent policy argument from the perspective of the agency issuing the regulation. "RIA is a particularly fascinating case for the analysis of the role of knowledge in policy-making because it has quasi-scientific ambitions, but also takes place at the heart of government where political decisions are transformed into laws, regulations and other policy instruments" (Hertin *et al.* 2009, p. 413). Substantial attention has been devoted to improving the economic analysis supporting RIAs (Harrington *et al.* 2009), analyzing the quality of RIAs (Hahn & Dudley 2007; Ellig *et al.* 2013), the diffusion of RIAs (Radaelli 2004), understanding types of knowledge utilization of RIAs (Rissi & Sager 2013), and understanding RIA procedures cross-nationally (Radaelli 2010). However, none have examined the citation activity in RIAs, an effort that we believe holds significant potential for understanding the use of science in policymaking. In aggregate, RIAs provide evidence directly relating scientific research to specific public policy outcomes unmatched by any other source.

We see several reasons for regulators to actively integrate scientific research into policymaking. US regulatory agencies are delegated with responsibility and authority for making laws (rules). The main task of regulators in rulemaking is to use their expertise to establish specific policy provisions within the framework outlined by legislation (Volden 2002; Kerwin & Furlong 2011). "Agencies have considerable capacity to consider a range of scientific research that has bearing on public health and environmental protection . . . allowing them to consider all available science" (Wagner 2004, pp. 591–592). Second, policymakers are interested in knowing the impacts of proposed policies, in part because they are accountable for them and, therefore, want to control outcomes. Research enables a better assessment of the impact of proposed policies (Lupia & McCubbins 1994). Furthermore, science may be used by policymakers to support

pre-existing positions. This procedural use of science relies on the integrity of the science in supporting the policy decision, particularly if policy outcomes are unexpectedly negative; the policymaker can claim using the best science available as political cover. Finally, political support for regulatory agencies rests in large measure on the legitimacy of their public justifications for action. Historically, Congress and the courts have deferred to regulatory agency interpretation of statutes, even when that interpretation may be at odds with judicial interpretation (*Chevron U.S.A., Inc. v. Natural Resources Defense Council, Inc.* 1984). However, US regulatory agency behavior has come under considerable criticism for its legitimacy (Vibert 2007), lack of accountability (Lodge & Stirton 2010), and scope. In a recent dissent, Chief Justice Roberts noted that, "the danger posed by the growing power of the administrative state cannot be dismissed" (*City of Arlington, Texas et al. v. Federal Communications Commission et al.* 2013). Thus, we would expect regulatory policymakers to support their decisions with convincing scientific evidence in order to maintain institutional legitimacy and political accountability.

4. Data and analysis

We collected RIAs for all economically significant regulations proposed by federal executive branch agencies from 2008 to 2012, excluding transfer and budget regulations, a total of 104 RIAs.[3] The RIAs were accessed from the materials collected and made available online through the Mercatus Center at George Mason University.[4] Table 1 presents descriptive data for our sample, tabulated by agency. The first column shows the distribution of RIAs across federal agencies; from 2008–2012, the EPA and the Department of Transportation (DOT) issued the largest number of economically significant RIAs: 26 and 15, respectively. For each of the RIAs, trained research assistants extracted citations from outside literature. The nature of the citations varies and includes scientific studies, laws and other legal precedents, government reports, and miscellaneous material, such as newspaper and magazine articles. Because the RIAs are performed by individual agencies without standardized formatting, the research assistants were

Table 1 Agency-by-agency descriptive data

	RIAs in sample	Mean scholarly cites per RIA	% Scholarly cites	Mean age of articles cited (years)
Department of Agriculture	6	3.50	18.58	17.29
Department of Energy	11	0.73	9.41	7.50
Health and Human Services	11	10.91	34.68	4.45
Department of Homeland Security	4	9.25	19.89	12.97
Department of Interior	7	0.43	3.95	2.67
Department of Justice	4	8.75	21.60	15.17
Department of Labor	12	7.00	16.94	6.50
Department of Transportation	15	5.73	18.82	14.95
Environmental Protection Agency	26	32.42	25.95	9.97
General Services Administration	1	1.00	3.85	8.00
Housing and Urban Development	2	7.50	6.52	10.93
Joint Banking Regulators	3	0.00	0.00	NA
Joint EPA/DOT	2	62.50	24.13	10.78

