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ABSTRACT

This paper reviews the use of nonmarket valuation in environmental policy at the U.S. Environmental Protection Agency (EPA). We examine trends in the nonmarket valuation literature over the last four and a half decades, and compare those trends to an assessment of how often nonmarket benefits are monetized and which methods are used in 49 recent EPA Regulatory Impact Analyses. Considering shortcomings in the application of nonmarket valuation in policy, we review EPA awarded research grants and their focus. We conclude that the nonmarket valuation literature continues to grow but that many nonmarket benefits continue to go unquantified and unmonetized in policy analysis. The use of nonmarket value estimates is generally limited to a small and dated body of work, but it appears that research grants are targeted to help fill some gaps.

INTRODUCTION

Benefit–cost analysis is the practical application of welfare economics, the study of the well-being of individuals. An important consideration for policymakers who must make environmental and resource allocation decisions is whether, and the extent to which, the benefits of the policy exceed their costs, i.e. whether they pass the benefit-cost test. In 1981, President Reagan's Executive Order 12291 mandated that to the extent permitted by law, federal regulations pass such a test. Subsequent executive orders amended the process that continues today, including Executive Order 12866, signed by President Clinton in 1993, which modified some of the original language, including a key change that benefits "justify" costs rather than necessarily "outweigh" them.

The changes in language still allow for efficiency enhancing policies, while reducing the burden of sometimes overly costly, and perhaps even infeasible, economic studies. All impacts are still required to be evaluated, but may be done qualitatively, and thus still inform policy decisions. Unfortunately, the absence of fully monetized benefits and costs, even if presented as some other form of quantitative or qualitative information, can lead to suboptimal policy decisions. There is a constant tradeoff between increased analytical burden to obtain more and better information and the resulting efficiency gains.

After almost 40 years of mandated benefit-cost analysis at the federal level, it may be difficult to understand how game-changing Reagan's executive order was for the economics profession. Reagan's motivation at the time was deregulatory, the notion being that many government regulations would not pass the benefit-cost test. Over time, however, as methods for estimating benefits and costs improved, a large number of federal regulations were estimated to yield positive net benefits.

This new regulatory process created a demand shock for economic analysis. For environmental regulation, however, it presented some unique challenges, much of which can be understood through Kerry Smith's edited volume "Environmental Policy under Reagan's Executive Order" (1984a) and Al McGartland's "Thirty Years of Economics at the Environmental Protection Agency" (2013). These publications provide a tour through the minds of benefit-cost analysts at the time, and raise many issues, some of which remain open and hotly debated. A key concern in the early years was the lack of existing benefit estimates that satisfied a rigorous set of guidelines to map current research to policy options. Smith (1984b) noted the need for "off-the-shelf" benefit estimates, what has since become known as benefit transfer.

The aforementioned challenges are reflected in early EPA Regulatory Impact Analyses (RIA), the technical document that contains, among other analyses, the benefit-cost analysis for a proposed regulation. For example, Grubb, Whittington, and Humphries (1984) found that only one of the first three EPA RIAs quantified and monetized environmental benefits. Morgenstern (1997) found that of twelve EPA RIAs between 1983 and 1995, benefits were not monetized in half of them and benefit transfer was used for the other half. Hahn and Dudley (2007) found that only about half of the 74 EPA RIAs published between 1982 and 1999 provided monetary estimates of benefits. Even in recent years, Fraas and Lutter (2011) show that challenges persist; they find that eleven of fourteen EPA RIAs published between 2005 and 2008 provide estimates in a single time period rather than for a stream of benefits and costs, as recommended by guidelines (EPA 2014; OMB 2003). Agencies face significant time and resource constraints when conducting regulatory analyses. Nevertheless, underlying many of the challenges of estimating benefits associated with environmental regulation are the methods.

Estimation of environmental benefits relies heavily on nonmarket valuation (NMV) methods. As its name implies, NMV is an approach for estimating the willingness to pay (WTP) of goods and services not traded in markets.[1] The 1983 predecessor to EPA's *Guidelines on Preparing Economic Analyses* (2014) acknowledged that WTP is the appropriate conceptual measure of benefits but recognized the lack of necessary data to implement the approach in many cases (Fisher 1984).

[1] NMV methods are generally classified into two main branches: revealed preference (RP) and stated preference (SP). RP methods work by exploiting information contained in market behavior that is very closely related to the nonmarket good or service of interest, whereas SP methods work by asking current and potential consumers directly about their preferences for such goods or services. RP methods include the travel cost (TC) and hedonic methods, and SP methods include contingent valuation (CV) and choice experiment (CE) methods.

A vast literature on the theory and application of NMV methods has developed over the years, but there is little documentation as to the extent that these methods and the progress made on them has found its way into federal environmental regulation. Atkinson et al. (2018) and Baker and Ruting (2014) summarize the role of valuation work in environmental policy for the U.K. and Australia, respectively, and Griffiths et al. (2012) and Wheeler (2015) have contributed to this topic for the U.S. Both Griffiths et al. and Wheeler, however, focused on surface water regulations, and the latter focused specifically on the application of benefit-transfer.

This study provides an updated and more comprehensive review of the use of NMV in federal environmental policy decisions at the U.S. Environmental Protection Agency (EPA). First, we examine trends in NMV studies and methods in the literature over the last three decades. Second, focusing on the Regulatory Impact Analyses (RIA) for all "major" regulations issued by the EPA over the last 12 years, we examine the extent to which different nonmarket values are identified, quantified, and monetized; and assess what NMV methods are most often used.[2] Third, we compare how shortcomings in the application of NMV in RIAs align with research grants awarded by the Agency.

The goal is to demonstrate for policymakers and researchers alike, where future efforts should be invested to improve the application of NMV, and thus better inform environmental policy. We believe that better identifying areas to improve the science of NMV is particularly relevant at this point in time. EPA under the Trump Administration has made an effort to reduce environmental benefits by, for example, narrowing the social cost of carbon to exclude global benefits in CAFE standards (Bento et al. 2018), ignoring co-benefits in the Mercury Rule (Aldy

[2] Executive Order 12866 specifies that an assessment be conducted for any "major" regulatory action, which is defined as those having "an annual effect on the economy of $100 million or more or adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, local, or tribal governments or communities."

et al. 2020), and taking previously monetized aquatic ecosystem benefits and instead discussing them only in qualitative terms (Boyle, Kotchen and Smith 2017). Identifying and prioritizing where NMV is most needed to monetize the benefits of environmental regulations will help yield the most welfare-enhancing outcomes. We conclude that the body of academic NMV literature grows apace; but the role of NMV in the policy process is limited to a very small, and generally dated, body of work. When quantification is possible, mortality and morbidity benefits are generally monetized, but the underlying estimates are outdated. Remaining benefits, such as recreational and ecological/ vegetative benefits, are quantified and monetized only rarely. In most cases, they receive only a qualitative discussion. Of the NMV methods used in EPA's RIAs, we find fairly frequent use of stated preference and hedonic wage methods, primarily to obtain mortality estimates via the value of a statistical life (VSL), but very limited use of travel cost. We find that proxy methods, such as cost-of-illness, avoided cost, and lost wages are used more often than not, particularly for morbidity benefits. We also find increased use of benefit-transfer, primarily in the form of integrated assessment models such as BenMAP (explained later) and the application of unit value estimates of the social cost of greenhouse gases (SC-GHG). In more limited cases, benefit transfer appears via the use of meta-analysis.

In cases where benefits are either not quantified at all or where monetized benefits are based on dated methods and/or estimates, the reasons appear many and varied, but we conclude that the two most likely reasons are that 1) biophysical data and models providing a defensible causal and quantified link between pollutants and their effects on human welfare are lacking, thereby precluding a significant amount of economic valuation that could have taken place, and 2) many regulatory analyses are conducted under significant time and resource constraints that

preclude application of alternative -- perhaps newer and more robust -- methods or estimates. Both issues were raised over 35 years ago by Smith (1984b).

ANALYSIS

NMV Article Counts in the Literature

Our first task is to estimate how much NMV literature is being produced by the research community, which particular NMV methods are being applied and refined, and to which topics are they being applied. This represents an update of Adamowicz's (2004) survey of the NMV literature. We counted the number of peer-reviewed journal articles published in the economics literature between 1974 and 2019 that feature nonmarket valuation methods. We did this using keyword searches in *EconLit*, the American Economic Association's comprehensive index of the world's economics literature (2020). *EconLit* indexes over 1,000 journals from 74 countries, and includes over one million articles, most of which are in English or have English summaries. Journals are selected for inclusion in *EconLit* on the basis of their peer-reviewed economic content, which must be substantial or of equal emphasis in interdisciplinary journals (AEA 2020).

We first conduct the following seven distinct keyword searches to identify as much of the NMV literature as possible: 1) "contingent valuation", 2) "choice experiment" or "conjoint analysis", 3) "WTP" or "willingness to pay" or "WTA" or "willingness to accept", 4) "travel cost" or "site choice" or "recreational demand", 5) "hedonic", 6) "VSL" or "value of a statistical life" or "mortality risk" or "VPF" or "value of a prevented fatality", and 7) "morbidity". For each of these searches, we apply the filters "Source Type: Academic Journals" and "Language: English". These searches are current as of January 7, 2020. Note that this approach captures any

article including one or more of the above keywords, meaning articles that use or merely reference NMV. We then import the results into Stata, remove duplicates, and apply a variety of keyword searches to classify articles by NMV method (see Stata code in Appendix). We categorize articles as either stated preferences (SP) or revealed preferences (RP). We then further characterize studies under the following subcategories: SP subcategories were contingent valuation (CVM) and choice experiment (CE), and RP subcategories were hedonic pricing and travel cost/site-choice/random-utility. A fifth subcategory was "Other WTP", which served as a residual catch-all for any articles for which we were not able to identify the particular subcategory method.[3]

The top panel of Figure 1 contains the annual counts of NMV studies published in the literature. A linear trend regression analysis for the sum of the nonmarket valuation articles indicates that these are increasing at a rate of 19 per year ($R^2 = 0.93$, n=30), although studentized residuals and Cook's D statistic suggest that 2019 is an outlier. This is likely due to an indexing lag. Omitting 2019, the number of articles is increasing at a rate of 21 per year ($R^2 = 0.97$, n=29). A quadratic model does not improve fit.

The number of CVM articles published has been fairly steady, in the range of 40-80 studies each year, with relatively higher numbers during the 2000-09 period, and lower numbers in recent years. Fitting the data with a quadratic trend regression ($R^2 = 0.80$, n=30), the number of CVM articles peaked in 2007. Studentized residuals and Cook's D statistic does not suggest any outliers, indicating that the continued decrease in 2019 is part of a longer trend. The number of CE articles was relatively small until circa 2005, but has since tripled from around 50 in 2005 to around 150 in 2018. The number of CE articles has been increasing at a rate of 5 per year (R^2

[3] Some studies feature multiple methods, and are allowed to fall under multiple subcategories. Such cases comprise only 5 percent of the sample.

= 0.91, n=30). The Cook's D statistic suggests that 2019 is an outlier, but omitting it does not improve model fit. Summing the CVM and CE article counts reveals that stated preference (SP) articles have been increasing at a rate of 6 per year (R^2 = 0.93, n=30). Omitting 2019, as suggested by the studentized residuals and Cook's D statistic, indicates that SP studies are increasing at a rate of 7 per year (R^2 = 0.93, n=29). A quadratic model does not improve fit. This indicates that the number of SP articles is increasing, with CE articles replacing CVM articles in popularity.

The number of "other WTP" articles has also grown to around 150 per year. This number in 2019 is a bit lower, again likely due to an indexing lag. The studentized residuals and Cook's D statistic again indicate 2019 is an outlier. Omitting 2019, the number of WTP articles has been increasing at a rate of 5 per year (R^2 = 0.95, n=29). The number of hedonics articles has grown steadily since 1990, to around 150 per year (a rate of increase of 7 studies per year (R^2 = 0.93)). The number of travel cost/site choice/random utility articles has remained fairly small and steady, at around 15 to 30 per year. Omitting 2019 as an outlier, the number of TCM articles has been increasing at a rate of less than 1 per year (R^2 = 0.70, n=29).

We also categorized articles by topic using a wide variety of keyword searches (see Stata code in Appendix). Articles covering multiple topics were allowed to count toward multiple topic categories, and comprise 35 percent of the sample. The two largest topics to which NMV methods are applied are health and environment/natural resources, followed by "other", agriculture/food, transportation, and recreational/fisheries. These counts can be found in Figure A1 in the Appendix.

Regulatory Impact Analyses

We next review all 55 major rules issued by the US Environmental Protection Agency between fiscal years 2008 and 2019, as reported in the annual reports to Congress on the benefits and costs of federal regulations.[4] Six of the rules, all dealing with the Renewable Fuels Volume Standards, did not have RIAs. The full set of rules reviewed, along with summary information and our coding values, are provided in Table A1 of the Appendix.[5,]

We assessed each RIA for specific benefit categories, use of NMV methods and/or estimates, and for the reasons given as to why specific nonmarket benefits were not fully monetized. We organized benefits into the following categories: reduced mortality, reduced morbidity, recreational benefits, ecological/vegetative benefits ("ecological" for short), improved visibility, and reduced property damage. These categories are based on the nonmarket benefit categories defined in EPA (2014), but modified slightly for our own purposes. We identified a total of 192 NMV studies published between 1974 and 2019 that are used directly or indirectly (e.g., via meta-analysis or BenMAP) in our set of RIAs (see Table A2 in the Appendix for a compilation).

Figure 2 reports the counts of specific benefit categories that are quantified and monetized, discussed qualitatively, or not mentioned at all across the 49 RIAs examined. This tabulation is based primarily on the upfront summary tables, which, per EPA's Economic Guidelines (2014), should summarize all benefits, including those that are only qualitatively

[4] Unless unavailable, we rely on the final rule RIAs. For the Light Duty Vehicle GHG rule (2060-AP58), we looked only at EPA's RIA accompanying the joint EPA-NHTSA rulemaking. The annual reports to Congress are prepared by OMB's Office of Information and Regulatory Affairs. The set of major EPA regulations are identified in Table A-1 in the appendix of each annual *Report to Congress on the Benefits and Costs of Federal Regulations and Unfunded Mandates on State, Local, and Tribal Entities* (2009-2014), and the annual *Report to Congress on the Benefits and Costs of Federal Regulations and Agency Compliance with the Unfunded Mandates Reform Act* (2015-2020). One additional rule (2060-AP58) was identified in Table 1-5(a) in the 2011 annual report.

[5] We acknowledge that our analysis excludes smaller EPA rules and other agency rules whose use of NMV methods and estimates may differ from what we present here. Future research should explore these additional analyses for their use of NMV.

identified, or possibly quantified but not monetized. Although it is possible for a benefit category to be quantified but not monetized, we found only a few such instances, and rolled these observations into the "discussed qualitatively" category. An important caveat in this finding is that we count an RIA as quantifying and monetizing a benefit category if it was able to do so for *at least one* endpoint in that category. In many cases, however, there were additional intermediate outcomes and endpoints in that same category that could not be quantified and/or monetized. For example, the RIA for the NESHAP and NSPS for the Portland Cement Manufacturing Industry (2060-AO15) monetized mortality and morbidity benefits due to reductions in PM2.5. These benefit categories are coded as being monetized in our review. However, the rule also quantified reductions in other pollutants affecting health (e.g., mercury), but did not monetize the resulting benefits. Figure 3 reports the number of RIAs that used each NMV method either directly or indirectly. Because of the strong overlap between benefit categories and the methods used to monetize them, our discussion will move back and forth between Figures 2 and 3.

Benefits due to reduced morbidity are among the most common monetized benefits resulting from environmental regulations issued by the EPA. As Figure 2 shows, one or more reduced morbidity benefit endpoints are quantified and monetized in 34 out of the 49 RIAs. In many of these cases, however, there were other reduced morbidity endpoints that could not be quantified and/or monetized. Only 9 RIAs included solely qualitative assessments of reduced morbidity. EPA utilizes multiple methods to estimate reduced morbidity benefits. We identified a total of 10 NMV studies published between 1979 and 2002, all CVM, used at various times to estimate morbidity benefits (see Appendix). These studies are used to cover a variety of symptoms and illnesses not requiring hospitalization. Later RIAs do not estimate some of these

benefits, citing that the EPA "no longer had sufficient confidence to retain [chronic bronchitis] in [the] primary benefits estimate" (Revisions to the NAAQS-PM rule, 2060-AO47).

For the remaining reduced morbidity benefits, EPA uses COI, avoided cost, and lost wages estimates. These endpoints include hospital admissions, emergency room visits for asthma, and non-fatal heart attacks (EPA 2018b; Smith et al. 1997; Stanford, McLaughlin, and Okamoto 1999; Cropper and Krupnick 1990; Russell et al. 1998; Wittels, Hay, and Gotto 1990). Estimates for reduced work loss days and school loss days are estimated using county-specific median wages and median full-time weekly wage among women 25 and older in 2015 (EPA 2018a). As Figure 3 shows, reduced morbidity benefits were estimated using these WTP-proxy methods 34 times, 8 times directly, and 26 times via BenMAP.

Developed in 2003, the EPA's Environmental Benefits Mapping and Analysis Program (BenMAP) is a tool used for analyzing the human health and welfare impacts of rules that improve air quality (EPA 2018a), such as the National Ambient Air Quality Standards for Particulate Matter (EPA 2006a, EPA 2012) and Ozone (EPA 2008, EPA 2015). BenMAP uses air-quality data to estimate health endpoints from exposure to fine particulate matter ($PM_{2.5}$) and ground level ozone using concentration-response functions. These endpoints are then multiplied by economic valuation unit values to produce a benefit estimate (EPA 2018a). Within BenMAP, the EPA's Value of a Statistical Life estimate (discussed below) is used to value the reduced incidence of premature mortality, which tend to make up over 90 percent of the monetized benefits.[6] For morbidity endpoints, BenMAP relies on the estimates discussed above. As shown in Figure 3, BenMAP is overwhelmingly the most commonly applied benefits estimation tool,

[6] For example, see the Reviews of the National Ambient Air Quality Standards for Ozone and Particulate Matter RIAs (2060-AP38 and 2060-AO47, respectively).

being used in 29 of the 49 RIAs examined, to provide monetized estimates for mortality and morbidity endpoints.

Benefits due to reduced mortality are monetized nearly as frequently as reduced morbidity and represent the largest benefits resulting from environmental regulations issued by the EPA. Although there have been other approaches used to value mortality risk reductions (e.g., human capital approach), the most accepted approach is to apply estimates of people's willingness to pay for changes in the risk of premature death, often summarized in terms of the Value of a Statistical Life (VSL).

Reduced mortality benefits are quantified and monetized in 32 of 49 RIAs. More specifically, these 32 RIAs were able to monetize changes in mortality risks through at least one mechanism or illness. In several of these cases there were other expected mortality risk reductions due to other related pollutants (not of primary interest) or due to other illnesses, but the resources or current scientific evidence was not sufficient for quantification and/or monetization. In fact, in 10 of the 41 RIAs where mortality impacts were expected, the analyses could only support a qualitative discussion of reduced mortality benefits.

When monetization is possible, EPA generally relies on a single central-estimate of the VSL based on a distribution fit to a set of 26 estimates obtained from 18 hedonic wage studies published between 1974 and 1991, and 5 CVM studies published between 1985 and 1991 (EPA 2014). This represents the only use of hedonic methods in the 49 RIAs reviewed. Thus, the 32 instances where mortality benefits were quantified and monetized correspond to the 32 cases shown in Figure 3 where the VSL was used either directly (3 times) or via BenMAP (29 times). As per SAB guidance, this set of primary VSL studies has remained fixed since the original 2000

publication of EPA's *Guidelines for Preparing Economic Analysis*, but EPA does adjust for inflation and anticipated increases in future income (EPA 2014).

The third-most frequently monetized benefit category is "climate" (18 out of 31 RIAs). Although climate impacts are really a bundle of benefit categories, we maintain it as a separate category because both the RIAs and the underlying models also bundle these benefit categories together.[7] Interestingly, we did not find instances where climate impacts were *only* qualitatively included in the RIAs. In other words, in all cases where climate impacts were identified, at least one of those impacts was monetized. But not all climate-related benefits were monetized in these cases, and often there was accompanying text that discussed other climate benefits purely in qualitative terms. Perhaps the presence of previously accepted off-the-shelf estimates facilitated monetization of at least some climate benefits. At the same time, there could be cases where an RIA only included a qualitative discussion of climate-related benefits in terms of the individual unbundled benefit categories.

When climate impacts were quantified and monetized, EPA relied on estimates of the social cost of greenhouse gasses (SC-GHG). These are unit value estimates of the social damages caused by an additional ton of the corresponding GHG being emitted into the atmosphere. The IWG's SC-CO_2 is estimated by averaging the distributions from each of three different Integrated Assessment Models (IAMs) – DICE, FUND, and PAGE (IWG on Social Cost of Carbon 2010).[8] More recent RIAs include estimates of the social cost of methane and nitrous oxide developed by Marten et al. (2015). Thus, the 18 instances where climate benefits

[7] For example, according to the IWG (2016a) "[the social cost of carbon] is intended to include (but is not limited to) changes in net agricultural productivity, human health, property damages from increased flood risk, and the value of ecosystem services due to climate change." (p. 3). RIAs that rely on these social cost estimates also include in the description changes in energy system costs, such as reduced costs for heating and increased costs for air conditioning.

[8] The IWG was disbanded in 2017 and the SC-GHGs used in RIAs have been revised since then.

were quantified and monetized correspond to the 18 cases shown in Figure 3 where one or more SC-GHG estimates were applied.

We combine the discussion of recreational and ecological benefits because we found that five out of the six RIAs that quantified and monetized these benefits relied on estimates that implicitly included, or at least could be interpreted as including, both benefit types. Five of the RIAs that Figure 2 reports as quantified and monetized for recreation and ecological benefits are in fact based on the same estimates, applied to the same quantified endpoints. The remaining RIA used separate estimates for recreational and ecological benefits. Although six RIAs were able to quantify and monetize some recreational and ecological benefits, in many cases there were still ecological endpoints that could not be monetized and were merely qualitatively discussed. In fact, as shown in Figure 2, in 27 of the 49 RIAs all recreational benefits were accounted for solely in qualitative terms, and in 35 RIAs all ecological benefits were accounted for only qualitatively.