DOT, Department of Transportation; EPA, Environmental Protection Agency; RIA, regulatory impact analysis.

required to read through the entire RIAs – sometimes running to hundreds of pages – to extract the individual citations. The RIAs vary significantly in length and complexity, as well as by the number and type of citations. Scholarly citation counts for the RIAs sampled range from 0 to 258, with a median of two and mean of 13.4. Among the 104 RIAs, there are a total of 1,378 citations of scholarly publications.[5] We consider an article to be a "scholarly publication" if it is in the Web of Science (WoS). This follows much bibliometric work that uses WoS for information on scholarly publications (e.g. Braam 2009; Vieira & Gomes 2011; Leydesdorff *et al*. 2013).

In the empirical analysis that follows, we first provide an overview of the scope, variation, and structure of the data linking RIAs to scientific publications. We then illustrate how these data can be utilized to further understand what predicts the connections that form between research and regulatory policy by examining the relationship between the scientific prominence of academic journals and the attention they receive in RIAs.

4.1. The use of scientific research by agency

The substance of public policy and the context within which policy is created vary widely across the agencies in our sample. As such, we would expect substantial variation in the degree to which published scientific research serves to inform policymaking.[6] We explore differences across agencies in citation patterns to better understand agency behavior and, indirectly, agency research needs. The second column of Table 1 shows the average number of citations of scholarly articles per RIA by agency, with the agencies citing the most scientific research, including joint DOT/EPA regulations, followed by the EPA and the Department of Health and Human Services (HHS) – all averaging more than 10 references to scholarly journal articles per RIA. On the other side of the spectrum, there are several agencies in our sample that average less than one citation to the scholarly literature, and 56 RIAs cite no scholarly journal articles. This finding indicates that that there are likely to be characteristics that vary by agency (e.g. personnel, nature of policy issues, input from interested parties, political environment), that shape the degree to which each agency relies on scientific research in the policymaking process.

The majority of references cited by RIAs do not constitute scientific publications. They include, among other sources, think tank reports, internal governmental reports, other regulations, and newspaper articles. Moreover, there is considerable variation across agencies in terms of the percentage of citations from scientific research.[7] As depicted in column 3 of Table 1, RIAs produced by the HHS, the EPA, and jointly between the DOT and EPA sample most aggressively form the scientific literature in relation to the total number of sources cited. These figures indicate that scientists who want to influence policy through the route of publishing policy-relevant research results have substantial competition. Indeed, the vast majority of references used to inform regulatory policy are not studies published in scholarly outlets. This result indicates that the norm is for published scientific research to be used in conjunction with other sources of expertise in rendering regulatory policy.

Another important dimension to consider regarding the science–policy connection is the time it takes for a study to be incorporated into an RIA. This is critical to developing a sense of how long it takes novel research to be incorporated into policy justifications. Column 4 of Table 1 gives the mean time lag between the publication of a scientific article and the citation of that article in an RIA. Across all agencies, the median time lag between publication and citation is approximately a decade. This lag varies widely across agencies. The HHS tends to cite studies within five years of their publication, whereas the Departments of Agriculture and Justice average over 15 years between the publication of a study and the time it is cited in an RIA. This indicates that researchers doing policy-relevant work may experience a considerable

delay between the publication of results and the incorporation of that research into a policy justification.

4.2. What research informs regulatory policy?

We can learn about the research that matters to regulatory policymakers by examining the disciplines and journals represented by the articles that RIAs cite. The first/top plot in Figure 1 depicts the total citations to subjects, using the WoS categorization of topics. Economic journals are cited more frequently than other subjects identified in the Journal Citation Reports (JCR) of the WoS, although a number of the categories are quite similar content-wise, for example, business and business-finance, or environmental sciences and environmental studies. Regulations are frequently intended to protect the health and safety of the public in a resource-effective manner. Thus, it is common for the benefits of a regulation to take the form of public health outcomes. On the other side of the equation, the costs come in the form of revenues and expenditures – both private and public – required to achieve those outcomes. A preliminary look at the subjects that are most relevant to regulatory policymaking reflects these cost and benefit dimensions, where disciplines, such as economics and business, play a more important role in assessing the costs of a regulation than other disciplines, and those that address health outcomes, such as public health, medicine, and environmental sciences, inform regulators' understanding of benefits more than costs. At the same time, a voluminous economics literature (e.g. Champ *et al.* 2003) addresses valuation of non-market benefits, such as cleaner air or lives saved, which are routinely engaged by regulatory agencies.[8]

We also sought to determine whether some journals stood out as particularly important in RIAs. Among the RIAs sampled, the journals *Environmental Health Perspectives, Epidemiology*, *American Journal of Respiratory and Critical Care Management*, and *Environmental Science and Technology* were the most widely cited. These are depicted in the second/bottom plot in Figure 1. It is clear that some journals receive heavy attention from regulators; those like the ones listed above are cited, on average, in approximately one of every five RIAs in our sample. Journals offer a more fine-grained proxy than discipline for the subject matter covered by the research used in RIAs. The fact that considerable variation in citation rates exists across journals indicates that there are likely distinct characteristics of journals and the research they publish that attracts the attention of regulators. In the next section we take one step in the direction of better understanding this process.

4.3. Do RIAs cite higher impact journals?

In this section we address our main inferential question: Is higher impact research cited more frequently by regulatory policymakers than lower impact research? Researchers have long been concerned that policymakers only utilize the results of scientific research when the results favor pre-existing political biases (Miles 1998). Describing this "political model" of use, Weiss (1979, p. 429) describes how research "becomes ammunition for the side that finds its conclusions congenial and supportive." Though discerning the correlation between political favorability and citation is beyond the scope of this study, we consider whether a preference for the quality of the research is exhibited in RIA citation patterns. In what follows we exploit the variation in attention to scientific journals to examine whether there is a relationship between attention within the scientific community and attention on the part of regulatory policymakers. In short, do policymakers tend to support high impact research? Specifically, we evaluate whether there is a direct relationship between the impact factor of a journal and the frequency with which a journal is cited in RIAs. We would expect that, if regulatory agencies cited more influential