All ecological benefit estimates were based on SP studies, primarily CVM studies, and to a lesser extent, CE studies. In one case the benefit estimates from a primary SP study were transferred directly to an RIA.[9] Otherwise, ecological benefit estimates applied in RIAs have relied on meta-analyses of the SP literature. For example, in the Steam Electric rule (2040-AF14) RIA a meta-analysis by Richardson and Loomis (2009) of 31 CVM studies (published between 1985 and 2005) was used to value threatened, endangered, and rare species. The 2015 Clean Water rule (2040-AF30) relied on 10 CVM studies published between 1986 and 2000 to estimate the benefits of preserved wetlands. The subsequent 2019 Waters of the US

[9] Estimates from Johnston et al.'s (2012) CE study were applied to aquatic ecosystem improvements and households in the North and Mid-Atlantic regions in order to partially estimate the non-use benefits of the 2014 Cooling Water Intake rule (2040-AE95).

Recodification rule (2040-AF74) estimated wetland benefits based on a meta-analysis of 11 of the 17 studies (published between 1991 and 2013) originally included in Moeltner et al.'s (2019) meta-analysis.

To value projected improvements in water quality, a series of RIAs relied on variants of a meta-analysis that was first developed for the Construction and Development rule (EPA 2009).[10] For example, projected benefits resulting from the 2011 Florida Lakes rule (2040-AF11) were monetized using a variant of the aforementioned meta-analysis based on 45 CVM and CE studies published between 1981 and 2008. That same meta-analysis was later updated to include 51 studies published between 1985 and 2013, and applied to the 2015 Steam Electric rule (2040-AF14) and 2015 Coal Ash Residuals rule (2050-AE81).

Despite its long-standing history in the NMV literature, the travel cost method was applied in just one instance across the 49 RIAs reviewed. The 2014 Cooling Water Intake rule (2040-AE95) takes its recreational fishing benefit values from the meta-analysis conducted as part of the 2006 Existing Facilities rule (EPA 2006b). This meta-analysis included 48 recreational fishing valuation studies, of which 27 were travel cost studies published between 1982 and 2004, 19 were CVM studies published between 1987 and 2003, and 2 were CE studies published in 1999 and 2002.

Five rules included monetization of improved visibility in some areas, all relying on Chestnut and Rowe's (1990) CVM study.[11] Their estimates were generated specifically under a grant from the EPA to estimate household WTP for protection of visibility at national parks from

[10] The Construction and Development Rule was not considered a major rule by OMB, and thus did not appear in any of the *Reports to Congress* and is excluded from the set of rules considered here.

[11] This included two 2008 emissions control rules for engines (2060-AM06, 2060-AM34), the 2008 National Ambient Air Quality Standards (NAAQS) for Ozone rule (2060-AN24), the 2011 Cross State Air Pollution rule (2060-AP50), and the 2012 National Emissions Standards for Hazardous Pollutants rule (2060-AP52).

air pollution impacts. These RIAs account for 5 of the 13 RIAs shown in Figure 3 as using SP estimates directly. Twenty-five other RIAs presented visibility impacts only in qualitative terms.

Our property damage category is limited to real property, and excludes damages such as market impacts on agriculture, commercial fisheries, and forestry. As Figure 2 reports, we found no RIAs that quantified and monetized property damages directly. We found, however, that 19 RIAs discussed property damage qualitatively. As noted above, additional property damages are embedded within the climate benefits.

EPA Grant Counts

Our third task is to estimate how much and what kind of NMV work is being generated via EPA's research grants programs. Our rationale is that EPA knows what knowledge gaps exist in the regulatory process as it pertains to NMV, and that, to the extent feasible, EPA will direct funds to research most likely to fill those gaps. It is important to note that research grants usually target a topic or methodological advancement of broader interest, and are not necessarily awarded with a particular regulation in mind. Therefore, funding allocation decisions within the grants program reflect longer-term priorities. RIAs are often more directly supported by internal research or external contracts. In this sense, our focus here on the research grants program provides only a partial picture of the Agency's investment into NMV research. Additionally, the EPA's Office of Research and Development, National Center for Environmental Economics, and various program offices often conduct original research studies that are not reflected in this

analysis.[12] Nonetheless, this analysis of the research grants program provides some idea of what the historical and current NMV knowledge gaps are.

We counted the number of EPA grants issued between 1995 and 2019 that feature NMV using the EPA's Grantee Research Project database (EPA 2020). The database contains 7,418 grant entries (based on the reported number of abstracts) stemming from 447 requests for proposals. We searched for the same keywords described above for *EconLit,* with two additions. Unlike *EconLit,* this database spans multiple disciplines, so we also searched for "economics" and "valuation", to aid in the identification of grants with at least some economics and/or valuation component. For the same reason, we also utilized the "Grantee Research Project Results Fielded Search" to identify all grants categorized under the "Economics and Decision Sciences" research category.[13] Both searches were conducted over the database's text contained on grant abstract detail, progress report, final report, and publication pages. Search results are current as of January 6, 2020. Results were imported into Stata, duplicates were removed, and additional keyword searches were used on grant titles, RFA titles, and program categories to further categorize grants by research topic and to identify economics and/or valuation activity (see Stata code in Appendix for details).

Our search resulted in a total of 609 grants between 1995 and 2019 that satisfied our search criteria of including some economics and/or valuation component. Figure 4 contains the grant counts by NMV method over year and research topic. The total number of economics-focused grants, both NMV and non-NMV, have trended downward over time, but we find that

[12] For example, see the National Center for Environmental Economics working paper series (https://www.epa.gov/environmental-economics/research-environmental-economics-ncee-working-paper-series).

[13] When conducing this search, we utilized the "This exact phrase" search option of the "Grantee Research Project Results Advanced Search", checking the "Research Centers", "Fellowships", "Grants", and "Small Business Innovation Research" categories.

this is due to a general downward trend in overall grant funding by EPA. The share of funding for economics-based grants appears to have remained fairly stable (see Appendix Figure A2). Of the 609 grants identified, 323 (53 percent) are categorized as economics grants that do not feature NMV. Of those featuring NMV, the largest category is the catch-all WTP category, containing grants that involve some kind of valuation but the specific method could not be immediately identified. The next largest categories are stated preference methods (CVM and CE), then revealed preference methods (travel cost and hedonics).

We categorized all 609 grants under one of six research topic categories: climate, ecological, energy/sustainability, health, waste, and "other", which includes all those not falling under any of the aforementioned categories. We find that the largest number of economics-based grants go towards ecological-focused activities (29%), followed by health (22%), "other" (18%), energy/sustainability (17%), waste (8%), and climate (6%).

DISCUSSION & CONCLUSION

In our sample of RIAs, NMV studies are most frequently applied through meta-analyses and integrated assessment models that have already undergone government review by the SAB and OMB, as well as through formal public comment, as part of previous rulemakings. Despite the common perception that stated preference (SP) studies are under-utilized in informing policy due to potential hypothetical bias, strategic responses, sample selection, and other concerns (Haab et al. 2013), we find SP is the most frequently applied NMV methodology. As shown in Figure 3, 36 of the 49 RIAs applied SP-based estimates to monetize at least one benefit endpoint. In 13 cases, a SP study or meta-analysis of SP studies was used directly, and in 23 cases, entered in the form of EPA's VSL estimate via BenMAP.

The middle panel of Figure 1 reports the counts of NMV studies used in the 49 RIAs reviewed. The bulk of these studies were published between 1985 and 2004, in contrast to the general trend in the literature (shown in the top panel) where most NMV studies have been published after 2000. The counts of studies shown in the middle panel, however, are somewhat misleading because it does not depict the frequency of use. The bottom panel of Figure 1 reports the frequency in which a NMV study is applied across the RIAs reviewed. The picture here emphasizes the lag between the NMV studies being applied in policy and the NMV studies being published in the literature. The bulk of NMV studies informing policy were published prior to 1992. Most of the studies published more recently were used infrequently (so far), usually being applied just once. As Table A2 in the Appendix shows, 32 studies published between 1974 and 2002 were each used 29 times or more, all pertaining to mortality and morbidity endpoints. Three climate studies published between 2010 and 2015 were used for monetization in RIAs between 3 and 9 times. The remaining 157 studies were used 5 times or less, with 98 of those studies being applied only once. Comparing our findings to Adamowicz (2004), we find that not much has changed during the 16 intervening years: he concluded that "there is not as much use of environmental valuation in policy analysis as could be expected given the academic efforts on this topic" (p. 419).

In addition to a temporal disconnect between the literature and policy applications, we find a disconnect between what methods are being applied in the NMV literature and the methodologies of studies being used to inform policy. The NMV literature is dominated by hedonic property value and stated preference studies. There has been steady growth in studies using revealed preference methods (hedonics and travel cost), a decline in use of CVM, and

rapid growth in CEs. However, CE studies, and research using hedonic property value and travel cost methods have been seldom used in environmental policy analysis.

While we have also found a significant number of RIAs where the benefits are not monetized, the number with monetized benefits is increasing over time. Comparing the sample of 12 RIAs from Morgenstern (1997) conducted from 1983 to 1995 to our sample of 49 RIAs conducted from 2009 to 2019, the proportion with monetized benefits has increased from 50% to 80%. While the share with monetized benefits has increased, the primary studies used to develop those estimates are dated relative to the research frontier. The prime example is the VSL estimate used by the EPA. More recent VSL work is often cited in the RIAs, such as Mrozek and Taylor (2002) and Viscusi and Aldy (2003), and an updated set of studies has been suggested (EPA 2014), but the original set of studies is still what is used for the main analyses in RIAs.[14] In EPA's *Guidelines* as well as in several RIAs, EPA provides the following or similar statement:

> *Until updated guidance is available, the Agency determined that a single, peer-reviewed estimate applied consistently best reflects the SAB-EEAC advice received to date. Therefore, the VSL described above that was vetted and endorsed by the SAB should be applied in relevant analyses while the Agency continues its efforts to update its guidance on this issue* (p. B-3, EPA 2014).

Given the disconnects between the NMV literature and its use in policy, we examined how EPA research grants are being allocated. We find that the EPA funds a large number of economics-based research grants, many of which featured NMV methods, and that, while overall research funding is in decline, the economics share has remained fairly stable. The VSL studies

[14] See Cropper, Hammitt, and Robinson (2011) and Viscusi (2018) for summaries of more recent VSL studies.

used to monetize mortality benefits in regulatory analyses are dated, and morbidity benefits are most often estimated using the theoretically inferior COI and lost wage approaches. EPA may be attempting to bridge this gap, given that health is the second-most funded grant topic.

Non-health impacts are usually not quantified or monetized in the regulatory analyses, which we attribute at least partly to the lack of established causal links for quantification. This burden falls partly on the modelling capabilities in the health and natural sciences, but also on NMV researchers. Carson and Hanemann (2005) point out that a key reason for the lack of use of SP studies in the policy process, for example, is that the estimates obtained in many studies are not directly tied to the relevant policy changes being considered by decision makers. This stems from a lack of "awareness among policymakers and many economists that the choice of the characteristics of the market constructed in the survey can, and generally does, influence the nature of the economic valuation estimates obtained. In this sense, the flexibility of contingent valuation is both a blessing and a curse in that, unless adequate attention is paid, it is possible to obtain estimates that are not directly tied to the relevant policy changes being considered by decision makers" (p. 825).

We find that ecological endpoints are often policy-relevant (as indicated by the 34 RIAs in which they are qualitatively discussed), but infrequently monetized (only 6 such cases out of the 49 RIAs). EPA's grants program may be trying to bridge this gap, at least indirectly, by funding ecological-focused grants. However, to ensure the resulting studies are useful in informing policy, efforts must again be made to align explicitly the ecological endpoints that are being valued with the modelling and quantification capabilities in the natural sciences.

Unfortunately, we see recreational, visibility, and property benefits monetized only infrequently, and we find no evidence of EPA directing external research funding in these

directions. We recognize that, as a proportion of the total benefits at stake, these categories may represent only a small fraction. Whether EPA funding should be directed towards these areas in the future depends on the anticipated influence of such benefit estimates on policy decisions.

Freeman (1984) speculated on the value of original, policy specific research vs. off-the-shelf estimates. One tentative conclusion was that off-the-shelf estimates were appropriate if there is little chance that they would change the sign of the net benefit calculation. In other words, the cost of a primary valuation study is only justified if the net benefits of the primary study are positive. The EPA's approach to benefit estimation has been to use what was called off-the-shelf estimates in 1984 but is now known as benefit transfer. A special issue in the journal *Environmental and Resource Economics* (Smith 2018) that arose from an EPA-funded benefit transfer workshop and development of the BenSplash model (Corona et al. forthcoming) – an IAM and benefits tool to value water quality improvements – suggests that this is still the EPA's preferred approach. This is also supported by the data, given that unit value estimates of EPA's VSL, the IWG's SC-GHGs, various meta-analyses, and BenMAP, are applied frequently in regulatory analysis.

The field of environmental economics, and non-market valuation specifically, rose to what it is today thanks to President Reagan's Executive Order 12291 in 1981. Now almost 40 years later, in moving our field forward and designing socially efficient environmental policies, it is important to further bridge gaps between the nonmarket valuation literature and policy.

In this paper we reviewed the trends in nonmarket valuation research, the use of nonmarket valuation research in RIAs conducted by the EPA, and EPA research grant funding priorities. We sought to address several issues raised by a number of economists about the future of the regulatory development process after Reagan's Executive Order 12991 (Smith 1984a).

We conclude that some progress has been made but, considering the optimism at the time, it is somewhat surprising that almost four decades later, so many of the issues raised are still unresolved. There are many obstacles that remain in connecting research, and the research community, to the needs of policy and policy analysts.

ACKNOWLEDGMENTS

We wish to thank Glenn Blomquist, Cathy Kling, and Elizabeth Kopits for reviewing an earlier version of the manuscript and providing comments that greatly improved it. We also thank participants at the 2020 W-4133 USDA Multistate Meeting in Athens, GA and audience members at the AERE-sponsored "Advances and Perspectives in Nonmarket Valuation" session at the 2019 Southern Economic Association Annual Meeting in Fort Lauderdale, FL who also provided very useful comments.

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Figure 1. Annual Counts of NMV Studies Published in the Literature (top), of NMV Studies Used in 2008-2019 EPA RIAs (middle), and of Individual Appearances of the NMV Studies used in 2008-2019 EPA RIAs (bottom).

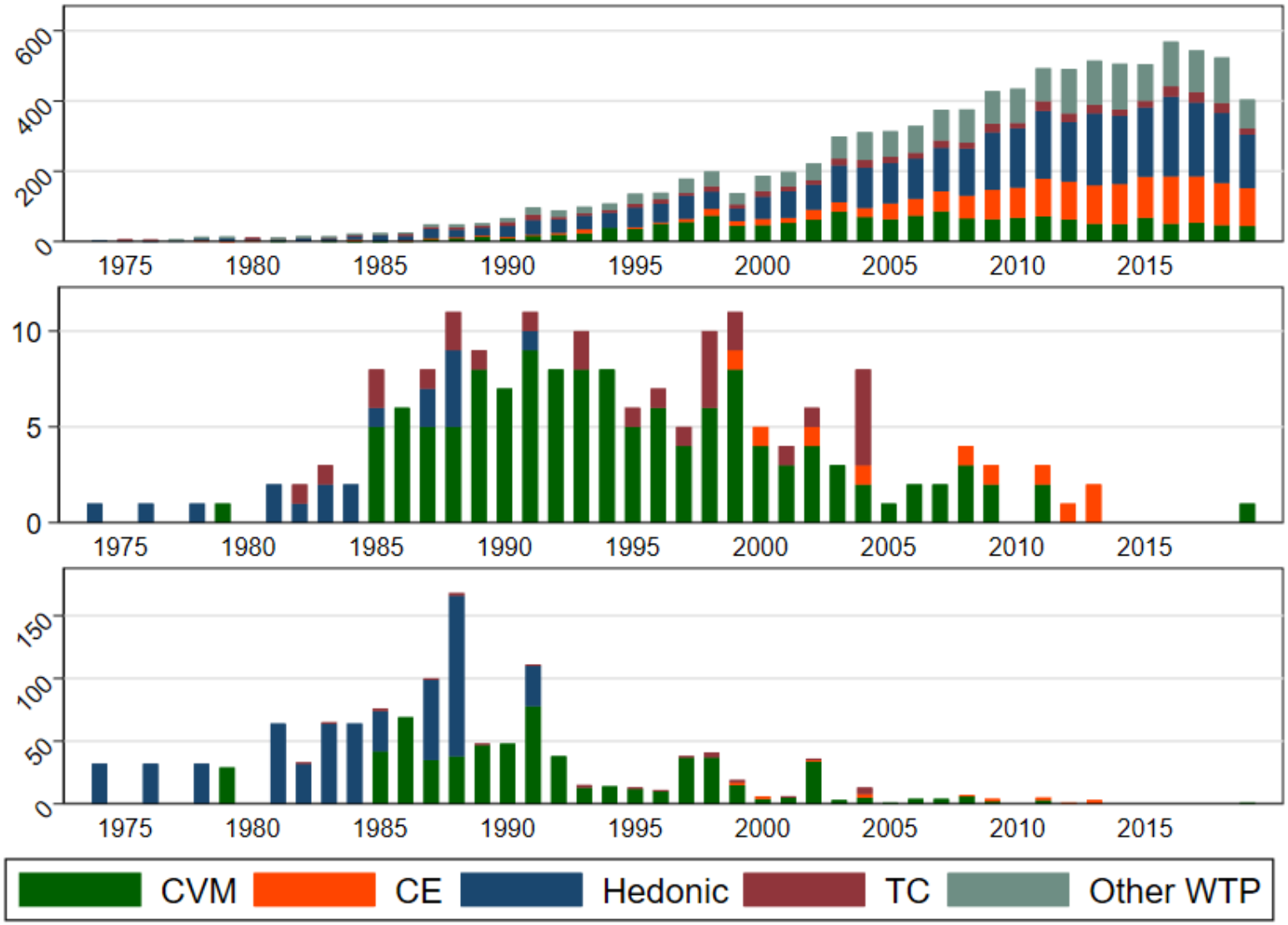


Figure 2. Counts of RIAs that contain at least one monetized benefit endpoint in each category, that only include qualitative discussion of benefit endpoints in each category, and that do not mention a benefit category at all.

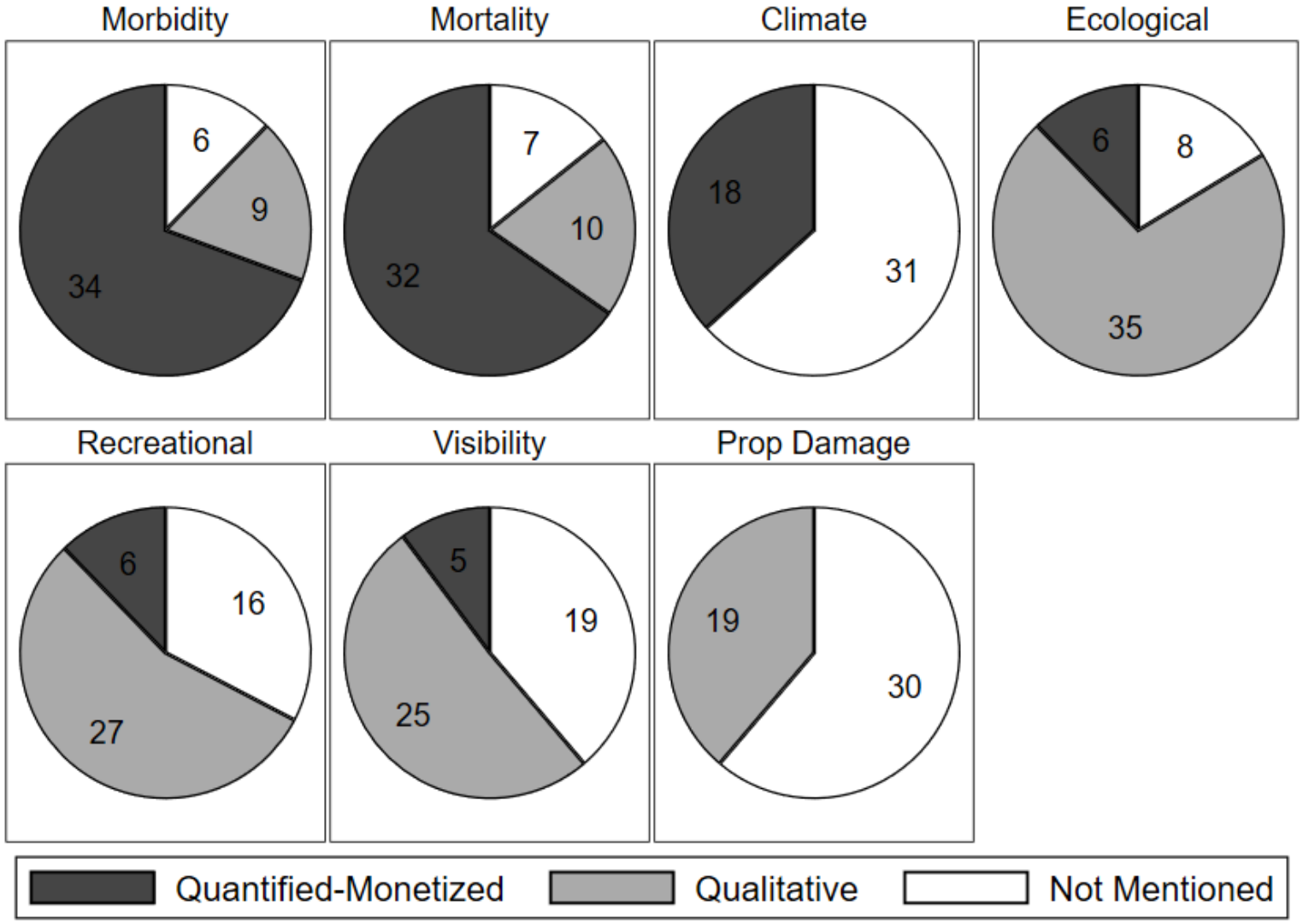


Figure 3. Counts of if and how each method or model was used to monetize at least one benefit endpoint in RIAs.