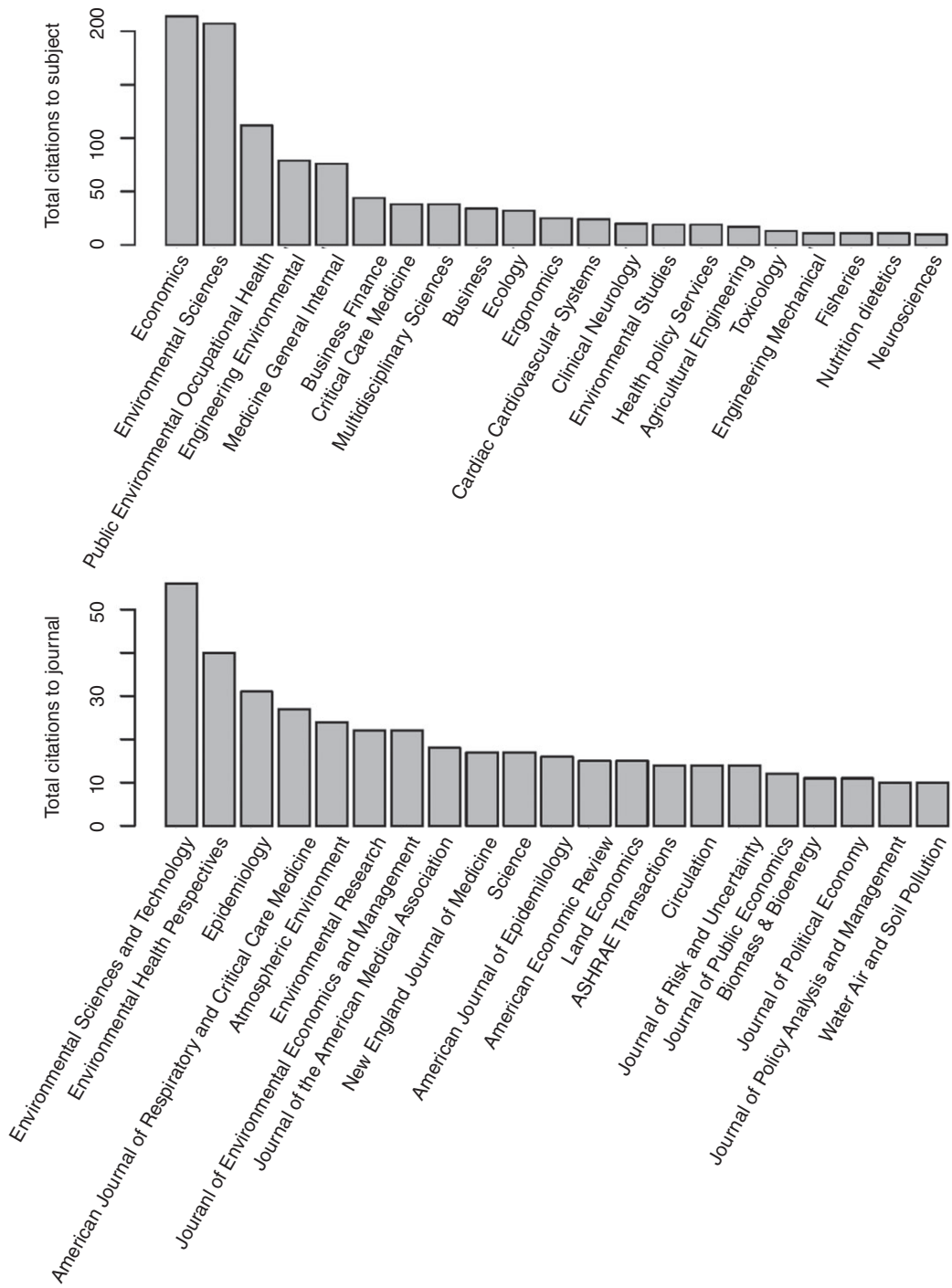

Figure 1 Number of citations to journals and Web of Science (WoS) subjects. The subjects and journals depicted are those in which at least ten articles are cited by in the sample of RIAs.

journals, there would be a positive relationship between the journal's impact factor and the number of times the journal is cited by regulatory agencies.

We study the relationship between attention within the scientific community and attention in RIAs by collecting data on the impact factor for each journal within JCR subject categories that have at least 25 journals cited in our sample of RIAs: economics, environmental sciences, and public health. Because citation patterns vary widely by discipline (Slyder *et al.* 2011), we only compare journals in the same JCR subject category. The impact factors we use measure the average number of citations received per article published in 2007–2011 (i.e. the 2011 five year impact factors).[9] In the 2011 JCRs, there are 322, 206, and 291 journals in economics, environmental sciences, and public health, respectively. We estimate the relationship between the impact factor of a journal and the number of times the journal is cited in our sample using a zero-inflated negative binomial regression (Zeileis *et al.* 2008). The impact factor is incorporated into the model as an independent variable via the base-*e* logarithmic function.[10] This is more theoretically sound than including the raw impact factor because we would expect a linear relationship between the number of citations by scientific papers and the number of citations by RIAs if both were a function of the underlying quality of the papers published in the journal.[11]

Figure 2 shows the predicted number of times a journal is cited based on the journal's impact factor within the three disciplines. The *p*-values of the zero-inflated negative binomial regression coefficients for impact factor in the areas of economics, environmental sciences, and public health are 5.25e-09, 1.02e-06, and 1.39e-06, respectively. As the figure shows, in each subject, there is a strong positive relationship between the journal's impact factor and the predicted number of citations. Journals with higher impact factors are more widely cited by RIAs.

To assure that we can robustly conclude that there is a positive relationship between a journal's impact factor and the frequency of citation in RIAs, we conduct a simple comparison of the journals cited in RIAs versus those that are not within the same three disciplines from our zero-inflated negative binomial analysis. We examine the mean impact factors for journals cited by RIAs and those not cited by RIAs in the same three disciplines. We find that the journals cited by RIAs have much higher impact factors, on average, than those not cited by RIAs, as depicted

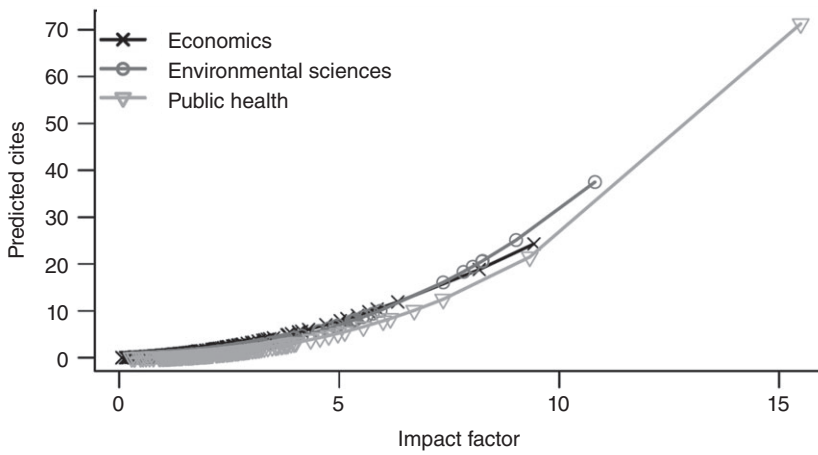

Figure 2 Relationship between journal impact factor and the predicted frequency of citation within regulatory impact analyses (RIAs) by three Web of Science (WoS) subject categories. All estimates are statistically significant at the 0.01 level, two-tailed. Points are placed at observed impact factors of journals in the respective subject areas.

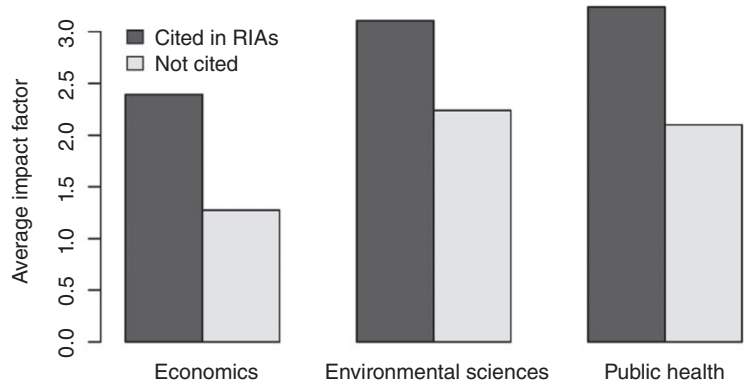

Figure 3 Comparison of the average impact factors of journals cited in regulatory impact analyses (RIAs) and those not cited in RIAs.

in Figure 3. All differences are statistically significant at the 99 + percent level based on Wilcoxon rank-sum tests.[12]

We conduct an additional analysis to evaluate the consistency of our results across agencies. Instead of pooling our sample across agencies and separating by subject area, we pool across the subject areas of economics, environmental sciences, and public health and conduct separate analyses based on the agency producing the RIA. We examine the five agencies that have at least 50 citations of scientific publications across our sample. This analysis will shed light on whether our results are driven by a single outlier agency (e.g. the EPA) or if they are consistent across agencies. We again estimate a zero-inflated negative binomial regression. The unit of analysis is the journal. The dependent variable is the number of times the journal is cited by RIAs produced by the respective agency. The natural log of the journal's impact factor (2011, five-year) is included as the main covariate of interest. We also include indicator variables for the subject area of the journal. The effects of impact factors across the agencies are presented in Figure 4. First, impact factors are positively related to citation rates in each agency. Second, the size of the effect is relatively consistent across agencies. These results indicate that greater attention to higher impact-factor journals is a common feature in the production of RIAs across federal agencies.