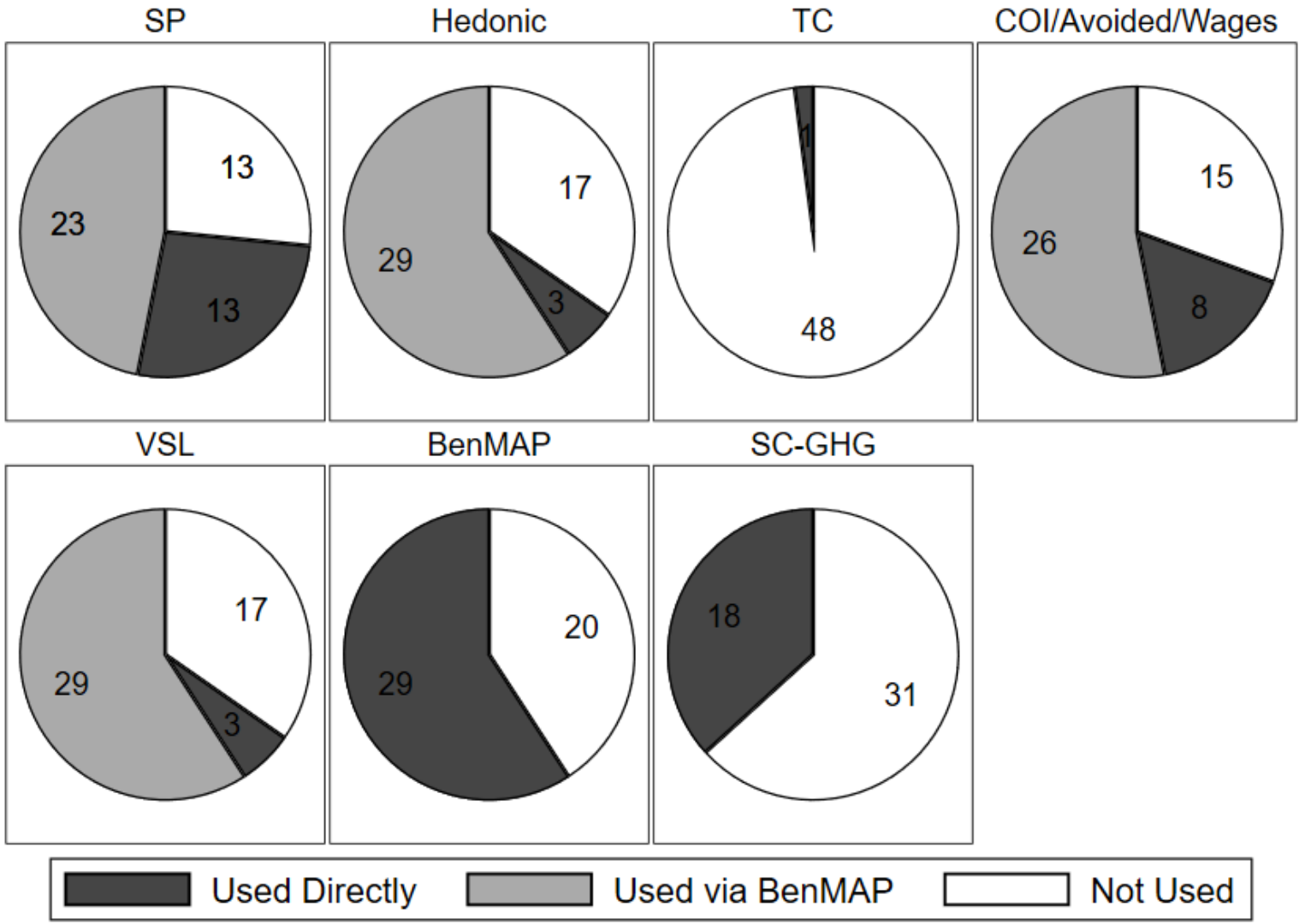
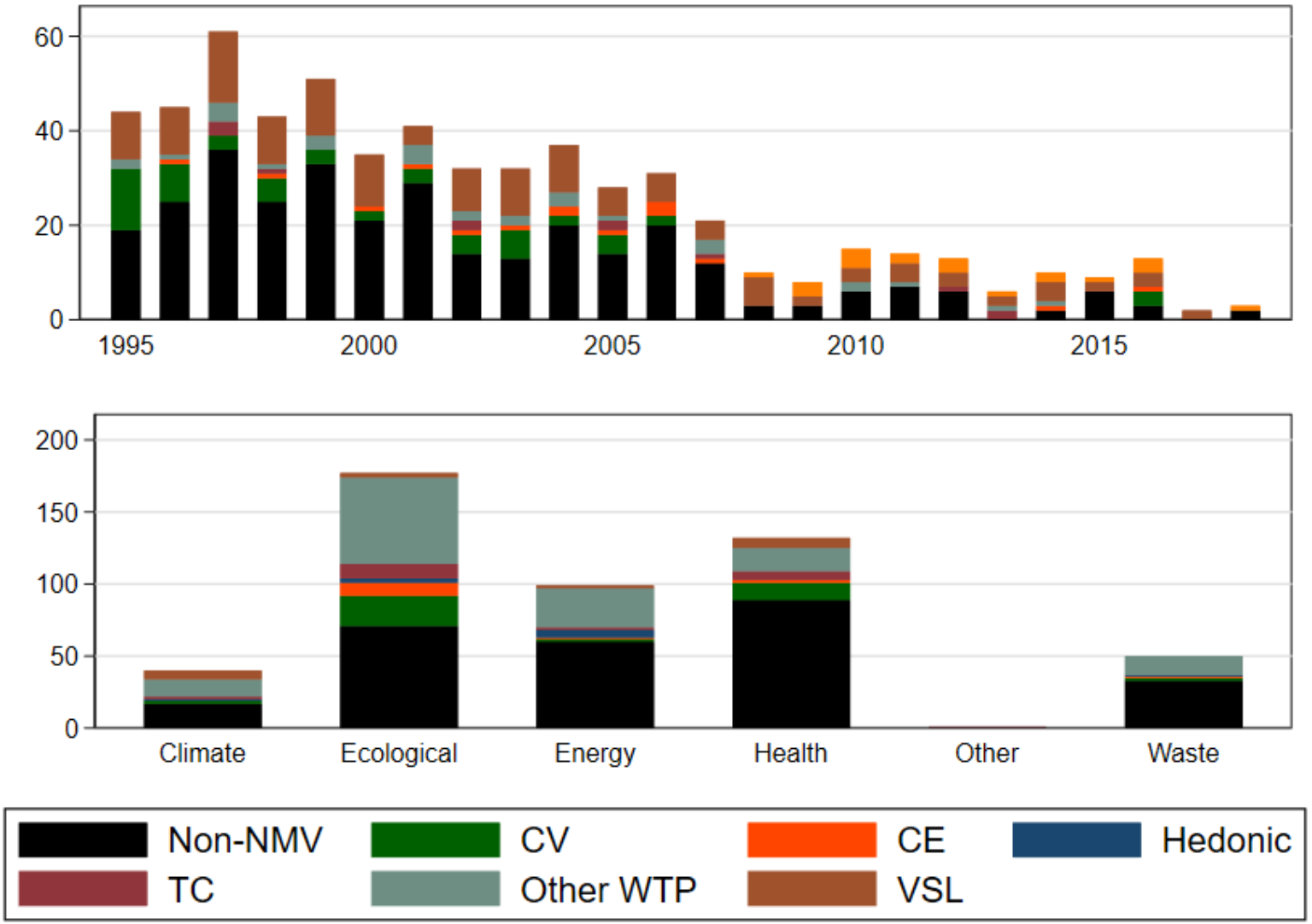


Figure 4. Counts of EPA grants by NMV Method over Year and Research Topic.



APPENDIX

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Figure A1. Counts of NMV Studies Published by Topic.

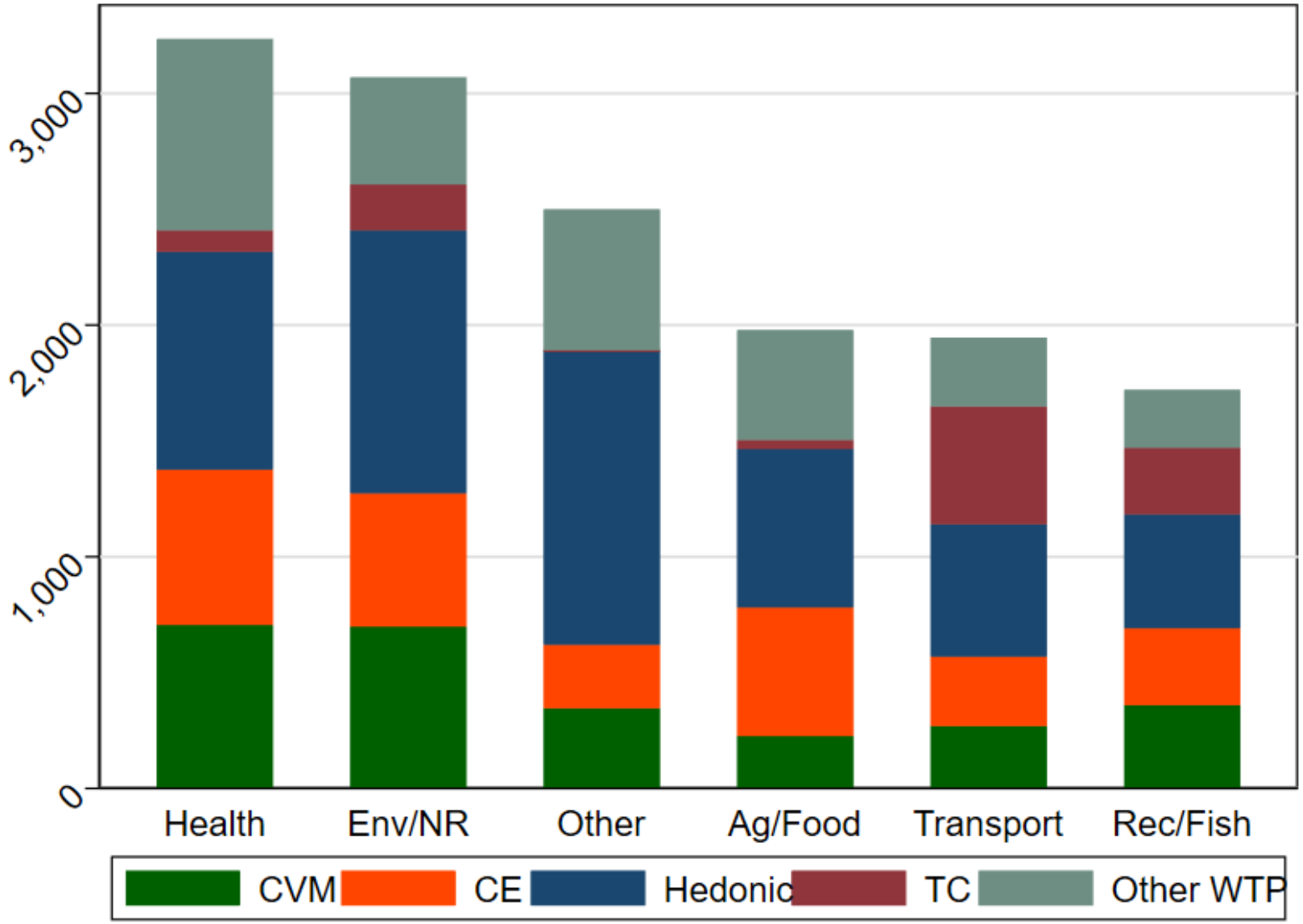

Figure A2. Total EPA Grant Funding and Economics-Based Share of Funding by year.

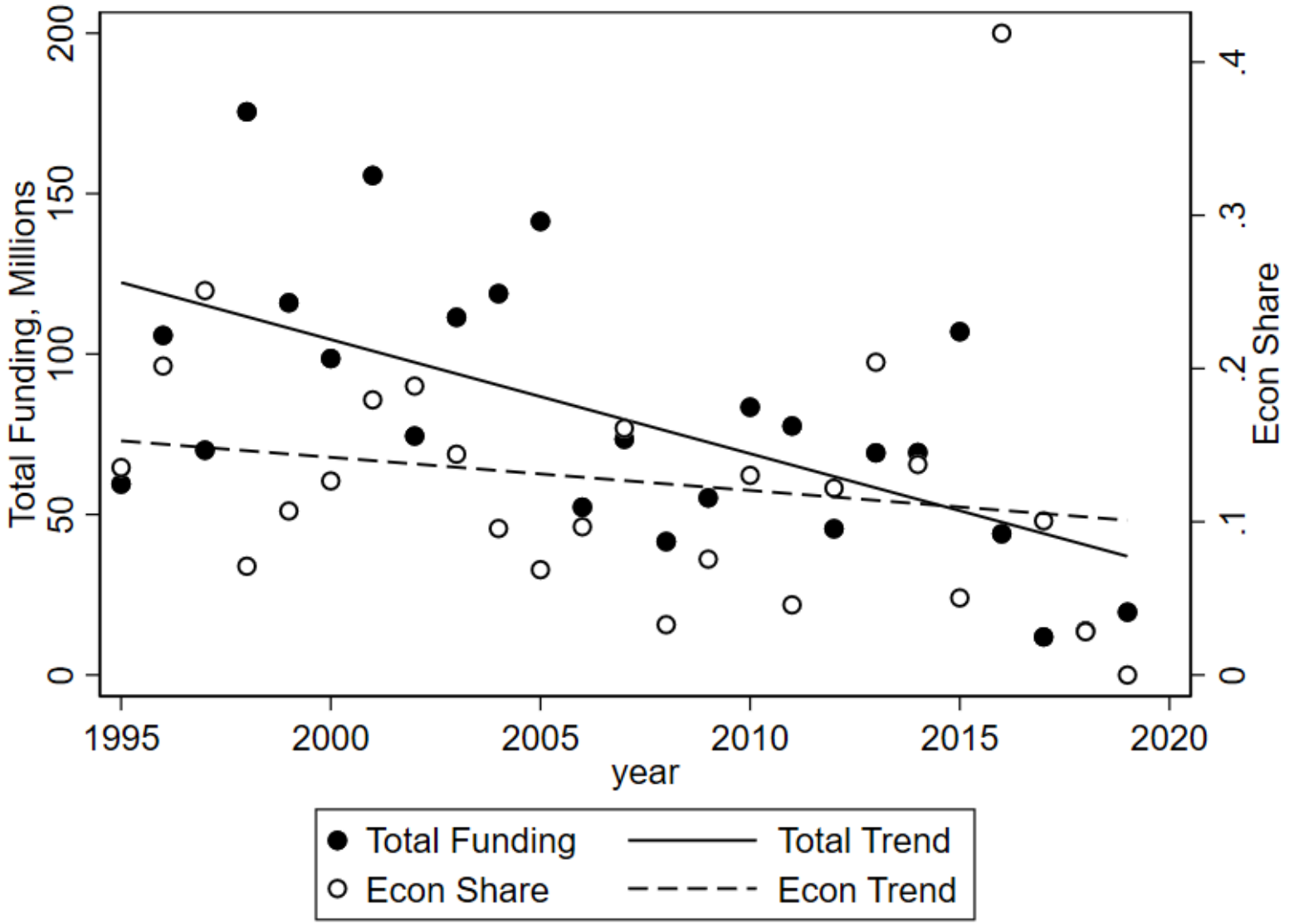

Table A1. Summary of rules reviewed, including coding values.

RIN	FY	Rule_Title
2050-AG31	2008	Definition of Solid Waste Revisions
2060-AM06	2008	Control of Emissions from New Locomotives and New Marine Diesel Engines Less than 30 Liters per Cylinder
2060-AM34	2008	Control of Emissions from Nonroad Spark-Ignition Engines and Equipment
2060-AN24	2008	Review of the National Ambient Air Quality Standards for Ozone
2060-AN72	2008	Petrolueum Refineries - New Source Perfromance Standards (NSPS) - Subpart J
2070-AC83	2008	Lead-Based Paint; Amendments for Renovation, Repair, and Painting
2060-AN83	2009	Review of the National Ambient Air Quality Standards for Lead
2060-AO79	2009	Greenhouse Gas Mandatory Reporting Rule
2050-AG16	2010	Revisions to the Spill Prevention, Control, and Countermeasure (SPCC) Rule [74 FR 58784]
2060-AO15	2010	National Emission Standards for Hazardous Air Pollutants from the Portland Cement Manufacturing Industry and Standards of Performance for Portland Cement Plants [75 FR 54970]
2060-AO38	2010	Control of Emissions From New Marine Compression-Ignition Engines at or Above 30 Liters per Cylinder [75 FR 22897]
2060-AO48	2010	Review of the National Ambient Air Quality Standards for Sulfur Dioxide [75 FR 35519]
2060-AO81	2010	Renewable Fuels Standard Program [75 FR 14670]
2060-AP36	2010	National Emission Standards for Hazardous Air Pollutants for Reciprocating Internal Combustion Engines (Diesel) [75 FR 9647]
2060-AP58; 2127-AK50	2010	Light-Duty Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards
2060-AP86	2010	Prevention of Significant Deterioration/Title V Greenhouse Gas Tailoring Rule [75 FR 31514]
2060-AQ13	2010	National Emission Standards for Hazardous Air Pollutants for Reciprocating Internal Combustion Engines -- Existing Stationary Spark Ignition (Gas-Fired) [75 FR
2070-AJ55	2010	Lead; Amendment to the Opt-out and Recordkeeping Provisions in the Renovation, Repair, and Painting Program [75 FR 24802]
2040-AF11	2011	Water Quality Standards (Numeric Nutrient Criteria) for Florida's Lakes and Flower Waters
2050-AG50	2011	Oil Pollution Prevention; Spill Prevention, Control, and Countermeasure Rule Requirements - Amendments for Milk Containers
2060-AP50	2011	Cross State Air Pollution Rule (CAIR Replacement Rule)
2060-AP61; 2127-AK74	2011	Commercial Medium- and Heavy-Duty On-Highway Vehicles and Work Truck Fuel Efficiency Standards
2060-AN72	2012	Petroleum Refineries New Source Performance Standards (NSPS) - Subparts J and Ja
2060-AP52	2012	National Emission Standards for Hazardous Air Pollutants From Coal- and Oil-Fired Electric Utility Steam Generating Units and Standards of Performance for Electric Utility Steam Generating Units
2060-AP76	2012	Oil and Natural Gas Sector - New Source Performance Standards and National Emissions Standards for Hazardous Air Pollutants
2060-AQ54	2012	Joint Rulemaking to Establish 2017 and Later Model Year Light DuteyVehicle GHG Emissions and CAFÉ Standards
2060-AO47	2013	Review of the National Ambient Air Quality Standards for Particulate Matter
2060-AQ58	2013	Reconsideration of the Final National Emission Standards for Hazardous Air Pollutants for Reciprocating Internal Combustion Engines
2060-AR13	2013	National Emission Standards for Hazardous Air Pollutants for Major Sources: Industrial, Commercial, and Institutional Boilers and Process Heaters; Proposed Reconsideration
2040-AE95	2014	Criteria & Standards for Cooling Water Intake Structures
2060-AQ86	2014	Control of Air Pollution From Motor Vehicles: Tier 3 Motor Vehicle Emission and Fuel Standards

Table A1. Summary of rules reviewed, including coding values.

RIN	FY	Rule_Title
2040-AF14	2015	Effluent Limitations Guidelines and Standards for the Steam Electric Power Generating Point Source Category
2040-AF30	2015	Clean Water Rule Definition of "Waters of the United States"
2050-AE81	2015	Standards for the Management of Coal Combustion Residuals Generated by Commercial Electric Power Producers
2050-AG46	2015	Revising Underground Storage Tank Regulations - Revisions to Existing Requirements and New Requirements for Secondary Containment and Operator Training
2060-AP38	2015	Review of the National Ambient Air Quality Standards for Ozone
2060-AP69	2015	NESHAP for Brick and Structural Clay Products Manufacturing and NESHAP for Clay Cermaics Manufacturing
2060-AP93	2015	Standards of Performance for the New Residential Wood Heaters and New Residential Hydronic Heaters and Forced-Air Furnaces
2060-AQ75	2015	Petroleum Refinery Sector Risk and Technology Review and New Source Performance Standards
2060-AR33	2015	Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units
2060-AS05	2016	Cross-State Air Pollution Rule Update for the 2008 Ozone NAAQS
2060-AS16; 2127-AL52	2016	Greenhouse Gas Emissions and Fuel Efficiency Standards for Medium- and Heavy- Duty Engines and Vehicles - Phase 2
2060-AS23; 2060-AM08	2016	Emissions Guidelines and Compliance Times for Municipal Solid Waste Landfills NSPS; Standards for Municipal Solid Waste Landfills
2060-AS30	2016	Oil and Natural Gas Sector: Emissions Standards for New and Modified Sources
2070-AJ44	2016	Formaldehyde; Third-Party Certification Framework for the Formaldehyde Standards for Composite Wood Products
2050-AG82	2017	Accidental Release Prevention Requirements: Risk Management Programs under the Clean Air Act
2040-AF74	2019	Definition of "Waters of the United States" - Recodification of Preexisting Rule
2060-AT67	2019	Emission Guidelines for Greenhouse Gas Emissions From Existing Electric Utility Generating Units; Revisions to Emission Guideline Implementing Regulations; Revisions to New Source Review Program
2070-AJ82	2019	Review of Dust-Lead Hazard Standards and the Definition of Lead-Based Paint
2060-AR55	2012	Regulation of Fuels and Fuel Additives: 2013 Biomass-Based Diesel Renewable Fuel Volume
2060-AR76	2015	Renewable Fuel 2014 Volume Standards
2060-AS22	2016	Renewable Fuel Volume Standards 2014-2016
2060-AT93	2019	Renewable Fuel Volume Standards for 2019 and Biomass-Based Diesel (BBD)Volume for 2020
2060-AT04	2018	Renewable Fuel Volume Standards for 2018 and Biomass Based Diesel Volume (BBD) for 2019
2060-AS72	2017	Renewable Fuel Volume Standards for 2017 and Biomass Based Diesel Volume (BBD) for 2018

Table A1. Summary of rules reviewed, including coding values.

RIN	Benefits ($M, 2001$)	Costs ($M, 2001$)	Rule_identified_in
2050-AG31	$16-285	$14	2009 Report to Congress, Table A-1
2060-AM06	$4,150-14,550	$295-392	2009 Report to Congress, Table A-1
2060-AM34	$900-4,760	$196-200	2009 Report to Congress, Table A-1
2060-AN24	$1,580-14,900	$6,680-7,730	2009 Report to Congress, Table A-1
2060-AN72	$176-1,670	$27	2009 Report to Congress, Table A-1
2070-AC83	$657-1,611	$383-417	2009 Report to Congress, Table A-1
2060-AN83	$455-5,203	$113-2,241	2010 Report to Congress, Table A-1
2060-AO79		$64-86	2010 Report to Congress, Table A-1
2050-AG16	$78-85 (cost savings)	$0	2011 Report to Congress, Table A-1
2060-AO15	$6.1B-16.3B	$0.8B-0.9B	2011 Report to Congress, Table A-1
2060-AO38			2011 Report to Congress, Table A-1
2060-AO48	$2.9B-38.6B	$0.3B-2.0B	2011 Report to Congress, Table A-1
2060-AO81			2011 Report to Congress, Table A-1
2060-AP36	$709-1,920	$296-311	2011 Report to Congress, Table A-1
2060-AP58; 2127-AK50	$3.9-18.2	$1.7-4.7	2011 Report to Congress, Table 1-5(a)
2060-AP86			2011 Report to Congress, Table A-1
2060-AQ13	$380-992	$202-209	2011 Report to Congress, Table A-1
2070-AJ55	$785-2,953	$267-290	2011 Report to Congress, Table A-1
2040-AF11	$23	$111-169	2012 Report to Congress, Table A-1
2050-AG50	$121 (cost savings)	$0	2012 Report to Congress, Table A-1
2060-AP50	$20,467-59,697	$691	2012 Report to Congress, Table A-1
2060-AP61; 2127-AK74	$2,150-2,564	$331-496	2012 Report to Congress, Table A-1
2060-AN72	$369-668	$84	2013 Report to Congress, Table A-1
2060-AP52	$28,185-76,868	$8,199	2013 Report to Congress, Table A-1
2060-AP76	$155	$142	2013 Report to Congress, Table A-1
2060-AQ54	$21,220-28,822	$5,305-8,828	2013 Report to Congress, Table A-1
2060-AO47	$2,979.5-7,531.5	$43.9-289.7	2014 Report to Congress, Table A-1
2060-AQ58	$616.6-1696.7	$404	2014 Report to Congress, Table A-1
2060-AR13	$21,102.7-56,555.3	$1,181.8-1,350.6	2014 Report to Congress, Table A-1
2040-AE95	$23.5-26.8	$222.9-241.0	2015 Report to Congress, Table A-1
2060-AQ86	$3,199-$10,638	1,063	2015 Report to Congress, Table A-1

Table A1. Summary of rules reviewed, including coding values.

RIN	Benefits ($M, 2001$)	Costs ($M, 2001$)	Rule_identified_in
2040-AF14	$303.1-443.3	$369.1-375.6	2016 Report to Congress, Table A-1
2040-AF30	$261.2-441.0	$122.1-358.3	2016 Report to Congress, Table A-1
2050-AE81	$181.7-$226.4	$398.7-$575.7	2016 Report to Congress, Table A-1
2050-AG46	$246.80	$127.40	2016 Report to Congress, Table A-1
2060-AP38	$1,159.3-2,723.9	$559	2016 Report to Congress, Table A-1
2060-AP69	$60.8-154	$23	2016 Report to Congress, Table A-1
2060-AP93	$2,428.1-5,952.8	$31.3-36.0	2016 Report to Congress, Table A-1
2060-AQ75			2016 Report to Congress, Table A-1
2060-AR33	$12,737.6-22,094.0	$2,480.0-2,641.6	2016 Report to Congress, Table A-1
2060-AS05	$418-710	$58	2017 Report to Congress, Table A-1
2060-AS16; 2127-AL52	$6,674.1-9,747.6	$845.8-1,124.7	2017 Report to Congress, Table A-1
2060-AS23; 2060-AM08	$422.1-446.1	$73.5-75.7	2017 Report to Congress, Table A-1
2060-AS30	$381.7-$420.6	$317.2-$343.4	2017 Report to Congress, Table A-1
2070-AJ44	$19.5-139.5	$28.5-62.2	2017 Report to Congress, Table A-1
2050-AG82		$103.68	2018-19-20 Report to Congress, Table A-1
2040-AF74	$43.7-126.0	$26.88-57.30	2018-19-20 Report to Congress, Table A-1
2060-AT67	$173.45-656.11	$105.80	2018-19-20 Report to Congress, Table A-1
2070-AJ82	$42.93-1,729.87	$23.69-86.60	2018-19-20 Report to Congress, Table A-1
2060-AR55			2013 Report to Congress, Table A-1
2060-AR76			2016 Report to Congress, Table A-1
2060-AS22	not estimated	$285.3M (Range:	2017 Report to Congress, Table A-1
2060-AT93		$190M-$630M	2018-19-20 Report to Congress, Table A-1
2060-AT04		$8M-$24M	2018-19-20 Report to Congress, Table A-1
2060-AS72		$686M-$1550M	2018-19-20 Report to Congress, Table A-1

Table A1. Summary of rules reviewed, including coding values.

RIN	Mortality	Morbidity	Recreation	Ecol_Veg	Visibility	Property	BenMAP	SCCO2_CH4	VSL	SP	TCM	HPM	HedWage
2050-AG31	1	1	0	1	0	0	0	0	0	0	0	0	0
2060-AM06	3	3/1	1	1	3/1	0	1	0	0	1	0	0	0
2060-AM34	3	3/1	1	1	3/1	0	1	0	0	1	0	0	0
2060-AN24	3	3/1	1	1	3/1	0	1	0	0	1	0	0	0
2060-AN72	3	3/1	0	0	0	0	1	0	0	0	0	0	0
2070-AC83	1	3	0	1	0	0	0	0	0	0	0	0	0
2060-AN83	3	3/1	0	0	1	0	1	0	0	0	0	0	0
2060-AO79	0	0	0	0	0	0	0	0	0	0	0	0	0
2050-AG16	1	1	0	1	0	0	0	0	0	0	0	0	0
2060-AO15	3/1	3/1	1	2	2	3(SC)/0	1	1	0	0	0	0	0
2060-AO38	3/1	3/1	1	1	1	1	1	0	0	0	0	0	0
2060-AO48	3/1	3/1	1	1	1	1	1	0	0	0	0	0	0
2060-AO81	3/1	3/1	1	1	1	3(SC)/1	1	1	0	0	0	0	0
2060-AP36	3	3/1	1	1	1	0	1	0	0	0	0	0	0
2060-AP58; 2127-AK50	3	3/1	1	1	2	3(SC)/1	1	1	0	0	0	0	0
2060-AP86	0	0	0	0	0	0	0	0	0	0	0	0	0
2060-AQ13	3	3/1	1	1	1	0	1	0	0	0	0	0	0
2070-AJ55	3/1	3/1	0	1	0	0	0	0	1	1	0	0	1
2040-AF11	1	1	3/1	3	0	1	0	0	0	1	0	0	0
2050-AG50	0	0	0	0	0	0	0	0	0	0	0	0	0
2060-AP50	3/1	3/1	1	1	3/1	3(SC)/0	1	1	0	1	0	0	0
2060-AP61; 2127-AK74	3/1	3/1	1	1	2	3(SC)/1	1	1	0	0	0	0	0
2060-AN72	3	3	1	1	1	0	1	0	0	0	0	0	0
2060-AP52	3	3	1	1	3/1	3(SC)/0	1	1	0	1	0	0	0
2060-AP76	1	1	0	1	1	0	0	0	0	0	0	0	0
2060-AQ54	3/1	3/1	1	1	1	3(SC)/1	1	1	0	0	0	0	0
2060-AO47	3/1	3/1	1	1	1	1	1	0	0	0	0	0	0
2060-AQ58	3	3	1	1	1	0	1	0	0	0	0	0	0
2060-AR13	3	3	1	1	2	3(SC)/1	1	1	0	0	0	0	0
2040-AE95	3(SC)/0	3(SC)/0	3/1	3/1	0	3(SC)/0	0	1	0	1	1	0	0
2060-AQ86	3/1	3/1	1	1	1	0	1	0	0	0	0	0	0

Table A1. Summary of rules reviewed, including coding values.

RIN	Mortality	Morbidity	Recreation	Ecol_Veg	Visibility	Property	BenMAP	SCCO2_CH4	VSL	SP	TCM	HPM	HedWage
2040-AF14	3	3/2/1	3/1	3/1	0	3(SC)/1	1	1	0	1	0	0	0
2040-AF30	0	1	3	3/1	0	0	0	0	0	1	0	0	0
2050-AE81	3/1	3/1	3/1	3/1	0	3(SC)/1	0	1	1	1	0	0	1
2050-AG46	1	1	0	2/1	0	1	0	0	0	0	0	0	0
2060-AP38	3	3	1	1	1	1	1	0	0	0	0	0	0
2060-AP69	3	3/1	0	1	1	3(SC)/0	1	1	0	0	0	0	0
2060-AP93	3	3/1	1	1	1	0	1	0	0	0	0	0	0
2060-AQ75	0	0	0	0	0	0	0	0	0	0	0	0	0
2060-AR33	3/1	3/1	1	1	1	3(SC)/1	1	1	0	0	0	0	0
2060-AS05	3	3	1	1	1	3(SC)/1	1	1	0	0	0	0	0
2060-AS16; 2127-AL52	3	3/1	1	1	1	3(SC)/1	1	1	0	0	0	0	0
2060-AS23; 2060-AM08	3(SC)/1	3(SC)/1	1	1	1	3(SC)/0	0	1	0	0	0	0	0
2060-AS30	3(SC)/1	3(SC)/1	1	1	1	3(SC)/0	0	1	0	0	0	0	0
2070-AJ44	3	3	0	0	0	0	0	0	1	1	0	0	1
2050-AG82	1	1	0	1	0	1	0	0	0	0	0	0	0
2040-AF74	0	0	3	3	0	1	0	0	0	1	0	0	0
2060-AT67	3/1	3/1	1	1	1	3(SC)/1	1	1	0	0	0	0	0
2070-AJ82	1	3/1	0	0	0	0	0	0	0	0	0	0	0
2060-AR55 2060-AR76 2060-AS22 2060-AT93 2060-AT04 2060-AS72	3	3	1	1	0	0	1	0	0	0	0	0	0

Table A1. Summary of rules reviewed, including coding values.

RIN	COI_AC	LostWages	NoCausal	NoTime	QuantDisconnect	MonetizDisconnect
2050-AG31	0	0	0	1	0	0
2060-AM06	0	0	0	1	1	0
2060-AM34	0	0	0	1	0	0
2060-AN24	0	0	1	1	1	0
2060-AN72	0	0	0	1	0	0
2070-AC83	0	1	1	1	0	0
2060-AN83	0	1	1	1	1	1
2060-AO79	0	0	0	0	0	0
2050-AG16	0	0	0	0	0	0
2060-AO15	0	0	1	1	1	1
2060-AO38	0	0	0	0	1	0
2060-AO48	0	0	1	1	1	1
2060-AO81	0	0	0	1	1	0
2060-AP36	0	0	0	1	0	0
2060-AP58; 2127-AK50	0	0	1	1	1	1
2060-AP86	0	0	0	0	0	0
2060-AQ13	0	0	1	1	0	0
2070-AJ55	1	1	0	1	0	0
2040-AF11	0	0	0	1	1	1
2050-AG50	0	0	0	0	0	0
2060-AP50	0	0	1	1	1	1
2060-AP61; 2127-AK74	1	1	1	1	1	1
2060-AN72	0	0	1	1	0	0
2060-AP52	0	1	1	1	0	0
2060-AP76	0	0	0	1	1	0
2060-AQ54	0	0	1	1	1	1
2060-AO47	1	1	1	1	1	1
2060-AQ58	1	1	1	1	1	0
2060-AR13	0	0	1	1	0	0
2040-AE95	0	0	0	0	0	1
2060-AQ86	0	0	0	1	1	1

Table A1. Summary of rules reviewed, including coding values.

RIN	COI_AC	LostWages	NoCausal	NoTime	QuantDisconnect	MonetizDisconnect
2040-AF14	1	0	0	0	1	1
2040-AF30	0	0	0	0	1	1
2050-AE81	1	1	1	1	1	1
2050-AG46	0	0	0	1	1	1
2060-AP38	0	0	1	1	1	1
2060-AP69	0	0	0	1	1	1
2060-AP93	0	0	0	1	1	1
2060-AQ75	0	0	0	0	0	0
2060-AR33	0	0	1	1	1	1
2060-AS05	0	0	1	1	1	1
2060-AS16; 2127-AL52	0	0	0	0	1	1
2060-AS23; 2060-AM08	0	0	0	1	1	0
2060-AS30	0	0	0	0	1	0
2070-AJ44	1	1	1	0	1	1
2050-AG82	0	0	0	1	1	0
2040-AF74	0	0	0	0	0	1
2060-AT67	0	0	1	1	1	0
2070-AJ82	0	1	1	1	1	0
2060-AR55 2060-AR76 2060-AS22 2060-AT93 2060-AT04 2060-AS72	0	0	0	1	0	0

Table A2. Compilation of NMV studies used directly or indirectly in RIAs of major rules, 2009-2019.

Study	Year	# Times Used	NMV Method	Benefit Category	Sources Using
Viscusi, Magat, and Huber	1991	33	CVM	Mortality, Morbidity	EPA Guidelines (2010), BenMAP, Industrial Economics (1994)
Smith	1974	32	Hedonic	Mortality	EPA Guidelines (2010), BenMAP
Smith	1976	32	Hedonic	Mortality	EPA Guidelines (2010), BenMAP
Viscusi	1978	32	Hedonic	Mortality	EPA Guidelines (2010), BenMAP
Olson	1981	32	Hedonic	Mortality	EPA Guidelines (2010), BenMAP
Viscusi	1981	32	Hedonic	Mortality	EPA Guidelines (2010), BenMAP
Marin and Psacharopoulos	1982	32	Hedonic	Mortality	EPA Guidelines (2010), BenMAP
Butler	1983	32	Hedonic	Mortality	EPA Guidelines (2010), BenMAP
Smith	1983	32	Hedonic	Mortality	EPA Guidelines (2010), BenMAP
Leigh and Folsom	1984	32	Hedonic	Mortality	EPA Guidelines (2010), BenMAP
Smith and Gilbert	1984	32	Hedonic	Mortality	EPA Guidelines (2010), BenMAP
Gegax, Gerking, and Schulze	1985	32	CVM	Mortality	EPA Guidelines (2010), BenMAP
Dillingham	1985	32	Hedonic	Mortality	EPA Guidelines (2010), BenMAP
Herzog and Schlottman	1987	32	Hedonic	Mortality	EPA Guidelines (2010), BenMAP
Leigh	1987	32	Hedonic	Mortality	EPA Guidelines (2010), BenMAP
Gerking, de Haan, and Schulze	1988	32	CVM	Mortality	EPA Guidelines (2010), BenMAP
Cousineau, Lacroix, and Girard	1988	32	Hedonic	Mortality	EPA Guidelines (2010), BenMAP
Garen	1988	32	Hedonic	Mortality	EPA Guidelines (2010), BenMAP
Moore and Viscusi (a)	1988	32	Hedonic	Mortality	EPA Guidelines (2010), BenMAP
Moore and Viscusi (b)	1988	32	Hedonic	Mortality	EPA Guidelines (2010), BenMAP
Jones-Lee	1989	32	CVM	Mortality	EPA Guidelines (2010), BenMAP
Miller and Guria	1991	32	CVM	Mortality	EPA Guidelines (2010), BenMAP
Kniesner and Leeth	1991	32	Hedonic	Mortality	EPA Guidelines (2010), BenMAP
Tolley et al.	1986	30	CVM	Morbidity	BenMAP, Industrial Economics (1993), Industrial Economics (1994)
Weitzel	1990	30	CVM	Morbidity	Industrial Economics (1993)
Loehman et al.	1979	29	CVM	Morbidity	BenMAP, Industrial Economics (1994)
Rowe and Chestnut	1986	29	CVM	Morbidity	BenMAP, Industrial Economics (1994)
Dickie and Gerking	1987	29	CVM	Morbidity	BenMAP, Industrial Economics (1994)

Table A2. Compilation of NMV studies used directly or indirectly in RIAs of major rules, 2009-2019.

Study	Year	# Times Used	NMV Method	Benefit Category	Sources Using
Krupnick and Cropper	1992	29	CVM	Morbidity	BenMAP
O'Connor and Blomquist	1997	29	CVM	Morbidity	BenMAP
Blumenschein and Johannesson	1998	29	CVM	Morbidity	BenMAP
Dickie and Ulery	2002	29	CVM	Morbidity	BenMAP
IWG on SC-C	2013	9	SC-C	Climate	Direct use
IWG on SC-C	2010	7	SC-C	Climate	Direct use
Chestnut and Rowe	1990	5	CVM	Visibility	Direct use
Cameron and Huppert	1989	4	CVM	Ecological, Recreational	2040-AF14, Construction & Development Rule (2009), Existing Facilities Rule (2006)
Lant and Tobin	1989	4	CVM	Ecological	2040-AF14, 2040-AF30, Construction & Development Rule (2009)
Whitehead and Blomquist	1991	4	CVM	Ecological	Moeltner et al. (2019), 2040-AF30, 2040-AF14
de Zoysa	1995	4	CVM	Ecological	2040-AF14, Construction & Development Rule (2009), Moeltner et al. (2019)
Roberts and Leitch	1997	4	CVM	Ecological	2040-AF14, Construction & Development Rule (2009), 2040-AF30
Aiken	1985	3	CVM	Ecological	2040-AF14, Construction & Development Rule (2009)
Rowe et al. (b)	1985	3	CVM	Ecological	2040-AF14, Construction & Development Rule (2009)
Sutherland and Walsh	1985	3	CVM	Ecological	2040-AF14, Construction & Development Rule (2009)
Anderson and Edwards	1986	3	CVM	Ecological	2040-AF14, Construction & Development Rule (2009)
Croke, Fabian, and Brenniman	1986	3	CVM	Ecological	2040-AF14, Construction & Development Rule (2009)
Welle	1986	3	CVM	Ecological	2040-AF14, Construction & Development Rule (2009)
Desvousges, Smith, and Fisher	1987	3	CVM	Ecological	2040-AF14, Construction & Development Rule (2009)
Bockstael, McConnell, and Strand	1988	3	CVM	Ecological	2040-AF14, Construction & Development Rule (2009)
Bockstael, McConnell, and Strand	1989	3	CVM, TCM	Recreational	2040-AF14, Existing Facilities Rule (2006)
Clonts and Malone	1990	3	CVM	Ecological	2040-AF14, Construction & Development Rule (2009)
Lant and Roberts	1990	3	CVM	Ecological	2040-AF14, Construction & Development Rule (2009)
Sanders, Walsh, and Loomis	1990	3	CVM	Ecological	2040-AF14, Construction & Development Rule (2009)
Wey	1990	3	CVM	Ecological	2040-AF14, Construction & Development Rule (2009)

Table A2. Compilation of NMV studies used directly or indirectly in RIAs of major rules, 2009-2019.

Study	Year	# Times Used	NMV Method	Benefit Category	Sources Using
Olsen, Richards, and Scott	1991	3	CVM	Ecological, Recreational	Construction & Development Rule (2009), Existing Facilities Rule (2006), Richardson and Loomis (2009)
Hayes et al.	1992	3	CVM	Ecological	2040-AF14, Construction & Development Rule (2009)
Kaoru	1993	3	CVM	Ecological	2040-AF14, Construction & Development Rule (2009)
Lyke	1993	3	CVM	Ecological	2040-AF14, Construction & Development Rule (2009)
Carson et al.	1994	3	CVM	Ecological	2040-AF14, Construction & Development Rule (2009)
Lindsey	1994	3	CVM	Ecological	2040-AF14, Construction & Development Rule (2009)
Whittington et al.	1994	3	CVM	Ecological	2040-AF14, Construction & Development Rule (2009)
Schulze et al.	1995	3	CVM	Ecological	2040-AF14, Construction & Development Rule (2009)
Whitehead et al.	1995	3	CVM	Ecological	2040-AF14, Construction & Development Rule (2009)
Herriges and Shogren	1996	3	CVM	Ecological	2040-AF14, Construction & Development Rule (2009)
Loomis (a)	1996	3	CVM	Ecological	2040-AF14, Construction & Development Rule (2009)
Huang, Haab, and Whitehead	1997	3	CVM	Ecological	2040-AF14, Construction & Development Rule (2009)
Opaluch et al.	1998	3	CVM	Ecological	2040-AF14, Construction & Development Rule (2009)
Lichtkoppler and Blaine	1999	3	CVM	Ecological	2040-AF14, Construction & Development Rule (2009)
Matthews, Homans, and Easter	1999	3	CVM	Ecological	2040-AF14, Construction & Development Rule (2009)
Stumborg, Baerenklau, and Bishop	2001	3	CVM	Ecological	2040-AF14, Construction & Development Rule (2009)
Hite	2002	3	CVM	Ecological	2040-AF14, Construction & Development Rule (2009)
Shrestha and Alavalapati	2004	3	CE	Ecological	2040-AF14, Construction & Development Rule (2009)
Lipton	2004	3	CVM	Ecological	2040-AF14, Construction & Development Rule (2009)
Marten et al.	2015	3	SC-CH4	Climate	Direct use
Loomis et al.	1991	2	CVM	Ecological	2040-AF30, Moeltner et al. (2019)
Wattage	1993	2	CVM	Ecological	2040-AF14
Blomquist and Whitehead	1998	2	CVM	Ecological	2040-AF30, Moeltner et al. (2019)
Breffle et al.	1999	2	CE	Ecological, Recreational	Construction & Development Rule (2009), Existing Facilities Rule (2006)
Johnston, Swallow, and Weaver	1999	2	CVM	Ecological	2040-AF14
Mullarkey and Bishop	1999	2	CVM	Ecological	2040-AF30, Moeltner et al. (2019)
Poor	1999	2	CVM	Ecological	2040-AF30, Moeltner et al. (2019)
Farber and Griner	2000	2	CE	Ecological	2040-AF14

Table A2. Compilation of NMV studies used directly or indirectly in RIAs of major rules, 2009-2019.