These findings are important for the political and scientific legitimacy of regulatory policymaking. Because of long-standing criticisms of "unelected bureaucrats" setting important policy directions, the legitimacy of regulatory policymaking rests only in part on the process by which rules are established, through the Administrative Procedures Act. Unlike traditional law making by elected officials, regulatory legitimacy rests also with the quality of the rules and the public justification for the policy chosen. There are numerous critiques of the quality of RIAs (Hahn & Dudley 2007; Ellig *et al.* 2013), which find them wanting in several ways, though our evidence suggests that regulators are choosing journals recognized as important by scientists over less prominent ones. Thus, while more analysis is needed, it appears that the quality of the science is important to regulators, and that at least some agencies are invoking quality science to support their policymaking.[13]

5. Discussion

This analysis is the first of its kind to collect and document citation use – scientific and otherwise – in RIAs as a measure of research use in policymaking across time and a wide range of policy

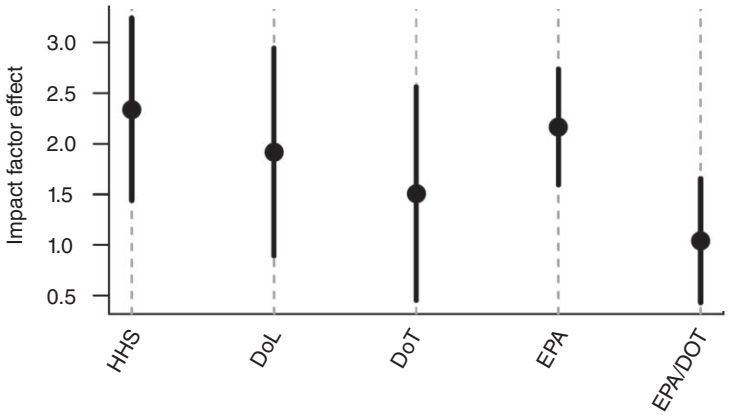

Figure 4 Effect of impact factor on the rate at which journals are cited in regulatory impact analyses (RIAs) across five agencies. Points are placed at the estimates of zero-inflated negative binomial regression coefficients. Bars span 95 percent confidence intervals. There are 562 journals in each sample. DoL, Department of Labor; DOT, Department of Transportation; EPA, Environmental Protection Agency; HHS, Health and Human Services.

issues. We present several preliminary findings and outline a number of important directions for future research.

The first finding is that a broad range of agencies – from the EPA to Housing and Urban Development to Transportation – choose to make substantial use of scientific research in justifying new regulations across a wide range of issue areas, though there are no formal requirements to do so. The mean number of scientific citations is 13.4, and 57.9 total citations, per RIA. The fact that RIAs regularly cite scientific research indicates that, at many agencies, research plays an important role in justifying public policy. There is significant variation in citations across agencies, which naturally leads to questions about the nature of the agencies, and the terms of public persuasion and debate that account for such variation. Some agencies, particularly the HHS and the US EPA, cite copiously, while others rarely cite the scientific literature. Further research is required to explain why agencies vary so considerably in their citation patterns, as it could be a product of their external political environment, the background and training of agency staff, priorities of upper administrators, or any number of other factors.

The question of *why* regulators cite scientific literature in RIAs is beyond the scope of this article, though there is some reason to believe the rationale may not be merely window dressing. First, not all regulatory agencies do cite scientific literature copiously, so it is not a political imperative that affects all agencies. Second, the nature of regulatory agencies suggests that in this arena research may find greater policy traction. Regulatory agencies are established to perform tasks ill-suited to Congress, whether because Congress lacks the expertise or because it would rather punish transgressions than set specific policies. Elected officials frequently have strong preferences for greater or lesser environmental protection, for example, though they are less likely to have strong a priori views about whether 0.07 parts per million or 0.08 parts per million is the appropriate standard for ozone concentrations. Elected officials always hold the potential to pass legislation for more specific requirements. Thus, in areas where agencies make specific, technical determinations where Congress has chosen not to intervene, scientific research may have greater impact. Finally, regulatory agencies are often under intense scrutiny from interest groups; citing spurious scientific material in an attempt to present a patina of credibility would be quickly discovered and publicly exposed.