Study	Year	# Times Used	NMV Method	Benefit Category	Sources Using
Takatsuka	2004	2	CVM, CE	Ecological	2040-AF14
Banzhaf et al.	2006	2	CVM	Ecological	2040-AF14
Whitehead	2006	2	CVM	Ecological	2040-AF14
Collins and Rosenberger	2007	2	CVM	Ecological	2040-AF14
Irvin, Haab, and Hitzhusen	2007	2	CVM	Ecological	2040-AF14
Borisova et al.	2008	2	CVM	Ecological	2040-AF14
Corrigan, Kling, and Zhou	2008	2	CVM	Ecological	2040-AF14
Downstream Strategies	2008	2	CVM	Ecological	2040-AF14
Collins, Rosenberger, and Fletcher	2009	2	CE	Ecological	2040-AF14
Banzhaf et al.	2011	2	CE	Ecological	2040-AF14
Welle and Hodgson	2011	2	CVM	Ecological	2040-AF14
Londoño Cadavid and Ando	2013	2	CE	Ecological	2040-AF14
Vaughan and Russell	1982	1	TCM	Recreational	Existing Facilities Rule (2006)
Norton, Smith, and Strand	1983	1	TCM	Recreational	Existing Facilities Rule (2006)
Hageman	1985	1	CVM	Ecological	Richardson and Loomis (2009)
Rowe et al. (a)	1985	1	TCM	Recreational	Existing Facilities Rule (2006)
Samples and Bishop	1985	1	TCM	Recreational	Existing Facilities Rule (2006)
Johnson and Linder	1986	1	CVM	Ecological	2040-AF30
Boyle and Bishop	1987	1	CVM	Ecological	Richardson and Loomis (2009)
Cameron and James (b)	1987	1	CVM	Recreational	Existing Facilities Rule (2006)
Cameron and James (a)	1987	1	CVM	Recreational	Existing Facilities Rule (2006)
Jones and Stokes Associates	1987	1	TCM	Recreational	Existing Facilities Rule (2006)
Bowker and Stoll	1988	1	CVM	Ecological	Richardson and Loomis (2009)
Cameron	1988	1	CVM	Ecological	Construction & Development Rule (2009)
King, Flynn, and Shaw	1988	1	CVM	Ecological	Richardson and Loomis (2009)
Hushak, Winslow, and Dutta	1988	1	TCM	Recreational	Existing Facilities Rule (2006)
Loomis	1988	1	TCM	Recreational	Existing Facilities Rule (2006)
Johnson	1989	1	CVM	Recreational	Existing Facilities Rule (2006)
Johnson and Adams	1989	1	CVM	Recreational	Existing Facilities Rule (2006)

Table A2. Compilation of NMV studies used directly or indirectly in RIAs of major rules, 2009-2019.

Study	Year	# Times Used	NMV Method	Benefit Category	Sources Using
Samples and Hollyer	1989	1	CVM	Ecological	Richardson and Loomis (2009)
Huppert	1989	1	CVM, TCM	Recreational	Existing Facilities Rule (2006)
Agnello	1989	1	TCM	Recreational	Existing Facilities Rule (2006)
Carson, Hanemann, and Steinberg	1990	1	CVM	Recreational	Existing Facilities Rule (2006)
Duffield	1991	1	CVM	Ecological	Richardson and Loomis (2009)
Rubin, Helfand, and Loomis	1991	1	CVM	Ecological	Richardson and Loomis (2009)
Stevens et al.	1991	1	CVM	Ecological	Richardson and Loomis (2009)
Whitehead	1991	1	CVM	Ecological	Richardson and Loomis (2009)
Morey, Shaw, and Rowe	1991	1	TCM	Recreational	Existing Facilities Rule (2006)
Duffield	1992	1	CVM	Ecological	Richardson and Loomis (2009)
Duffield and Patterson	1992	1	CVM	Ecological	Richardson and Loomis (2009)
Hagan et al.	1992	1	CVM	Ecological	Richardson and Loomis (2009)
Milliman et al.	1992	1	CVM	Recreational	Existing Facilities Rule (2006)
Whitehead	1992	1	CVM	Ecological	Richardson and Loomis (2009)
Whitehead and Groothuis	1992	1	CVM	Ecological	Construction & Development Rule (2009)
Berrens, Bergland, and Adams	1993	1	CVM	Recreational	Existing Facilities Rule (2006)
Carson and Mitchell	1993	1	CVM	Ecological	Construction & Development Rule (2009)
Dillman, Beran, and Hook	1993	1	CVM	Ecological	2040-AF30
Duffield, Patterson, and Neher	1993	1	CVM	Ecological	Richardson and Loomis (2009)
Swanson	1993	1	CVM	Ecological	Richardson and Loomis (2009)
Morey, Rowe, and Watson	1993	1	TCM	Recreational	Existing Facilities Rule (2006)
Shafer et al.	1993	1	TCM	Recreational	Existing Facilities Rule (2006)
Cummings, Ganderton, and McGuckin	1994	1	CVM	Ecological	Richardson and Loomis (2009)
Loomis and Larson	1994	1	CVM	Ecological	Richardson and Loomis (2009)
McConnell and Strand	1994	1	CVM	Recreational	Existing Facilities Rule (2006)
Reaves, Kramer, and Holmes	1994	1	CVM	Ecological	Richardson and Loomis (2009)
USDOI	1994	1	CVM	Ecological	Richardson and Loomis (2009)
Beran	1995	1	CVM	Ecological	Moeltner et al. (2019)
Johnson et al.	1995	1	CVM	Recreational	Existing Facilities Rule (2006)

Table A2. Compilation of NMV studies used directly or indirectly in RIAs of major rules, 2009-2019.

Study	Year	# Times Used	NMV Method	Benefit Category	Sources Using
Alexander	1995	1	TCM	Recreational	Existing Facilities Rule (2006)
Berrens, Ganderton, and Silva	1996	1	CVM	Ecological	Richardson and Loomis (2009)
Lee	1996	1	CVM	Recreational	Existing Facilities Rule (2006)
Loomis (b)	1996	1	CVM	Ecological	Richardson and Loomis (2009)
Magat, Viscusi, and Huber	1996	1	CVM	Morbidity	Direct use
Schuhmann	1996	1	TCM	Recreational	Existing Facilities Rule (2006)
Loomis and Ekstrand	1997	1	CVM	Ecological	Richardson and Loomis (2009)
Lupi et al.	1997	1	TCM	Recreational	Existing Facilities Rule (2006)
Boyle, Roach, and Waddington	1998	1	CVM	Recreational	Existing Facilities Rule (2006)
Dalton, Bastian, and Jacobs	1998	1	CVM	Recreational	Existing Facilities Rule (2006)
MacDonald, Bergstrom, and Houston	1998	1	CVM	Ecological	Moeltner et al. (2019)
Gautam and Steinbeck	1998	1	TCM	Recreational	Existing Facilities Rule (2006)
Lupi and Hoehn	1998	1	TCM	Recreational	Existing Facilities Rule (2006)
Pendleton and Mendelsohn	1998	1	TCM	Recreational	Existing Facilities Rule (2006)
Schuhmann	1998	1	TCM	Recreational	Existing Facilities Rule (2006)
Giraud, Loomis, and Johnson	1999	1	CVM	Ecological	Richardson and Loomis (2009)
Hushak and Bielen	1999	1	CVM	Ecological	Construction & Development Rule (2009)
Kirkley et al.	1999	1	CVM	Recreational	Existing Facilities Rule (2006)
Hicks et al.	1999	1	TCM	Recreational	Existing Facilities Rule (2006)
Whitehead and Haab	1999	1	TCM	Recreational	Existing Facilities Rule (2006)
Azevedo, Herriges, and Kling	2000	1	CVM	Ecological	2040-AF30
Kotchen and Reiling	2000	1	CVM	Ecological	Richardson and Loomis (2009)
Loomis et al.	2000	1	CVM	Ecological	Construction & Development Rule (2009)
Whitehead and Aiken	2000	1	CVM	Recreational	Existing Facilities Rule (2006)
Azevedo, Herriges, and Kling	2001	1	CVM	Ecological	Construction & Development Rule (2009)
Layton, Brown, and Plummer	2001	1	CVM	Ecological	Richardson and Loomis (2009)
Murdock	2001	1	TCM	Recreational	Existing Facilities Rule (2006)
Hicks	2002	1	CE, TCM	Recreational	Existing Facilities Rule (2006)
Giraud et al.	2002	1	CVM	Ecological	Richardson and Loomis (2009)

Table A2. Compilation of NMV studies used directly or indirectly in RIAs of major rules, 2009-2019.

Study	Year	# Times Used	NMV Method	Benefit Category	Sources Using
Whitehead, Hoban, and Clifford	2002	1	CVM	Ecological	Construction & Development Rule (2009)
Morey et al.	2002	1	TCM	Recreational	Existing Facilities Rule (2006)
Bell, Huppert, and Johnson	2003	1	CVM	Ecological	Richardson and Loomis (2009)
Chambers and Whitehead	2003	1	CVM	Ecological	Richardson and Loomis (2009)
Williams and Bettoli	2003	1	CVM	Recreational	Existing Facilities Rule (2006)
Link and Tol	2004	1	SC-C	Climate	2060-AO81
Besedin, Ranson, and Johnston	2004	1	TCM	Recreational	Existing Facilities Rule (2006)
US EPA (a)	2004	1	TCM	Recreational	Existing Facilities Rule (2006)
US EPA (b)	2004	1	TCM	Recreational	Existing Facilities Rule (2006)
US EPA (c)	2004	1	TCM	Recreational	Existing Facilities Rule (2006)
US EPA (d)	2004	1	TCM	Recreational	Existing Facilities Rule (2006)
Stanley	2005	1	CVM	Ecological	Richardson and Loomis (2009)
Guo et al.	2006	1	SC-C	Climate	2060-AO81
Hope	2006	1	SC-C	Climate	2060-AO81
Wahba and Hope	2006	1	SC-C	Climate	2060-AO81
Viscusi, Huber, and Bell	2008	1	CE	Ecological	Construction & Development Rule (2009)
Nordhaus	2008	1	SC-C	Climate	2060-AO81
Whitehead et al.	2009	1	CVM	Ecological	Moeltner et al. (2019)
Richardson and Loomis	2009	1	Meta-Analysis	Ecological	Direct use
Anthoff, Tol, and Yohe	2009	1	SC-C	Climate	2060-AO81
Awondo, Eagan, and Dwyer	2011	1	CVM	Ecological	Moeltner et al. (2019)
Johnston et al.	2012	1	CE	Ecological	Direct use
Newell and Swallow	2013	1	CE	Ecological	Moeltner et al. (2019)
Moeltner et al.	2019	1	Meta-Analysis	Ecological	Direct use

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/* Keyword search used in EconLit

Last run 1/7/20

Keyword search of ALL FIELDS

Filters:
Source Type:  Academic journals
Language: English

CV:  kw: "contingent valuation"

CE:  "choice experiment" or "conjoint analysis"

WTP:  "WTP" or "willingness to pay" or "WTA" or "willingness to accept"

VSL:  "VSL" or "value of a statistical life" or "mortality risk" or "VPF" or "value of a prevented fatality"

Morbidity:  "morbidity"

TCM:  "travel cost" or "site choice" or "recreational demand"

HPM:  "hedonic"

*/
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77
78  rename (recheaderuiTerm recheadercontrolInfoartinfo G N O recheadercontrolInfojinfojt
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79
80  drop recid recresultID recheaderlongDbName recheadershortDbName H I J K L M P Q
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81
82  collapse (firstnm) CVM CE WTP VSL Morbidity TCM HPM year journal language subject author_lead title
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83
84  replace journal = lower(journal)
85  replace title = lower(title)
86  replace abstract = lower(abstract)
87  replace journal = strtrim(journal)
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91  *Further categorize papers that contain key method keywords in title and/or abstract
92  gen HPM_text = 1 if strpos(title, "hedonic") > 0
93  replace HPM_text = 1 if strpos(title, "property value") > 0
94  replace HPM_text = 1 if strpos(title, "house") > 0
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118 replace CE_text = 1 if strpos(title, "choice set") > 0
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120 replace CE_text = 1 if strpos(title, "conjoint") > 0
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replace stated = 1 if strpos(title, "existence value") > 0
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* Environmental / Natural Resource articles
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replace Env_NR = 1 if strpos(title, "endangered") > 0
replace Env_NR = 1 if strpos(title, "species") > 0
replace Env_NR = 1 if strpos(title, "energy") > 0
replace Env_NR = 1 if strpos(title, "conservation") > 0
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replace Env_NR = 1 if strpos(abstract, "energy") > 0
replace Env_NR = 1 if strpos(abstract, "conservation") > 0
replace Env_NR = 1 if strpos(abstract, "forest") > 0
replace Env_NR = 1 if strpos(abstract, "green") > 0
replace Env_NR = 1 if strpos(abstract, "natural") > 0
replace Env_NR = 1 if strpos(abstract, "ecosystem") > 0
replace Env_NR = 1 if strpos(abstract, "electricity") > 0
replace Env_NR = 1 if strpos(abstract, "noise") > 0
replace Env_NR = 1 if strpos(abstract, "externalities") > 0
replace Env_NR = 1 if strpos(abstract, "coastal") > 0
replace Env_NR = 1 if strpos(abstract, "river") > 0
replace Env_NR = 1 if strpos(abstract, "biodiversity") > 0
replace Env_NR = 1 if strpos(abstract, "marine") > 0
replace Env_NR = 1 if strpos(abstract, "sustainable") > 0
replace Env_NR = 1 if strpos(abstract, "sustainability") > 0
replace Env_NR = 1 if strpos(abstract, "wetland") > 0
replace Env_NR = 1 if strpos(abstract, "wildlife") > 0
replace Env_NR = 1 if strpos(abstract, "emissions") > 0
replace Env_NR = 1 if strpos(abstract, "ecological") > 0
replace Env_NR = 1 if strpos(abstract, "nuclear") > 0
replace Env_NR = 1 if strpos(abstract, "flood") > 0
replace Env_NR = 1 if strpos(abstract, "protected") > 0
replace Env_NR = 1 if strpos(abstract, "habitat") > 0
replace Env_NR = 1 if strpos(abstract, "watershed") > 0
replace Env_NR = 1 if strpos(abstract, "recycling") > 0

*Recreation / fisheries articles
gen Rec_Fish = 1 if strpos(title, "recreation") > 0
replace Rec_Fish = 1 if strpos(title, "tourism") > 0
replace Rec_Fish = 1 if strpos(title, "tourist") > 0
replace Rec_Fish = 1 if strpos(title, "cultural") > 0
```

```
replace Rec_Fish = 1 if strpos(title, "preservation") > 0
replace Rec_Fish = 1 if strpos(title, "heritage") > 0
replace Rec_Fish = 1 if strpos(title, "nature") > 0
replace Rec_Fish = 1 if strpos(title, "fish") > 0
replace Rec_Fish = 1 if strpos(title, "beach") > 0
replace Rec_Fish = 1 if strpos(title, "mountain") > 0
replace Rec_Fish = 1 if strpos(title, "hunting") > 0
replace Rec_Fish = 1 if strpos(title, "historic") > 0
replace Rec_Fish = 1 if strpos(title, "weather") > 0
replace Rec_Fish = 1 if strpos(title, "salmon") > 0
replace Rec_Fish = 1 if strpos(title, "fishing") > 0
replace Rec_Fish = 1 if strpos(title, "bass") > 0
replace Rec_Fish = 1 if strpos(title, "shellfish") > 0
replace Rec_Fish = 1 if strpos(title, "oyster") > 0
replace Rec_Fish = 1 if strpos(title, "crab") > 0
replace Rec_Fish = 1 if strpos(title, "outdoor") > 0
replace Rec_Fish = 1 if strpos(title, "hotel") > 0

replace Rec_Fish = 1 if strpos(abstract, "recreation") > 0
replace Rec_Fish = 1 if strpos(abstract, "tourism") > 0
replace Rec_Fish = 1 if strpos(abstract, "tourist") > 0
replace Rec_Fish = 1 if strpos(abstract, "cultural") > 0
replace Rec_Fish = 1 if strpos(abstract, "preservation") > 0
replace Rec_Fish = 1 if strpos(abstract, "heritage") > 0
replace Rec_Fish = 1 if strpos(abstract, "nature") > 0
replace Rec_Fish = 1 if strpos(abstract, "fish") > 0
replace Rec_Fish = 1 if strpos(abstract, "beach") > 0
replace Rec_Fish = 1 if strpos(abstract, "mountain") > 0
replace Rec_Fish = 1 if strpos(abstract, "hunting") > 0
replace Rec_Fish = 1 if strpos(abstract, "historic") > 0
replace Rec_Fish = 1 if strpos(abstract, "weather") > 0
replace Rec_Fish = 1 if strpos(abstract, "salmon") > 0
replace Rec_Fish = 1 if strpos(abstract, "fishing") > 0
replace Rec_Fish = 1 if strpos(abstract, "bass") > 0
replace Rec_Fish = 1 if strpos(abstract, "shellfish") > 0
replace Rec_Fish = 1 if strpos(abstract, "oyster") > 0
replace Rec_Fish = 1 if strpos(abstract, "crab") > 0
replace Rec_Fish = 1 if strpos(abstract, "outdoor") > 0
replace Rec_Fish = 1 if strpos(abstract, "hotel") > 0

* Food articles
gen Food = 1 if strpos(title, "food") > 0
replace Food = 1 if strpos(title, "fresh produce") > 0
replace Food = 1 if strpos(title, "fruit") > 0
replace Food = 1 if strpos(title, "vegetable") > 0
replace Food = 1 if strpos(title, "meat") > 0
replace Food = 1 if strpos(title, "potato") > 0
replace Food = 1 if strpos(title, "oyster") > 0
replace Food = 1 if strpos(title, "apple") > 0
replace Food = 1 if strpos(title, "lamb") > 0
replace Food = 1 if strpos(title, "egg") > 0
replace Food = 1 if strpos(title, "juice") > 0
replace Food = 1 if strpos(title, "ham") > 0
replace Food = 1 if strpos(title, "fresh pears") > 0
replace Food = 1 if strpos(title, "pear grower") > 0
replace Food = 1 if strpos(title, "edamame") > 0
replace Food = 1 if strpos(title, "beer") > 0
replace Food = 1 if strpos(title, "grass-fed") > 0
replace Food = 1 if strpos(title, "beef") > 0
replace Food = 1 if strpos(title, "chicken") > 0
replace Food = 1 if strpos(title, "pork") > 0
replace Food = 1 if strpos(title, "milk") > 0
replace Food = 1 if strpos(title, "aflatoxin-free maize") > 0
```

```
replace Food = 1 if strpos(title, "maternal nutrient supplement") > 0
replace Food = 1 if strpos(title, "soft drink") > 0
replace Food = 1 if strpos(title, "cassava") > 0
replace Food = 1 if strpos(title, "olive") > 0
replace Food = 1 if strpos(title, "country of origin label") > 0
replace Food = 1 if strpos(title, "bread") > 0
replace Food = 1 if strpos(title, "pistachio") > 0
replace Food = 1 if strpos(title, "wine") > 0
replace Food = 1 if strpos(title, "livestock production claim") > 0
replace Food = 1 if strpos(title, "organicos frescos") > 0
replace Food = 1 if strpos(title, "fries") > 0
replace Food = 1 if strpos(title, "steak") > 0
replace Food = 1 if strpos(title, "sensory attributes") > 0
replace Food = 1 if strpos(title, "chardonnays") > 0
replace Food = 1 if strpos(title, "coffee") > 0
replace Food = 1 if strpos(title, "fair trade") > 0
replace Food = 1 if strpos(title, "organic") > 0
replace Food = 1 if strpos(title, "free-range") > 0
replace Food = 1 if strpos(title, "free range") > 0
replace Food = 1 if strpos(title, "genetically") > 0
replace Food = 1 if strpos(title, "certification") > 0
replace Food = 1 if strpos(title, "brands") > 0
replace Food = 1 if strpos(title, "labelling") > 0
replace Food = 1 if strpos(title, "yogurt") > 0
replace Food = 1 if strpos(title, "sausage") > 0

replace Food = 1 if strpos(abstract, "food") > 0
replace Food = 1 if strpos(abstract, "fresh produce") > 0
replace Food = 1 if strpos(abstract, "fruit") > 0
replace Food = 1 if strpos(abstract, "vegetable") > 0
replace Food = 1 if strpos(abstract, "meat") > 0
replace Food = 1 if strpos(abstract, "potato") > 0
replace Food = 1 if strpos(abstract, "oyster") > 0
replace Food = 1 if strpos(abstract, "apple") > 0
replace Food = 1 if strpos(abstract, "lamb") > 0
replace Food = 1 if strpos(abstract, "egg") > 0
replace Food = 1 if strpos(abstract, "juice") > 0
replace Food = 1 if strpos(abstract, "ham") > 0
replace Food = 1 if strpos(abstract, "fresh pears") > 0
replace Food = 1 if strpos(abstract, "pear grower") > 0
replace Food = 1 if strpos(abstract, "edamame") > 0
replace Food = 1 if strpos(abstract, "beer") > 0
replace Food = 1 if strpos(abstract, "grass-fed") > 0
replace Food = 1 if strpos(abstract, "beef") > 0
replace Food = 1 if strpos(abstract, "chicken") > 0
replace Food = 1 if strpos(abstract, "pork") > 0
replace Food = 1 if strpos(abstract, "milk") > 0
replace Food = 1 if strpos(abstract, "aflatoxin-free maize") > 0
replace Food = 1 if strpos(abstract, "maternal nutrient supplement") > 0
replace Food = 1 if strpos(abstract, "soft drink") > 0
replace Food = 1 if strpos(abstract, "cassava") > 0
replace Food = 1 if strpos(abstract, "olive") > 0
replace Food = 1 if strpos(abstract, "country of origin label") > 0
replace Food = 1 if strpos(abstract, "bread") > 0
replace Food = 1 if strpos(abstract, "pistachio") > 0
replace Food = 1 if strpos(abstract, "wine") > 0
replace Food = 1 if strpos(abstract, "livestock production claim") > 0
replace Food = 1 if strpos(abstract, "organicos frescos") > 0
replace Food = 1 if strpos(abstract, "fries") > 0
replace Food = 1 if strpos(abstract, "steak") > 0
replace Food = 1 if strpos(abstract, "sensory attributes") > 0
replace Food = 1 if strpos(abstract, "chardonnays") > 0
replace Food = 1 if strpos(abstract, "coffee") > 0
```

```
replace Food = 1 if strpos(abstract, "fair trade") > 0
replace Food = 1 if strpos(abstract, "organic") > 0
replace Food = 1 if strpos(abstract, "free-range") > 0
replace Food = 1 if strpos(abstract, "free range") > 0
replace Food = 1 if strpos(abstract, "genetically") > 0
replace Food = 1 if strpos(abstract, "certification") > 0
replace Food = 1 if strpos(abstract, "brands") > 0
replace Food = 1 if strpos(abstract, "labelling") > 0
replace Food = 1 if strpos(abstract, "yogurt") > 0
replace Food = 1 if strpos(abstract, "sausage") > 0

*Ag articles
gen Ag = 1 if strpos(title, "agri") > 0
replace Ag = 1 if strpos(title, "farm") > 0
replace Ag = 1 if strpos(title, "dairy") > 0
replace Ag = 1 if strpos(title, "livestock") > 0
replace Ag = 1 if strpos(title, "cotton") > 0
replace Ag = 1 if strpos(title, "maize") > 0
replace Ag = 1 if strpos(title, "crop") > 0
replace Ag = 1 if strpos(title, "fertilizer") > 0
replace Ag = 1 if strpos(title, "production") > 0
replace Ag = 1 if strpos(title, "irrigation") > 0
replace Ag = 1 if strpos(title, "soil") > 0
replace Ag = 1 if strpos(title, "pesticide") > 0
replace Ag = 1 if strpos(title, "cattle") > 0
replace Ag = 1 if strpos(title, "plant") > 0
replace Ag = 1 if strpos(title, "invasive") > 0
replace Ag = 1 if strpos(title, "swine") > 0

replace Ag = 0 if strpos(title, "water quality") > 0
replace Ag = 0 if strpos(title, "runoff") > 0
replace Ag = 0 if strpos(title, "nutrient leaching") > 0
replace Ag = 0 if strpos(title, "dissolved oxygen") > 0
replace Ag = 0 if strpos(title, "chlorophyll") > 0
replace Ag = 0 if strpos(title, "algae") > 0
replace Ag = 0 if strpos(title, "aquatic") > 0
replace Ag = 0 if strpos(title, "fish") > 0
replace Ag = 0 if strpos(title, "ecosystem") > 0

replace Ag = 1 if strpos(abstract, "agri") > 0
replace Ag = 1 if strpos(abstract, "farm") > 0
replace Ag = 1 if strpos(abstract, "dairy") > 0
replace Ag = 1 if strpos(abstract, "livestock") > 0
replace Ag = 1 if strpos(abstract, "cotton") > 0
replace Ag = 1 if strpos(abstract, "maize") > 0
replace Ag = 1 if strpos(abstract, "crop") > 0
replace Ag = 1 if strpos(abstract, "fertilizer") > 0
replace Ag = 1 if strpos(abstract, "production") > 0
replace Ag = 1 if strpos(abstract, "irrigation") > 0
replace Ag = 1 if strpos(abstract, "soil") > 0
replace Ag = 1 if strpos(abstract, "pesticide") > 0
replace Ag = 1 if strpos(abstract, "cattle") > 0
replace Ag = 1 if strpos(abstract, "plant") > 0
replace Ag = 1 if strpos(abstract, "invasive") > 0
replace Ag = 1 if strpos(abstract, "swine") > 0

replace Ag = 0 if strpos(abstract, "water quality") > 0
replace Ag = 0 if strpos(abstract, "runoff") > 0
replace Ag = 0 if strpos(abstract, "nutrient leaching") > 0
replace Ag = 0 if strpos(abstract, "dissolved oxygen") > 0
replace Ag = 0 if strpos(abstract, "chlorophyll") > 0
replace Ag = 0 if strpos(abstract, "algae") > 0
replace Ag = 0 if strpos(abstract, "aquatic") > 0
```

```
replace Ag = 0 if strpos(abstract, "fish") > 0
replace Ag = 0 if strpos(abstract, "ecosystem") > 0

* Transportation articles
gen Transport = 1 if strpos(title, "travel") > 0
replace Transport = 1 if strpos(title, "rail") > 0
replace Transport = 1 if strpos(title, "train") > 0
replace Transport = 1 if strpos(title, "time saving") > 0
replace Transport = 1 if strpos(title, "automobile") > 0
replace Transport = 1 if strpos(title, "vehicle") > 0
replace Transport = 1 if strpos(title, "trip time") > 0
replace Transport = 1 if strpos(title, "traffic") > 0
replace Transport = 1 if strpos(title, "aviation") > 0
replace Transport = 1 if strpos(title, "work trip") > 0
replace Transport = 1 if strpos(title, "value of time") > 0
replace Transport = 1 if strpos(title, "commute") > 0
replace Transport = 1 if strpos(title, "commuting") > 0
replace Transport = 1 if strpos(title, "road safety") > 0
replace Transport = 1 if strpos(title, "travel mode") > 0
replace Transport = 1 if strpos(title, "subway") > 0
replace Transport = 1 if strpos(title, "alternative-fuel vehicle") > 0
replace Transport = 1 if strpos(title, "ridership") > 0
replace Transport = 1 if strpos(title, "transit") > 0
replace Transport = 1 if strpos(title, "transportation") > 0
replace Transport = 1 if strpos(title, "toll") > 0
replace Transport = 1 if strpos(title, "driving") > 0
replace Transport = 1 if strpos(title, "electric car") > 0
replace Transport = 1 if strpos(title, "road") > 0
replace Transport = 1 if strpos(title, "airport") > 0
replace Transport = 1 if strpos(title, "route") > 0

replace Transport = 1 if strpos(abstract, "travel") > 0
replace Transport = 1 if strpos(abstract, "rail") > 0
replace Transport = 1 if strpos(abstract, "train") > 0
replace Transport = 1 if strpos(abstract, "time saving") > 0
replace Transport = 1 if strpos(abstract, "automobile") > 0
replace Transport = 1 if strpos(abstract, "vehicle") > 0
replace Transport = 1 if strpos(abstract, "trip time") > 0
replace Transport = 1 if strpos(abstract, "traffic") > 0
replace Transport = 1 if strpos(abstract, "aviation") > 0
replace Transport = 1 if strpos(abstract, "work trip") > 0
replace Transport = 1 if strpos(abstract, "value of time") > 0
replace Transport = 1 if strpos(abstract, "commute") > 0
replace Transport = 1 if strpos(abstract, "commuting") > 0
replace Transport = 1 if strpos(abstract, "road safety") > 0
replace Transport = 1 if strpos(abstract, "travel mode") > 0
replace Transport = 1 if strpos(abstract, "subway") > 0
replace Transport = 1 if strpos(abstract, "alternative-fuel vehicle") > 0
replace Transport = 1 if strpos(abstract, "ridership") > 0
replace Transport = 1 if strpos(abstract, "transit") > 0
replace Transport = 1 if strpos(abstract, "transportation") > 0
replace Transport = 1 if strpos(abstract, "toll") > 0
replace Transport = 1 if strpos(abstract, "driving") > 0
replace Transport = 1 if strpos(abstract, "electric car") > 0
replace Transport = 1 if strpos(abstract, "road") > 0
replace Transport = 1 if strpos(abstract, "airport") > 0
replace Transport = 1 if strpos(abstract, "route") > 0

* Health articles
gen Health = 1 if strpos(title, "health") > 0
replace Health = 1 if strpos(title, "mortality") > 0
replace Health = 1 if strpos(title, "statistical life") > 0
replace Health = 1 if strpos(title, "VSL") > 0
```

```
replace Health = 1 if strpos(title, "cancer") > 0
replace Health = 1 if strpos(title, "death") > 0
replace Health = 1 if strpos(title, "disease") > 0
replace Health = 1 if strpos(title, "injury") > 0
replace Health = 1 if strpos(title, "mental") > 0
replace Health = 1 if strpos(title, "medical") > 0
replace Health = 1 if strpos(title, "illness") > 0
replace Health = 1 if strpos(title, "chronic") > 0
replace Health = 1 if strpos(title, "drug") > 0
replace Health = 1 if strpos(title, "fatal") > 0
replace Health = 1 if strpos(title, "asthma") > 0
replace Health = 1 if strpos(title, "acute") > 0
replace Health = 1 if strpos(title, "exposure") > 0

replace Health = 1 if strpos(abstract, "health") > 0
replace Health = 1 if strpos(abstract, "mortality") > 0
replace Health = 1 if strpos(abstract, "statistical life") > 0
replace Health = 1 if strpos(abstract, "VSL") > 0
replace Health = 1 if strpos(abstract, "cancer") > 0
replace Health = 1 if strpos(abstract, "death") > 0
replace Health = 1 if strpos(abstract, "disease") > 0
replace Health = 1 if strpos(abstract, "injury") > 0
replace Health = 1 if strpos(abstract, "mental") > 0
replace Health = 1 if strpos(abstract, "medical") > 0
replace Health = 1 if strpos(abstract, "illness") > 0
replace Health = 1 if strpos(abstract, "chronic") > 0
replace Health = 1 if strpos(abstract, "drug") > 0
replace Health = 1 if strpos(abstract, "fatal") > 0
replace Health = 1 if strpos(abstract, "asthma") > 0
replace Health = 1 if strpos(abstract, "acute") > 0
replace Health = 1 if strpos(abstract, "exposure") > 0

replace Health = 1 if VSL == 1 | Morbidity == 1
gen Ag_Food = 1 if Ag == 1 | Food == 1
gen Other = 1 if Env_NR == . & Rec_Fish == . & Ag_Food == . & Transport == . & Health == .

*keep only 1974-2018
drop if year < 1974
drop if year > 2019

sort journal year author_lead, stable

replace title = subinstr(title,".","",.)
replace title = lower(title)
replace author_lead = lower(author_lead)
duplicates drop year language author_lead title, force

egen method_total = rowtotal(CVM CE WTP TCM HPM)
egen topic_total = rowtotal(Env_NR Rec_Fish Transport Health Ag_Food Other)
egen CVM_count = total(CVM)
egen CE_count = total(CE)
egen WTP_count = total(WTP)
egen HPM_count = total(HPM)
egen TCM_count = total(TCM)
egen CVM_Env_NR = total(Env_NR) if CVM == 1
egen CE_Env_NR = total(Env_NR) if CE == 1
egen WTP_Env_NR = total(Env_NR) if WTP == 1
egen HPM_Env_NR = total(Env_NR) if HPM == 1
egen TCM_Env_NR = total(Env_NR) if TCM == 1
egen CVM_Rec_Fish = total(Rec_Fish) if CVM == 1
egen CE_Rec_Fish = total(Rec_Fish) if CE == 1
egen WTP_Rec_Fish = total(Rec_Fish) if WTP == 1
egen HPM_Rec_Fish = total(Rec_Fish) if HPM == 1
```

```
562   egen TCM_Rec_Fish = total(Rec_Fish) if TCM == 1
563   egen CVM_Ag_Food = total(Ag_Food) if CVM == 1
564   egen CE_Ag_Food = total(Ag_Food) if CE == 1
565   egen WTP_Ag_Food = total(Ag_Food) if WTP == 1
566   egen HPM_Ag_Food = total(Ag_Food) if HPM == 1
567   egen TCM_Ag_Food = total(Ag_Food) if TCM == 1
568   egen CVM_Health = total(Health) if CVM == 1
569   egen CE_Health = total(Health) if CE == 1
570   egen WTP_Health = total(Health) if WTP == 1
571   egen HPM_Health = total(Health) if HPM == 1
572   egen TCM_Health = total(Health) if TCM == 1
573   egen CVM_Transport = total(Transport) if CVM == 1
574   egen CE_Transport = total(Transport) if CE == 1
575   egen WTP_Transport = total(Transport) if WTP == 1
576   egen HPM_Transport = total(Transport) if HPM == 1
577   egen TCM_Transport = total(Transport) if TCM == 1
578   egen CVM_Other = total(Other) if CVM == 1
579   egen CE_Other = total(Other) if CE == 1
580   egen WTP_Other = total(Other) if WTP == 1
581   egen HPM_Other = total(Other) if HPM == 1
582   egen TCM_Other = total(Other) if TCM == 1
583   egen Env_NR_count = total(Env_NR)
584   egen Rec_Fish_count = total(Rec_Fish)
585   egen Ag_Food_count = total(Ag_Food)
586   egen Transport_count = total(Transport)
587   egen Health_count = total(Health)
588   egen Other_count = total(Other)
589
590   rename HPM Hedonic
591
592   save Econ_Lit_NMV_Counts, replace
593
594   * Graphs
595   * by Year
596   use Econ_Lit_NMV_Counts, clear
597   graph bar (count) CVM CE Hedonic TCM WTP, over(year, relabel(1 " " 2 "1975" 3 " " 4 " " 5 " " 6 " " 7
       "1980" 8 " " 9 " " 10 " " 11 " " 12 "1985" 13 " " 14 " " 15 " " 16 " " 17 "1990" 18 " " 19 " " 20 "
      " 21 " " 22 "1995" 23 " " 24 " " 25 " " 26 " " 27 "2000" 28 " " 29 " " 30 " " 31 " " 32 "2005" 33 " "
       34 " " 35 " " 36 " " 37 "2010" 38 " " 39 " " 40 " " 41 " " 42 "2015" 43 " " 44 " " 45 " " 46 " "))
      stack ylabel(, angle(0)) nolabel legend(off) saving(Lit_Count_by_Year.gph, replace) allc scheme(
      s1color)
598
599   * by Year
600   * for RIA comparison
601   use Econ_Lit_NMV_Counts, clear
602   graph bar (count) CVM CE Hedonic TCM WTP, over(year, relabel(1 " " 2 "1975" 3 " " 4 " " 5 " " 6 " " 7
       "1980" 8 " " 9 " " 10 " " 11 " " 12 "1985" 13 " " 14 " " 15 " " 16 " " 17 "1990" 18 " " 19 " " 20 "
      " 21 " " 22 "1995" 23 " " 24 " " 25 " " 26 " " 27 "2000" 28 " " 29 " " 30 " " 31 " " 32 "2005" 33 " "
       34 " " 35 " " 36 " " 37 "2010" 38 " " 39 " " 40 " " 41 " " 42 "2015" 43 " " 44 " " 45 " " 46 " "))
      stack ylabel(, angle(45)) nolabel legend(rows(1)) saving(Lit_Count_by_Year_compared.gph, replace)
      allc scheme(s1color) legend(label(4 "TC")) legend(label(5 "Other WTP")) legend(colgap(*.4))
603
604   * legend(rows(1) order(5 4 3 2 1) ring(0) bplace(nw) rowgap(*.25) colgap(*.25))
605
606   * by Method (changes dataset)
607   keep CVM_count CE_count WTP_count HPM_count TCM_count
608   collapse (firstnm) CVM_count CE_count WTP_count HPM_count TCM_count
609   stack CVM_count CE_count WTP_count HPM_count TCM_count, into(counts)
610   gen CVM = counts if _stack == 1
611   gen CE = counts if _stack == 2
612   gen WTP = counts if _stack == 3
613   gen HPM = counts if _stack == 4
614   gen TCM = counts if _stack == 5
```

```
615
616  graph bar (sum) CVM CE HPM TCM WTP, over(_stack, relabel(1 "CVM" 2 "CE" 3 "Other WTP" 4 "Hedonic" 5
     "Travel Cost") sort((sum) counts) descending) stack ylabel(, angle(45)) nolabel legend(off) saving(
     Lit_Count_by_Method.gph, replace) scheme(s1color)
617
618  * by Topic (changes dataset)
619  use Econ_Lit_NMV_Counts, clear
620  keep CVM_Env_NR CE_Env_NR WTP_Env_NR HPM_Env_NR TCM_Env_NR CVM_Rec_Fish CE_Rec_Fish WTP_Rec_Fish
     HPM_Rec_Fish TCM_Rec_Fish CVM_Ag_Food CE_Ag_Food WTP_Ag_Food HPM_Ag_Food TCM_Ag_Food CVM_Health
     CE_Health WTP_Health HPM_Health TCM_Health CVM_Transport CE_Transport WTP_Transport HPM_Transport
     TCM_Transport CVM_Other CE_Other WTP_Other HPM_Other TCM_Other
621  collapse (firstnm) CVM_Env_NR CE_Env_NR WTP_Env_NR HPM_Env_NR TCM_Env_NR CVM_Rec_Fish CE_Rec_Fish
     WTP_Rec_Fish HPM_Rec_Fish TCM_Rec_Fish CVM_Ag_Food CE_Ag_Food WTP_Ag_Food HPM_Ag_Food TCM_Ag_Food
     CVM_Health CE_Health WTP_Health HPM_Health TCM_Health CVM_Transport CE_Transport WTP_Transport
     HPM_Transport TCM_Transport CVM_Other CE_Other WTP_Other HPM_Other TCM_Other
622  stack CVM_Env_NR CE_Env_NR WTP_Env_NR HPM_Env_NR TCM_Env_NR CVM_Rec_Fish CE_Rec_Fish WTP_Rec_Fish
     HPM_Rec_Fish TCM_Rec_Fish CVM_Ag_Food CE_Ag_Food WTP_Ag_Food HPM_Ag_Food TCM_Ag_Food CVM_Health
     CE_Health WTP_Health HPM_Health TCM_Health CVM_Transport CE_Transport WTP_Transport HPM_Transport
     TCM_Transport CVM_Other CE_Other WTP_Other HPM_Other TCM_Other, into(CVM CE WTP HPM TCM)
623  gen counts = CVM + CE + HPM + TCM + WTP
624  egen rank = rank(counts), field
625
626  graph bar (asis) CVM CE HPM TCM WTP, over(_stack, relabel(1 "Env/NR" 2 "Rec/Fish" 3 "Ag/Food" 4
     "Health" 5 "Transport" 6 "Other") sort(rank)) stack ylabel(, angle(45)) nolabel saving(
     Lit_Count_by_Topic.gph, replace) scheme(s1color) legend(rows(1) label(3 "Hedonic") label(4 "TC")
     label(5 "Other WTP") colgap(*.3))
627
628  graph export "Lit_Count_by_Topic.png", as(png) replace
629
630  * legend(rows(1) order(5 4 3 2 1) ring(0) bplace(nw) rowgap(*.25) colgap(*.25))
631  *scheme(sj)
632
633  graph combine "Lit_Count_by_Method.gph" "Lit_Count_by_Year.gph" "Lit_Count_by_Topic.gph", rows(3)
     imargin(tiny) scheme(s1color)
634
635  graph export "Article_Count_ALL.png", as(png) replace
636
637  graph combine "Lit_Count_by_Method.gph" "Lit_Count_by_Topic.gph", rows(2) imargin(tiny) scheme(
     s1color)
638
639  graph export "Article_Count_2.png", as(png) replace
640
641
642
643
644
645
646
647
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649
650
651
652
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656
657
658
659
660
661
```

```
clear all
cd "C:\Users\Dan\Dropbox (AgEcon Miss State)\2020\2020 Papers\AEPP NMV Project\Revisions"

import excel NMV_in_RIAsTemplate_Revised_Aug6.xlsx, sheet("Template") cellrange(A2:AV57) firstrow

cd "C:\Users\Dan\Dropbox (AgEcon Miss State)\2020\2020 Papers\AEPP NMV Project\RIAs\Stata"

drop if FINALIZED == "RIA-DNE"

replace Mortality = "3" if Mortality == "3/1" | Mortality == "3/2"
replace Mortality = "1" if Mortality == "3(SC)/1"
replace Mortality = "0" if Mortality == "3(SC)/0"

replace Morbidity = "3" if Morbidity == "3/1" | Morbidity == "3/2" | Morbidity == "3/2/1"
replace Morbidity = "1" if Morbidity == "3(SC)/1"
replace Morbidity = "0" if Morbidity == "3(SC)/0"

replace Recreation = "3" if Recreation == "3/1"

replace Ecol_Veg = "3" if Ecol_Veg == "3/1" | Ecol_Veg == "3/2"
replace Ecol_Veg = "1" if Ecol_Veg == "2/1" | Ecol_Veg == "2"

replace Visibility = "3" if Visibility == "3/1"
replace Visibility = "1" if Visibility == "2"

replace Property = "1" if Property == "3(SC)/1"
replace Property = "0" if Property == "3(SC)/0"

destring Mortality Morbidity Recreation Ecol_Veg Visibility Property BenMAP SCCO2_CH4 VSL SP TCM HPM
HedWage COI_AC LostWages NoCausal NoTime QuantDisconnect MonetizDisconnect, replace

* Build BenMap into pie charts
replace VSL = 2 if BenMAP == 1 & VSL == 0
replace SP = 2 if BenMAP == 1 & SP == 0
replace HedWage = 2 if BenMAP == 1 & HedWage == 0
replace COI_AC = 2 if BenMAP == 1 & COI_AC == 0
replace LostWages = 2 if BenMAP == 1 & LostWages == 0

* Create climate benefits variable
gen Climate = SCCO2_CH4
replace Climate = 3 if SCCO2_CH4 == 1

*Merge COI/Avoided and Lost Wages
egen COI_AC_Lost = rowmax(COI_AC LostWages)

save RIA_counts, replace

*Graphs
*Benefits
graph pie, over(Mortality) legend(label(1 "Not Mentioned") label(2 "Qualitative") label(3
"Quantified-Monetized") order(3 2 1) rows(1)) plabel(_all sum, size(large)) title("Mortality") saving
(Pie_mort.gph, replace) pie(1, color(white)) pie(2, color(gs10)) pie(3, color(gs3)) line(lcolor(black
)) scheme(s1color)

graph pie, over(Morbidity) plabel(_all sum, size(large)) title("Morbidity") saving(Pie_morb.gph,
replace) pie(1, color(white)) pie(2, color(gs10)) pie(3, color(gs3)) line(lcolor(black)) scheme(
s1color)

graph pie, over(Recreation) plabel(_all sum, size(large)) title("Recreational") saving(Pie_Rec.gph,
replace) pie(1, color(white)) pie(2, color(gs10)) pie(3, color(gs3)) line(lcolor(black)) scheme(
s1color)

graph pie, over(Ecol_Veg) plabel(_all sum, size(large)) title("Ecological") saving(Pie_ecol.gph,
```