There is significant variation across disciplines and journals in terms of the frequency of citation in RIAs. In citations, regulators focus most heavily on economics, public health, and related disciplines. Within disciplines, there is a strong positive relationship between a journal's impact factor and its citation frequency in RIAs. Thus, evidence suggests that the scholarly assessment of research quality is associated with its use as justification for public policy. This suggests that agencies are not simply or randomly collecting research findings, but are seeking more scientifically credible sources to justify their regulations. Additional research is needed to determine if regulators are utilizing the best possible research in justifying regulatory decisions.

Further research is necessary to model the complex interactions involving multiple parties in regulatory policymaking (e.g. regulators, funding agencies, the scientific community, think tanks, congressional committees), though we believe these data hold considerable promise in understanding how and why science is used by federal regulators, the nature of the research community that provides input to federal policymakers, and the nature of agencies that use science in reaching policy decisions. In addition, these are time series data crossing multiple agencies and policy domains, so the conclusions we draw can be generalized widely and over time, particularly when we augment these data with citation patterns back to 1981. Yet our initial findings – that many regulators cite scientific research, that they cite high impact research, and that considerable variation exists across agencies – point both to the fact that good science matters in policymaking and that further research is required to better understand the science–policy connections.

Acknowledgment

We would like to thank Russell Pandres for his excellent research assistance. All mistakes are our own.

Notes

1 The journal, *Knowledge: Creation, Diffusion, Utilization*, started in 1979, but ceased publication and was replaced by *Science Communication*.
2 The first of these was President Reagan's Executive Order 12291 in 1981, though many others have followed, most recently President Obama's EO 13563 in 2011.
3 Economically significant regulations are those that are determined by the OIRA to impose a cost to the US economy of at least $100 million annually, or to otherwise adversely affect the economy. The OIRA also designates rules as "significant" by including several other criteria. Thus, economically significant regulations are a subset of significant regulations. For further explanation, see http://www.reginfo.gov. There are four RIAs proposed toward the end of 2012 that did not make it into our dataset. We have no reason to suspect that this omission has influenced the conclusions we draw.
4 The Mercatus center can be accessed at http://mercatus.org/. There is no central repository for RIAs, and we are in the process of collecting RIAs back to 1981, when the first Executive Order required their preparation, through Freedom of Information Act (FOIA) requests to individual agencies.
5 Employing a liberal definition of what constitutes a citation (e.g. other laws and regulations), this represents approximately 23 percent of the 5,960 total citations in the 104 RIAs.
6 Scientific research is identified here as research published in a journal listed in the WoS. All future references to citations are scientific journal citations, unless otherwise noted.
7 We do not, in this paper, seek to explain the variation in number or type of citations across agencies, though we plan to address this in subsequent work. We are currently developing a coding protocol to accurately and meaningfully classify non-scholarly citations.

8 We note the relative paucity of journal citations from political science, public administration, and public policy journals. We speculate this involves their general treatment of public policy more as a dependent variable, something to be explained, as opposed to other natural and social science disciplines (e.g. economics, medicine) that study the impact of various policy interventions on social or economic outcomes. The latter is likely to be of far greater interest to regulators and policymakers more generally.

9 We realize that this creates a potential disconnect between when an article cited by an RIA is published and when the impact factor of the journal in which the article is published is assessed in our data. However, varying the year in which the impact factor is measured based on the publication year of articles cited would not be amenable to the simple cross-journal comparisons we draw in this analysis. The unit of analysis is a journal, with one observation for each journal in a discipline. An alternative approach would be a time-series cross-sectional (i.e. panel) design with journal-year observations. Our data are too sparse to perform such an analysis, as some disciplines would have no journals cited in several years. Extension of our database back in time would make a panel design more feasible.

10 Our conclusions are robust to the use of the more common two-year impact factor. We use the five-year impact factor to assure that the years covered by the impact factors include most of the years in which the RIAs were produced, rather than just 2010 and 2011.

11 We used the R-package pscl to estimate the negative binomial regressions and assess the confidence intervals around predicted values.

12 We use the Wilcoxon rank-sum test, rather than the *t*-test, because the impact factor distributions are highly skewed.

13 We checked a random sample of 20 citations to determine whether the RIA citation was spurious or connected with the substance of the RIA. In all instances, the substance of the citation was related to the RIA material. Further analysis is required to determine whether regulators are citing the best possible science in support of their substantive findings.

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