```
    replace) pie(1, color(white)) pie(2, color(gs10)) pie(3, color(gs3)) line(lcolor(black)) scheme(
    s1color)
56
57  graph pie, over(Visibility) plabel(_all sum, size(large)) title("Visibility") saving(Pie_vis.gph,
    replace) pie(1, color(white)) pie(2, color(gs10)) pie(3, color(gs3)) line(lcolor(black)) scheme(
    s1color)
58
59  graph pie, over(Property) plabel(_all sum, size(large)) title("Prop Damage") saving(Pie_prop.gph,
    replace) pie(1, color(white)) pie(2, color(gs10)) pie(3, color(gs3)) line(lcolor(black)) scheme(
    s1color)
60
61  graph pie, over(Climate) plabel(_all sum, size(large)) title("Climate") saving(Pie_climate.gph,
    replace) pie(1, color(white)) pie(2, color(gs3)) line(lcolor(black)) scheme(s1color)
62
63  *Combine benefit graphs
64  grc1leg2 Pie_morb.gph Pie_mort.gph Pie_climate.gph Pie_ecol.gph Pie_Rec.gph Pie_vis.gph Pie_prop.gph,
     cols(4) imargin(tiny) legendfrom(Pie_mort.gph) saving(Benefits_Pies, replace) scheme(s1color)
65
66  graph export Benefits_Pies.png, as(png) replace
67
68  *Models
69  graph pie, over(BenMAP) plabel(_all sum, size(large)) title("BenMAP") saving(Pie_BenMap.gph, replace)
     pie(1, color(white)) pie(3, color(gs10)) pie(2, color(gs3)) line(lcolor(black)) scheme(s1color)
70
71  graph pie, over(SCCO2_CH4) plabel(_all sum, size(large)) title("SC-GHG") saving(Pie_scc.gph, replace)
     pie(1, color(white)) pie(2, color(gs3)) line(lcolor(black)) scheme(s1color)
72
73  graph pie, over(VSL) plabel(_all sum, size(large)) legend(label(1 "Not Used") label(2 "Used") label(3
     "via BenMAP") order(2 3 1) rows(1)) title("VSL") saving(Pie_vsl.gph, replace) pie(1, color(white))
    pie(3, color(gs10)) pie(2, color(gs3)) line(lcolor(black)) scheme(s1color)
74
75  *Methods
76  graph pie, over(SP) plabel(_all sum, size(large)) legend(label(1 "Not Used") label(2 "Used Directly")
     label(3 "Used via BenMAP") order(2 3 1) rows(1)) plabel(_all sum, size(large)) title("SP") saving(
    Pie_sp.gph, replace) pie(1, color(white)) pie(3, color(gs10)) pie(2, color(gs3)) line(lcolor(black))
    scheme(s1color)
77
78  graph pie, over(TCM) plabel(_all sum, size(large)) title("TC") saving(Pie_tcm.gph, replace) pie(1,
    color(white)) pie(3, color(gs10)) pie(2, color(gs3)) line(lcolor(black)) scheme(s1color)
79
80  graph pie, over(HPM) plabel(_all sum, size(large)) title("Hedonic") saving(Pie_hprop.gph, replace)
    pie(1, color(white)) pie(3, color(gs10)) pie(2, color(gs3)) line(lcolor(black)) scheme(s1color)
81
82  graph pie, over(HedWage) plabel(_all sum, size(large)) title("Hedonic") saving(Pie_hwage.gph, replace
    ) pie(1, color(white)) pie(3, color(gs10)) pie(2, color(gs3)) line(lcolor(black)) scheme(s1color)
83
84  graph pie, over(COI_AC) plabel(_all sum, size(large)) title("COI/Avoided") saving(Pie_coi.gph,
    replace) pie(1, color(white)) pie(3, color(gs10)) pie(2, color(gs3)) line(lcolor(black)) scheme(
    s1color)
85
86  graph pie, over(LostWages) plabel(_all sum, size(large)) title("Lost Wages") saving(Pie_lost.gph,
    replace) pie(1, color(white)) pie(3, color(gs10)) pie(2, color(gs3)) line(lcolor(black)) scheme(
    s1color)
87
88  graph pie, over(COI_AC_Lost) plabel(_all sum, size(large)) title("COI/Avoided/Wages") saving(
    Pie_coi_ac_lost.gph, replace) pie(1, color(white)) pie(3, color(gs10)) pie(2, color(gs3)) line(lcolor
    (black)) scheme(s1color)
89
90  *Methods & Models Combined
91  grc1leg2 Pie_sp.gph Pie_hwage.gph Pie_tcm.gph Pie_coi_ac_lost.gph Pie_vsl.gph Pie_BenMap.gph Pie_scc.
    gph, rows(2) imargin(tiny) legendfrom(Pie_sp.gph) saving(Methods_Pies, replace) scheme(s1color)
92
93  graph export Methods_Models_Pies.png, as(png) replace
```

```
/*
EPA Grants Search Details

https://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/search.welcome

"Grantee Research Project Results ADVANCED Search"
"This exact phrase:"
contingent valuation
choice experiment
conjoint analysis
hedonic
travel cost
site choice
willingness to pay
willingness to accept
recreational demand
VSL
value of a statistical life
mortality risk
morbidity
economics
valuation
visibility

Types of EPA-Funded Research Projects (checked)
Research Centers
Fellowships
Grants
Small Business Innovation Research

Select the fields to be returned in table (checked)
identifier code
institution
principal investigator
EPA representative
grants amount
project start date
research category
RFA
*/

clear all
cd "C:\Users\Dan\Dropbox (AgEcon Miss State)\2020\2020 Papers\AEPP NMV Project\EPA_Grant_Counts"

import excel CV.xlsx, sheet("CV") firstrow allstring
gen CVtemp = 1
save CV, replace

clear all
import excel CE.xlsx, sheet("CE") firstrow allstring
gen CEtemp = 1
save CE, replace

clear all
import excel HP.xlsx, sheet("HP") firstrow allstring
gen HPtemp = 1
save HP, replace

clear all
import excel SC.xlsx, sheet("SC") firstrow allstring
gen SCtemp = 1
save SC, replace

clear all
import excel TC.xlsx, sheet("TC") firstrow allstring
gen TCtemp = 1
save TC, replace

clear all
```

```
import excel WA.xlsx, sheet("WA") firstrow allstring
gen WAtemp = 1
save WA, replace

clear all
import excel WP.xlsx, sheet("WP") firstrow allstring
gen WPtemp = 1
save WP, replace

clear all
import excel CA.xlsx, sheet("CA") firstrow allstring
gen CAtemp = 1
save CA, replace

clear all
import excel RD.xlsx, sheet("RD") firstrow allstring
gen RDtemp = 1
save RD, replace

clear all
import excel VSL.xlsx, sheet("VSL") firstrow allstring
gen VSLtemp = 1
save VSL, replace

clear all
import excel MOR.xlsx, sheet("MOR") firstrow allstring
gen MORtemp = 1
save MOR, replace

clear all
import excel MR.xlsx, sheet("MR") firstrow allstring
gen MBtemp = 1
save MR, replace

clear all
import excel ECONcat.xlsx, sheet("ECONcat") firstrow allstring
gen ECONcat = 1
save ECONcat.dta, replace

clear all
import excel VIS.xlsx, sheet("VIS") firstrow allstring
gen VIS = 1
save VIS, replace

clear all
import excel ECONkey.xlsx, sheet("ECONkey") firstrow allstring
gen ECONkey = 1
save ECONkey, replace

clear all
import excel VALUATIONkey.xlsx, sheet("VALUATIONkey") firstrow allstring
gen VALUATION = 1
save VALUATIONkey, replace

use CV, clear
append using CE
append using WP
append using HP
append using TC
append using CA
append using SC
append using RD
append using WA
append using VSL
append using MOR
append using MR
append using VIS
append using ECONcat
append using ECONkey
append using VALUATIONkey
```

```
140   save Grant_Counts, replace
141
142   drop NUMBER
143
144   rename PROJECTSTARTDATE date
145   split date, p(-)
146   gen year = 1989 if date1 == "89"
147   replace year = 1990 if date1 == "90"
148   replace year = 1991 if date1 == "91"
149   replace year = 1992 if date1 == "92"
150   replace year = 1993 if date1 == "93"
151   replace year = 1994 if date1 == "94"
152   replace year = 1995 if date1 == "95"
153   replace year = 1996 if date1 == "96"
154   replace year = 1997 if date1 == "97"
155   replace year = 1998 if date1 == "98"
156   replace year = 1999 if date1 == "99"
157   replace year = 2000 if date1 == "00"
158   replace year = 2001 if date1 == "01"
159   replace year = 2002 if date1 == "02"
160   replace year = 2003 if date1 == "03"
161   replace year = 2004 if date1 == "04"
162   replace year = 2005 if date1 == "05"
163   replace year = 2006 if date1 == "06"
164   replace year = 2007 if date1 == "07"
165   replace year = 2008 if date1 == "08"
166   replace year = 2009 if date1 == "09"
167   replace year = 2010 if date1 == "10"
168   replace year = 2011 if date1 == "11"
169   replace year = 2012 if date1 == "12"
170   replace year = 2013 if date1 == "13"
171   replace year = 2014 if date1 == "14"
172   replace year = 2015 if date1 == "15"
173   replace year = 2016 if date1 == "16"
174   replace year = 2017 if date1 == "17"
175   replace year = 2018 if date1 == "18"
176   replace year = 2020 if date1 == "19"
177   replace year = 2001 if date1 == "1"
178   replace year = 2002 if date1 == "2"
179   replace year = 2003 if date1 == "3"
180   replace year = 2004 if date1 == "4"
181   replace year = 2005 if date1 == "5"
182   replace year = 2006 if date1 == "6"
183   replace year = 2007 if date1 == "7"
184   replace year = 2008 if date1 == "8"
185   replace year = 2009 if date1 == "9"
186
187   replace year = 1989 if date2 == "89"
188   replace year = 1990 if date2 == "90"
189   replace year = 1991 if date2 == "91"
190   replace year = 1992 if date2 == "92"
191   replace year = 1993 if date2 == "93"
192   replace year = 1994 if date2 == "94"
193   replace year = 1995 if date2 == "95"
194   replace year = 1996 if date2 == "96"
195   replace year = 1997 if date2 == "97"
196   replace year = 1998 if date2 == "98"
197   replace year = 1999 if date2 == "99"
198   replace year = 2000 if date2 == "00"
199   replace year = 2001 if date2 == "01"
200   replace year = 2002 if date2 == "02"
201   replace year = 2003 if date2 == "03"
202   replace year = 2004 if date2 == "04"
203   replace year = 2005 if date2 == "05"
204   replace year = 2006 if date2 == "06"
205   replace year = 2007 if date2 == "07"
206   replace year = 2008 if date2 == "08"
207   replace year = 2009 if date2 == "09"
208   replace year = 2010 if date2 == "10"
209   replace year = 2011 if date2 == "11"
```

```
210   replace year = 2012 if date2 == "12"
211   replace year = 2013 if date2 == "13"
212   replace year = 2014 if date2 == "14"
213   replace year = 2015 if date2 == "15"
214   replace year = 2016 if date2 == "16"
215   replace year = 2017 if date2 == "17"
216   replace year = 2018 if date2 == "18"
217   replace year = 2020 if date2 == "19"
218   replace year = 2001 if date2 == "1"
219   replace year = 2002 if date2 == "2"
220   replace year = 2003 if date2 == "3"
221   replace year = 2004 if date2 == "4"
222   replace year = 2005 if date2 == "5"
223   replace year = 2006 if date2 == "6"
224   replace year = 2007 if date2 == "7"
225   replace year = 2008 if date2 == "8"
226   replace year = 2009 if date2 == "9"
227   destring year, replace
228
229   order year, before(date)
230   drop date date1 date2
231   rename GRANTAMOUNT funding
232   destring funding, replace
233
234   by EPAID,sort: egen CV = max(CVtemp)
235   by EPAID,sort: egen CE = max(CEtemp)
236   by EPAID,sort: egen HPM = max(HPtemp)
237   by EPAID,sort: egen sc = max(SCtemp)
238   by EPAID,sort: egen TCM = max(TCtemp)
239   by EPAID,sort: egen wa = max(WAtemp)
240   by EPAID,sort: egen WTP = max(WPtemp)
241   by EPAID,sort: egen ca = max(CAtemp)
242   by EPAID,sort: egen rd = max(RDtemp)
243   by EPAID,sort: egen VSL = max(VSLtemp)
244   by EPAID,sort: egen mor = max(MORtemp)
245   by EPAID,sort: egen mb = max(MBtemp)
246   by EPAID,sort: egen vis = max(VIS)
247   by EPAID,sort: egen Econcat = max(ECONcat)
248   by EPAID,sort: egen Econkey = max(ECONkey)
249   by EPAID,sort: egen Valuation = max(VALUATION)
250
251   drop CVtemp CEtemp HPtemp SCtemp TCtemp WAtemp WPtemp CAtemp RDtemp VSLtemp MORtemp MBtemp
      ECONcat ECONkey VALUATION VIS
252
253   rename (EPAID ABSTRACT ViewProjectDetails PRINCIPALINVESTIGATOR INSTITUTION
      EPAREPRESENTATIVE RFA RESEARCHCATEGORY) (epaid title link investigators institution eparep
      rfa researchcategory)
254
255   duplicates report
256   duplicates drop epaid, force
257   duplicates report
258
259   replace CE = 1 if ca == 1
260   replace TCM = 1 if sc == 1 | rd == 1
261   replace WTP = 1 if wa == 1 | Valuation == 1
262   replace CE = 1 if strpos(title, "Discrete Choice") > 0
263   replace CV = 0 if CV == .
264   replace CE = 0 if CE == .
265   replace WTP = 0 if WTP == .
266   replace TCM = 0 if TCM == .
267   replace HPM = 0 if HPM == .
268   replace VSL = 0 if VSL == .
269   replace HPM = 0 if TCM == 1
270   replace CV = 0 if HPM == 1 | TCM == 1
271   replace CE = 0 if CV == 1 | HPM == 1 | TCM == 1
272   replace VSL = 0 if CE == 1 | CV == 1 | HPM == 1 | TCM == 1
273   replace WTP = 0 if VSL == 1 | CE == 1 | CV == 1 | HPM == 1 | TCM == 1
274
275   gen NMV = 1 if VSL == 1 | CE == 1 | CV == 1 | HPM == 1 | TCM == 1 | WTP == 1
276   replace NMV = 0 if NMV == .
```

```
277  gen NonNMV = 1 - NMV
278
279  *Economics
280  gen Econ = 1 if Econcat == 1 | Econkey == 1
281  replace Econ = 1 if strpos(researchcategory,"Economics") > 0
282  replace Econ = 1 if NMV == 1
283  replace Econ = 0 if Econ == .
284  drop if Econ == 0 & NonNMV == 0
285
286  gen nonecon = 0 if strpos(title, "Economic") > 0
287  replace nonecon = 0 if strpos(title, "economic") > 0
288  replace nonecon = 0 if strpos(title, "Econometric") > 0
289  replace nonecon = 0 if strpos(title, "econometric") > 0
290  replace nonecon = 0 if strpos(title, "Policy") > 0
291  replace nonecon = 0 if strpos(title, "policy") > 0
292  replace nonecon = 0 if strpos(title, "Incentive") > 0
293  replace nonecon = 0 if strpos(title, "incentive") > 0
294  replace nonecon = 0 if strpos(title, "Decision") > 0
295  replace nonecon = 0 if strpos(title, "decision") > 0
296  replace nonecon = 0 if strpos(title, "Statistical") > 0
297  replace nonecon = 0 if strpos(title, "statistical") > 0
298  replace nonecon = 0 if strpos(researchcategory,"Economics") > 0
299  replace nonecon = 1 if strpos(title, "Economical") > 0
300  replace nonecon = 1 if strpos(title, "Economic Capture") > 0
301  replace nonecon = 1 if nonecon != 0
302  drop if nonecon == 1 & NonNMV == 1
303
304  order NMV NonNMV CV CE WTP HPM TCM VSL ca sc rd wa mor mb Econ Valuation, after(epaid)
305
306  *Benefit Categories by EPA Research Category & RFA
307
308  * By title
309  gen Ecological = 1 if strpos(title, "Ecological Impact of Vegetated Stormwater Systems") > 0
310  replace Ecological = 1 if strpos(title, "Impact of Fugitive Methane Emissions on Ecosystem
     Services") > 0
311  replace Ecological = 1 if strpos(title, "Sustainability and Risk of Fragmented Habitats") > 0
312  replace Ecological = 1 if strpos(title, "Integrated Environmental Futures for the U.S.") > 0
313  replace Ecological = 1 if strpos(title, "Effects of Nutrients on Algal Growth") > 0
314  replace Ecological = 1 if strpos(title, "Community Values and the Long-term Ecological
     Integrity") > 0
315  replace Ecological = 1 if strpos(title, "The role of ecosystem processes in restoring local
     and regional species diversity") > 0
316  replace Ecological = 1 if strpos(title, "Land Use Planning for Urban Wildlife and Education"
     ) > 0
317  replace Ecological = 1 if strpos(title, "Industrial Ecology") > 0
318  replace Ecological = 1 if strpos(title, "Urban Quagmire: Law and Chicago's Wetlands,
     1820-1920") > 0
319  replace Ecological = 1 if strpos(title, "Ecological Production Function Approach") > 0
320  replace Ecological = 1 if strpos(title, "Multiple-Stressors in the Lake Erie Ecosystem") > 0
321  replace Ecological = 1 if strpos(title, "Designing Incentives that Strengthen Local
     Capacity") > 0
322  replace Ecological = 1 if strpos(title, "Impact of Social Systems on Ecology") > 0
323  replace Ecological = 1 if strpos(title, "A Tool to Improve Analysis of Environmental
     Quality and Sustainability") > 0
324  replace Ecological = 1 if strpos(title, "Computer-Aided Hybrid Models for Environmental") > 0
325  replace Ecological = 1 if strpos(title, "Marine Facilities and Water Pollution") > 0
326  replace Ecological = 1 if strpos(title, "An Experimental Economics Examination of Incentive
     Mechanisms for Reducing Ambient Water Pollution") > 0
327  replace Ecological = 1 if strpos(title, "Center for Integrating Statistical and
     Environmental Science") > 0
328  replace Ecological = 1 if strpos(title, "Testing the Potential to Implement Collective
     Enforcement") > 0
329  replace Ecological = 1 if strpos(title, "The Importance of Pulsed Physical Events for
     Watershed Sustainability") > 0
330  replace Ecological = 1 if strpos(title, "Over-compliance in Point Source Water Pollution") >
      0
331  replace Ecological = 1 if strpos(title, "Ecological, Demographic, and Economic Evaluation")
     > 0
332  replace Ecological = 1 if strpos(title, "Wildfire Risk Reduction: Homeowners and
     Decision-Making in the Wildland Urban Interface") > 0
```

```
333   replace Ecological = 1 if strpos(title, "Economic Impacts of Multiple Stresses") > 0
334   replace Ecological = 1 if strpos(title, "Economic Effects of Multiple Stresses") > 0
335   replace Ecological = 1 if strpos(title, "Data Integration and Decision Support Core") > 0
336   replace Ecological = 1 if strpos(title, "Ecological, Demographic, and Economic Evaluation")
      > 0
337
338   gen Health = 1 if strpos(title, "The Role of Information in Environmental Health Policy") > 0
339   replace Health = 1 if strpos(title, "The Economic Value of Health Improvements in Drinking
      Water") > 0
340   replace Health = 1 if strpos(title, "Heat-related Hospital Admissions Among the Elderly") > 0
341   replace Health = 1 if strpos(title, "Perceptions of and Exposure to Arsenic in Private and
      Public Drinking Water") > 0
342   replace Health = 1 if strpos(title, "Project 5: Projecting and Quantifying Future Changes")
      > 0
343   replace Health = 1 if strpos(title, "Water Infrastructure Sustainability and Health in
      Alabama") > 0
344   replace Health = 1 if strpos(title, "Geochemical, Biological and Economic Effects of
      Arsenic") > 0
345   replace Health = 1 if strpos(title, "Quasi-Experimental Evidence on How Airborne
      Particulates Affect Human Health") > 0
346   replace Health = 1 if strpos(title, "Contingent Valuation for Ecological and Noncancer
      Effects") > 0
347   replace Health = 1 if strpos(title, "Wildfires in the Rocky Mountains Region") > 0
348   replace Health = 1 if strpos(title, "Electrochemical Arsenic Remediation") > 0
349   replace Health = 1 if strpos(title, "Arsenic and Microbial Removal Filter in Rural Nepal") >
       0
350   replace Health = 1 if strpos(title, "Causal Inference Framework to Support Policy Decisions
      by Evaluating the Effectiveness of Past Air Pollution Control") > 0
351   replace Health = 1 if strpos(title, "National Pollution Mixtures on Health") > 0
352   replace Health = 1 if strpos(title, "How will cleaner cooking and lighting practices impact
      regional air quality") > 0
353   replace Health = 1 if strpos(title, "Experimental Interventions to Facilitate Clean
      Cookstove Adoption") > 0
354   replace Health = 1 if strpos(title, "Mechanistic Evaluation of the Toxicity of Chemical
      Mixtures") > 0
355   replace Health = 1 if strpos(title, "Regulation of Embryonic Neuronal Development by
      Chemical Mixtures from Brick") > 0
356   replace Health = 1 if strpos(title, " Reducing Risk by Restoring Relationships") > 0
357
358   gen Climate = 1 if strpos(title, "Modeling Alternative Vehicle Technology Potential for
      Climate Change") > 0
359   replace Climate = 1 if strpos(title, "Households, Consumption, and Energy Use") > 0
360   replace Climate = 1 if strpos(title, "An Integrated Modeling and Decision Framework to
      Evaluate Adaptation Strategies for Sustainable") > 0
361   replace Climate = 1 if strpos(title, "Vulnerability of Water Resources to Global Climate
      Change") > 0
362   replace Climate = 1 if strpos(title, "A National Assessment of the Impact of Climate Change"
      ) > 0
363   replace Climate = 1 if strpos(title, "Integrated Assessment of the Public Health Effects of
      Climate Change") > 0
364   replace Climate = 1 if strpos(title, "Integrated Assessment of Economic Adaptation
      Strategies for Climate Change Impacts") > 0
365   replace Climate = 1 if strpos(title, "Sensitivity Analysis of the Effect of Changes in Mean
      and Variability of Climate") > 0
366   replace Climate = 1 if strpos(title, "An Integrated Assessment of the Effects of Climate
      Change") > 0
367   replace Climate = 1 if strpos(title, "Assessment of the Consequences of Climate Change on
      the South Florida Environment") > 0
368   replace Climate = 1 if strpos(title, "Impact of Climate on the Lower Yakima River Basin") > 0
369   replace Climate = 1 if strpos(title, "Statistical Approaches to Detection and Downscaling
      of Climate Variability") > 0
370   replace Climate = 1 if strpos(title, "Predicting Ecological and Socioeconomic Costs of
      Climate Change") > 0
371   replace Climate = 1 if strpos(title, "Effects of Climate Change On Ecosystem Services") > 0
372   replace Climate = 1 if strpos(title, "Center for Air, Climate, and Energy Solutions") > 0
373   replace Climate = 1 if strpos(title, "Modeling Emissions from Energy Transitions") > 0
374
375   gen Waste = 1 if strpos(title, "Improving Resource Recovery of Organic Waste") > 0
376   replace Waste = 1 if strpos(title, "Pollution Prevention: The Role of Environmental
      Management and Information") > 0
```

```
377   replace Waste = 1 if strpos(title, "Intelligent Decision Making and System Development for
      Comprehensive Waste Minimization") > 0
378   replace Waste = 1 if strpos(title, "Preparation of Pollution Prevention and Socio-Economic
      Monographs") > 0
379   replace Waste = 1 if strpos(title, "Design of Optimal Cost-Sharing Arrangements for
      Nonpoint Source Pollution") > 0
380   replace Waste = 1 if strpos(title, "The Role of Information and Learning in Nonpoint Source
      Pollution Control") > 0
381   replace Waste = 1 if strpos(title, "Development of Source-Separation Latrine Technology for
      Sustainable Human Waste Management") > 0
382   replace Waste = 1 if strpos(title, "From Brownfields to Green Streets") > 0
383   replace Waste = 1 if strpos(title, "Urban Regeneration through Environmental Remediation") >
       0
384   replace Waste = 1 if strpos(title, "Encouraging Innovation Through Umbrella Permitting") > 0
385   replace Waste = 1 if strpos(title, "P2 Incentive Contracts Enhancing Diffusion") > 0
386   replace Waste = 1 if strpos(title, "A Novel Pressure-Exchange Ejector Refrigeration System")
       > 0
387   replace Waste = 1 if strpos(title, "Catalysts for Environmentally Benign Organic") > 0
388   replace Waste = 1 if strpos(title, "Risk Communication in Community Participation") > 0
389
390   gen Energy = 1 if strpos(title, "From Field to Fuel Tank") > 0
391   replace Energy = 1 if strpos(title, "Use of source reduction and energy efficiency") > 0
392   replace Energy = 1 if strpos(title, "The Political Ecology of Sustainable Agriculture") > 0
393   replace Energy = 1 if strpos(title, "Reusable Biodegradable Solvents from Biodiesel") > 0
394   replace Energy = 1 if strpos(title, "Community Based Biodiesel Production from Trap Grease")
       > 0
395   replace Energy = 1 if strpos(title, "Technological and Economic Sustainability of Coupling
      Wastewater") > 0
396   replace Energy = 1 if strpos(title, "Smoothing the Peaks") > 0
397   replace Energy = 1 if strpos(title, "Barriers to the Adoption of Sustainable Lighting") > 0
398   replace Energy = 1 if strpos(title, "Sustainable Water Development Program for Rural
      Nigeria") > 0
399   replace Energy = 1 if strpos(title, "Integrated Development of Environmentally Friendly
      Sustainable Water") > 0
400   replace Energy = 1 if strpos(title, "Sustainable Anaerobic Digester/Cook Stove Design to
      Promote") > 0
401   replace Energy = 1 if strpos(title, "Development of Sustainable Integrated Aquaculture") > 0
402   replace Energy = 1 if strpos(title, "Design and Consumer Testing of Marketable Residential
      LED") > 0
403   replace Energy = 1 if strpos(title, "Urban Green Roof Applications") > 0
404   replace Energy = 1 if strpos(title, "Sustainable Urban Planning in a Built") > 0
405   replace Energy = 1 if strpos(title, "Developing an Effective Water Purification System") > 0
406   replace Energy = 1 if strpos(title, "Manure Digester Biogas-Powered Fuel Cells") > 0
407   replace Energy = 1 if strpos(title, "UV-Tube Design Concept for Sustainable") > 0
408   replace Energy = 1 if strpos(title, "Sustainable Urban Water Management") > 0
409   replace Energy = 1 if strpos(title, "Next Generation Volume Reduction Green Infrastructure")
       > 0
410   replace Energy = 1 if strpos(title, "Sustainable Community Oriented Stormwater Management")
      > 0
411   replace Energy = 1 if strpos(title, "Green Infrastructure Design and Visualization") > 0
412   replace Energy = 1 if strpos(title, "Creating Sustainability Indicators to Assess the
      Physical") > 0
413   replace Energy = 1 if strpos(title, "Computational Requirements of Statistical Learning") > 0
414   replace Energy = 1 if strpos(title, "A Cost-Benefit Analysis of Public Incentives of
      Private Enterprise Investment in Sustainable Urban Development") > 0
415   replace Energy = 1 if strpos(title, "Environmentally Conscious Design and Manufacturing") > 0
416   replace Energy = 1 if strpos(title, "Risk Based Urban Watershed Management-Integration") > 0
417   replace Energy = 1 if strpos(title, "Policy Frameworks to Stimulate Environmental
      Technology") > 0
418   replace Energy = 1 if strpos(title, "Integrating Framework for Urbanizing Watersheds") > 0
419   replace Energy = 1 if strpos(title, "Cuyahoga Sustainability Network") > 0
420   replace Energy = 1 if strpos(title, "Using Market Forces to Implement Sustainable
      Stormwater Management") > 0
421   replace Energy = 1 if strpos(title, "Multi-Objective Decision Model for Urban Water Use") > 0
422   replace Energy = 1 if strpos(title, "Culture and Urban Water Use in the Arid Southwest") > 0
423   replace Energy = 1 if strpos(title, "Cognitive and Institutional Barriers") > 0
424   replace Energy = 1 if strpos(title, "Non-Hydrological Benefits and Citizen Preference") > 0
425   replace Energy = 1 if strpos(title, "Public Engagement and Outreach") > 0
426   replace Energy = 1 if strpos(title, "Rainwater Harvesting") > 0
427   replace Energy = 1 if strpos(title, "Developing and Applying a Rooftop Rainwater Harvesting"
```

```
) > 0
replace Energy = 1 if strpos(title, "Measuring the Impacts of Existing Artificial Optical Radiation") > 0
replace Energy = 1 if strpos(title, "Development of An Economic Grain Storage System") > 0

gen Other = 1 if strpos(title, "Comparison of the Effect of American Bison and Cattle") > 0

gen categorized = 1 if Ecological == 1 | Climate == 1 | Health == 1 | Energy == 1 | Waste == 1

*Climate
replace Climate = 1 if strpos(researchcategory,"Climate") > 0 & categorized == .
replace Climate = 1 if strpos(researchcategory,"Greenhouse Gases") > 0 & categorized == .

*Health
replace Health = 1 if strpos(researchcategory,"Health") > 0 & categorized == .
replace Health = 1 if strpos(researchcategory, "Toxicology") > 0 & categorized == .
replace Health = 1 if strpos(researchcategory, "Pesticides and Toxic Substances") > 0 & categorized == .
replace Health = 1 if strpos(researchcategory, "Endocrine Disruptors") > 0 & categorized == .
replace Health = 1 if strpos(researchcategory, "Chemicals") > 0 & categorized == .
replace Health = 0 if strpos(researchcategory, "ecological health") > 0 & categorized == .
replace Health = 1 if strpos(rfa, "Environmental Lung Disease Center") > 0 & categorized == .
replace Health = 1 if strpos(rfa, "Pesticide") > 0 & categorized == .
replace Health = 1 if strpos(researchcategory, "Particulate Matter") > 0 & categorized == .
replace Health = 1 if strpos(researchcategory, "Emission Reductions") > 0 & categorized == .
replace Health = 1 if strpos(rfa, "Center on Airborne Organics") > 0 & categorized == .
replace Health = 1 if strpos(rfa, "Center for Air Toxic Metals") > 0 & categorized == .
replace Health = 1 if strpos(researchcategory, "Visibility") > 0 & categorized == .

*Ecological
replace Ecological = 1 if strpos(researchcategory,"Ecological") > 0 & categorized == .
replace Ecological = 1 if strpos(researchcategory,"Ecology") > 0 & categorized == .
replace Ecological = 1 if strpos(rfa, "Ecosystem Modeling") > 0 & categorized == .
replace Ecological = 1 if strpos(researchcategory, "Harmful Algal Blooms") > 0 & categorized == .
replace Ecological = 1 if strpos(researchcategory, "Hydrology") > 0 & categorized == .
replace Ecological = 1 if strpos(researchcategory, "Aquatic") > 0 & categorized == .
replace Ecological = 1 if strpos(researchcategory, "Marine") > 0 & categorized == .
replace Ecological = 1 if strpos(researchcategory, "Coastal") > 0 & categorized == .
replace Ecological = 1 if strpos(researchcategory, "Oceanography") > 0 & categorized == .
replace Ecological = 1 if strpos(rfa, "Coral Reef") > 0 & categorized == .
replace Ecological = 1 if strpos(rfa, "Alabama Center for Estuarine Studies") > 0 & categorized == .

*Waste
replace Waste = 1 if strpos(researchcategory,"Waste") > 0 & categorized == .
replace Waste = 1 if strpos(researchcategory,"Pollution Prevention/Sustainable Development") > 0 & categorized == .
replace Waste = 1 if strpos(researchcategory,"Pollution Prevention") > 0 & categorized == .
replace Waste = 1 if strpos(researchcategory,"Cleanup of Contaminated Sediments") > 0 & categorized == .
replace Waste = 1 if strpos(researchcategory,"Oil Spill Impacts") > 0 & categorized == .
replace Waste = 1 if strpos(researchcategory, "Clean Industrial and Treatment Technologies") > 0 & categorized == .
replace Waste = 1 if strpos(rfa, "Urban Waste Management") > 0 & categorized == .

*Energy/Sustainability
replace Energy = 1 if strpos(researchcategory,"Sustainability") > 0 & categorized == .
replace Energy = 1 if strpos(researchcategory,"Green") > 0 & categorized == .
replace Energy = 1 if strpos(researchcategory,"Sustainable") > 0 & categorized == .
replace Energy = 1 if strpos(researchcategory,"Sustainabile") > 0 & categorized == .
replace Energy = 1 if strpos(researchcategory,"Innovation in Manufacturing") > 0 & categorized == .
replace Energy = 1 if strpos(researchcategory, "Built Environment") > 0 & categorized == .
replace Energy = 1 if strpos(researchcategory, "Building Materials") > 0 & categorized == .
replace Energy = 1 if strpos(researchcategory, "Urban") > 0 & categorized == .

*Categorize remaining using title keywords
replace categorized = 1 if Climate == 1 | Health == 1 | Ecological == 1 | Waste == 1 |
```

```
    Energy == 1

replace Climate = 1 if strpos(title, "climate") > 0 & categorized == .
replace Climate = 1 if strpos(title, "Climate") > 0 & categorized == .
replace Climate = 1 if strpos(title, "Carbon Abatement") > 0 & categorized == .
replace Climate = 1 if strpos(title, "Greenhouse Gas") > 0 & categorized == .

replace Health = 1 if strpos(title,"health") > 0 & categorized == .
replace Health = 1 if strpos(title, "Health") > 0 & categorized == .
replace Health = 1 if strpos(title,"exposure") > 0 & categorized == .
replace Health = 1 if strpos(title,"Exposure") > 0 & categorized == .
replace Health = 1 if strpos(title, "toxicology") > 0 & categorized == .
replace Health = 1 if strpos(title, "endocrine disruptor") > 0 & categorized == .
replace Health = 1 if strpos(title, "chemical") > 0 & categorized == .
replace Health = 1 if strpos(title, "Pesticide") > 0 & categorized == .
replace Health = 1 if strpos(title, "Pharmacokinetic") > 0 & categorized == .
replace Health = 1 if strpos(title, "Risk-Tradeoff") > 0 & categorized == .
replace Health = 1 if strpos(title, "visibility") > 0 & categorized == .
replace Health = 1 if strpos(title, "particulate matter") > 0 & categorized == .
replace Health = 1 if strpos(title, "SO<sub>2</sub> Allowance") > 0 & categorized == .
replace Health = 1 if strpos(title, "Ozone") > 0 & categorized == .
replace Health = 1 if strpos(title, "Emissions Trading") > 0 & categorized == .
replace Health = 1 if strpos(title, "Tradable Emission") > 0 & categorized == .
replace Health = 1 if strpos(title, "RECLAIM Trading") > 0 & categorized == .
replace Health = 1 if strpos(title, "Engine Emission") > 0 & categorized == .

replace Ecological = 1 if strpos(title,"ecological") > 0 & categorized == .
replace Ecological = 1 if strpos(title, "Ecological") > 0 & categorized == .
replace Ecological = 1 if strpos(title,"Ecology") > 0 & categorized == .
replace Ecological = 1 if strpos(title,"ecology") > 0 & categorized == .
replace Ecological = 1 if strpos(title, "Ecosystem") > 0 & categorized == .
replace Ecological = 1 if strpos(title, "Forest") > 0 & categorized == .
replace Ecological = 1 if strpos(title, "Wildfire") > 0 & categorized == .
replace Ecological = 1 if strpos(title, "Zebra Mussel") > 0 & categorized == .
replace Ecological = 1 if strpos(title, "Biodiversity") > 0 & categorized == .
replace Ecological = 1 if strpos(title, "Immunosuppression in Birds") > 0 & categorized == .
replace Ecological = 1 if strpos(title, "Conservation") > 0 & categorized == .
replace Ecological = 1 if strpos(title, "Deforestation") > 0 & categorized == .
replace Ecological = 1 if strpos(title, "Endangered") > 0 & categorized == .
replace Ecological = 1 if strpos(title, "Wildlife") > 0 & categorized == .
replace Ecological = 1 if strpos(title, "Shoreline") > 0 & categorized == .
replace Ecological = 1 if strpos(title, "Salmon") > 0 & categorized == .
replace Ecological = 1 if strpos(title, "Fish") > 0 & categorized == .
replace Ecological = 1 if strpos(title, "Great Apes") > 0 & categorized == .
replace Ecological = 1 if strpos(title, "Vernal Pool") > 0 & categorized == .
replace Ecological = 1 if strpos(title, "Habitat Restoration") > 0 & categorized == .
replace Ecological = 1 if strpos(title, "Environmental Restoration") > 0 & categorized == .
replace Ecological = 1 if strpos(title, "harmful algal blooms") > 0 & categorized == .
replace Ecological = 1 if strpos(title, "Water") > 0 & categorized == .
replace Ecological = 1 if strpos(title, "Nonpoint Source") > 0 & categorized == .
replace Ecological = 1 if strpos(title, "Exurban") > 0 & categorized == .
replace Ecological = 1 if strpos(title, "Vadose Zone") > 0 & categorized == .
replace Ecological = 1 if strpos(title, "Mangrove") > 0 & categorized == .
replace Ecological = 1 if strpos(title, "Marine Aquaculture") > 0 & categorized == .
replace Ecological = 1 if strpos(title, "Coastal") > 0 & categorized == .
replace Ecological = 1 if strpos(title, "Wetland") > 0 & categorized == .
replace Ecological = 1 if strpos(title, "wetland") > 0 & categorized == .
replace Ecological = 1 if strpos(title, "Sea Crisis") > 0 & categorized == .
replace Ecological = 1 if strpos(title, "Wilderness") > 0 & categorized == .

replace Waste = 1 if strpos(title, "waste") > 0 & categorized == .
replace Waste = 1 if strpos(title, "pollution") > 0 & categorized == .
replace Waste = 1 if strpos(title, "Waste") > 0 & categorized == .
replace Waste = 1 if strpos(title, "Pollution") > 0 & categorized == .
replace Waste = 1 if strpos(title, "Sewer") > 0 & categorized == .
replace Waste = 1 if strpos(title, "Toxics") > 0 & categorized == .
replace Waste = 1 if strpos(title, "Brownfields") > 0 & categorized == .
replace Waste = 1 if strpos(title, "Phytoremediation") > 0 & categorized == .
replace Waste = 1 if strpos(title, "Remediation") > 0 & categorized == .
replace Waste = 1 if strpos(title, "Chemical Use") > 0 & categorized == .
```

```
557   replace Waste = 1 if strpos(title, "Undesirable Facilities") > 0 & categorized == .
558   replace Waste = 1 if strpos(title, "Industrial Site") > 0 & categorized == .
559   replace Waste = 1 if strpos(title, "Polluter Behavior") > 0 & categorized == .
560   replace Waste = 1 if strpos(title, "Sanitation") > 0 & categorized == .
561   replace Waste = 1 if strpos(title, "Cleanup") > 0 & categorized == .
562
563   *Energy
564   replace Energy = 1 if strpos(title, "Environmental Labeling") > 0 & categorized == .
565   replace Energy = 1 if strpos(title, "Green") > 0 & categorized == .
566   replace Energy = 1 if strpos(title, "Sustainable") > 0 & categorized == .
567   replace Energy = 1 if strpos(title, "Sustainability") > 0 & categorized == .
568   replace Energy = 1 if strpos(title, "Urban") > 0 & categorized == .
569   replace Energy = 1 if strpos(title, "Productivity Benefits") > 0 & categorized == .
570   replace Energy = 1 if strpos(title, "Energy") > 0 & categorized == .
571   replace Energy = 1 if strpos(title, "CAFE Standards") > 0 & categorized == .
572   replace Energy = 1 if strpos(title, "Biodiesel") > 0 & categorized == .
573   replace Energy = 1 if strpos(title, "Natural Gas") > 0 & categorized == .
574   replace Energy = 1 if strpos(title, "Biofuel") > 0 & categorized == .
575   replace Energy = 1 if strpos(title, "Biomass") > 0 & categorized == .
576   replace Energy = 1 if strpos(title, "Energy Efficiency") > 0 & categorized == .
577   replace Energy = 1 if strpos(title, "Wind Resources") > 0 & categorized == .
578   replace Energy = 1 if strpos(title, "Solar Electric") > 0 & categorized == .
579   replace Energy = 1 if strpos(title, "Older Cars") > 0 & categorized == .
580   replace Energy = 1 if strpos(title, "Mineral and Renewable Assets") > 0 & categorized == .
581   replace Energy = 1 if strpos(title, "Fuel Economy") > 0 & categorized == .
582
583   egen total_cats = rowtotal(Climate Health Ecological Waste Energy)
584
585   replace Other = 1 if total_cats == 0
586   replace Waste = 0 if Other == 1
587   replace Energy = 0 if Other == 1
588   replace Health = 0 if Health == .
589   replace Climate = 0 if Climate == .
590   replace Ecological = 0 if Ecological == .
591   replace Waste = 0 if Waste == .
592   replace Energy = 0 if Energy == .
593   replace Other = 0 if Other == .
594
595   save Grant_Counts, replace
596
597   * Bar Charts
598
599   graph bar (sum) CV CE WTP HPM TCM VSL NonNMV, over(NMV, relabel(1 "Non-NMV" 2 "NMV")) stack
      nolabel yvaroptions(sort(1) rev) legend(rows(2) order(3 1 5 6 2 4) ring(0) bplace(nw) rowgap
      (*.5) colgap(*.5)) bar(7, color(black)) saving(Grant_Count_by_Method.gph, replace)
600
601   *ytitle("Grants by Method")
602
603   graph bar (sum) NMV NonNMV, over(year, relabel(1 "1995" 2 " " 3 " " 4 " " 5 " " 6 "2000" 7
      " " 8 " " 9 " " 10 " " 11 "2005" 12 " " 13 " " 14 " " 15 " " 16 "2010" 17 " " 18 " " 19 " "
      20 " " 21 "2015" 22 " " 23 " " 24 " " 25 "2020")) ylabel(, angle(horizontal)) stack nolabel
      legend(rows(2) order(2 1) ring(0) bplace(ne) rowgap(*.5) colgap(*.5) label(2 "Non-NMV")) bar
      (1, color(none)) bar(2, color(black)) saving(Grant_Count_by_Year.gph, replace)
604
605   *ytitle("Grants by Year") scheme(sj)
606
607   *This graph requires dataset change
608   collapse (sum) NMV NonNMV, by(Health Ecological Climate Waste Energy Other)
609   gen topic = "Health" in 6
610   replace topic = "Ecological" in 5
611   replace topic = "Climate" in 4
612   replace topic = "Waste" in 3
613   replace topic = "Energy/Sustain" in 2
614   replace topic = "Other" in 1
615   gen all = NMV + NonNMV
616
617   graph bar (sum) NMV NonNMV, over(topic, sort(all) descending) stack nolabel legend(rows(2)
      order(2 1) ring(0) bplace(ne) rowgap(*.5) colgap(*.5) label(2 "Non-NMV")) bar(1, color(none
      )) bar(2, color(black)) saving(Grant_Count_by_Topic.gph, replace)
618
```

```
619   *ytitle("Grants by Topic")
620
621   *Combine
622   graph combine Grant_Count_by_Method.gph Grant_Count_by_Year.gph Grant_Count_by_Topic.gph,
      scheme(sj) rows(3) imargin(tiny)
623   graph export Grant_Count_ALL.png, as(png) replace
```