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Title page
Research trends in environmental and resource economics: Insights from four decades of JEEM*

Roland Kube[a], Andreas Löschel[a,b,c,d], Henrik Mertens[e] and Till Requate[e]

This version: July 12, 2018

Abstract
This paper provides a contemporary analysis of how research issues have developed in the *Journal of Environmental Economics and Management* (*JEEM*) over the four decades of its existence. We have classified the articles in the journal along five dimensions: content, methods, environmental media, the regional dimension of studies, and cross-cutting issues. While up to about 10 years ago, non-market valuation and cost-benefit analysis, natural resource economics, and environmental policy instruments represented the lion's share of articles published in the journal, more recently we observe a significant shift towards a more diversified array of research areas, with climate change and energy issues finding their way into the journal. In addition, increasing methodological plurality becomes apparent, reflected in a significant shift away from economic theory and towards empirical approaches. We also analyze key distinctions between the major environmental economics journals. Finally, we analyze *JEEM*'s external influence on leading general economics (A+) journals. We find that that A+ citations are positively correlated with a focus on climate change economics, market-based environmental policies and policy comparisons, the use of econometric and statistical methods or experimental approaches, and negatively correlated with a focus on water pollution and other pollutants such as pesticides.

JEL Codes: B20, B40, Q00

Keywords: environmental economics research issues, research trends, environmental economics journals, citation impacts.

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1. Introduction

The aim of this paper is to provide a contemporary analysis of how research issues have developed in the *Journal of Environmental Economics and Management* (JEEM) over the four decades of its existence. In his citation analysis, Hamermesh (2013) warns against mere navel-gazing: "One hopes that the rationale for this activity is that it stimulates more than just a prurient interest, and that it can enhance our understanding of the process of scientific discovery, the nature of interpersonal interactions, and the role of rewards and incentives in stimulating activity." To our knowledge, the present paper is the first to examine *JEEM*'s progress in the 21st century. The research behind it is motivated by interest in a series of key environmental and socioeconomic issues that have altered the foundations for modern-day environmental economics research.

Public attitudes towards environmental issues have changed over the last two decades. International surveys like the International Social Survey Programme (ISSP) still rank air and water pollution as the primary environmental problems in most countries. Notably the growth of the Chinese economy has taken place at the expense of hazardous air pollution levels in densely populated urban areas.[1] But next to pollution issues, climate change has become the most prominent environmental problem around the globe (Smith et al. 2017). This has spawned far-reaching international agreements and a variety of mitigation policies. Other important environmental problems are the loss of ecosystem services and biodiversity, waste-management, deforestation, urban sprawl, resource depletion in general, and energy use in particular. The diffusion of renewable energy technologies such as solar and wind power has made significant progress, and the use of biofuels has become an important factor in many countries. Besides major catastrophes such as Hurricane Katrina in 2005 and the large oil spill surrounding the Deepwater Horizon in 2010, the early 2000s are remarkable for a peak in resource prices, most notably for crude oil. But the demand for minerals and rare earth elements has also been on the rise, owing in part to the rapid growth of emerging economies. For economics researchers, digitization has facilitated better data availability and more detailed insights from econometric data analyses.

For our purposes, we collected all 1,672 *JEEM* articles published from 1974-2014 as well as the 100 most cited articles in *JEEM, Ecological Economics, Land Economics, Environmental & Resource Economics* and the *American Journal of Agricultural Economics*. We chose to end our analysis in 2014 in order to avoid confounding impacts from the foundation of the *Journal of the Association of Environmental and Resource Economists (JAERE)* in 2014. A multi-dimensional classification scheme reveals major shifts and underlying patterns in study content, the methods applied, the particular environmental media (notably the pollutants and resources under investigation), the regional dimension of articles, and finally what we call cross-cutting issues and define below. To the best of our knowledge, the repercussions of these recent developments on past and future environmental economics research have not yet been subjected to full-scale investigation.

Our paper is a contribution to a series of bibliometric research papers on the evolution and performance of environmental and resource economics as an economics subfield. Several of

[1] See Delang (2016), Ahlers and Hansen (2017).

these have homed in on *JEEM* in particular, as it is one of the most prominent field journals in environmental and resource economics. However, compared to the analysis presented here, no other study has gone into the same degree of detail on the substance of the articles published in *JEEM* or placed as much emphasis on the particular pollutants and resources investigated. We further extend the existing literature by providing what we believe to be the first review to discuss *JEEM*'s progress in the 21st century. Shogren and Durden (1990) examine the first 15 years of *JEEM* (1974-88), the number of contributions from different institutes and countries, and the number of citations from leading general-interest economics journals. Brookshire and Scrogin (2000) not only update this study but also categorize *JEEM* articles between 1974 and 1998 by content with a view to identifying major research trends. Deacon et al. (1998) identify the main topics up to 1998 and assess major future research issues and methodologies such as non-market valuation methods, renewable energy sources, global externalities (climate change, biodiversity), spatial issues, and land use. Fisher and Ward (2000) contribute to *JEEM*'s 25th anniversary celebrations with an analysis of thematic coverage and a breakpoint analysis of major topics (oil, climate, sustainability, forest, water) following policy-relevant events (e.g. the oil shock in 1980, the Brundtland Report in 1987, and the Rio Conference in 1992). Smith (2000) quantifies *JEEM*'s influence on the non-market valuation literature with a citation count and assesses performance relative to comparable field journals. He concludes that *JEEM* "has, over time, become recognized as a primary source for research in environmental economics." In their case study, Schymura and Löschel (2014) investigate the incidence of, and the reasons for, increasing co-authorship in *JEEM*. One major finding is an increase in cooperation with regard to the methodological dimension of articles. The pattern of external funding for single-authored and co-authored articles differs which might be related to the interdisciplinary nature of environmental and resource economics: with third party money, researchers are able to work in larger teams to address complex issues, and vice versa, larger consortia may be better positioned to raise external funds. Another branch of literature assesses the importance of the environmental economics field in the broader economics profession as a whole. Based on a Google Scholar search heuristic, Auffhammer (2009) analyzes the performance of the articles from different environmental and resource economics journals cited most frequently since 2000 in leading general economics (A+) journals. Hoepner et al. (2012) look at the impact factor of different environmental and ecological economics journals between 2000 and 2009. Kosnik (2015) and Rath and Wohlrabe (2016) report on JEL Category Q contributions in top-ranking general economics journals. Ma and Stern (2006) identify the most influential publications in *JEEM* and *Ecological Economics* between 1994 and 2003 and the overlap and interdependencies of research themes between these two field journals.

More recently, two other field journals have been assessed in a way that resembles our approach. Polyakov et al. (2017) analyze authorship patterns in *Environmental and Resource Economics* by using automated text analysis to classify articles between 1991 and 2015 into a scheme similar to ours. Costanza et al. (2004, 2016) investigate the most influential publications of *Ecological Economics* in terms of citation counts both within the journal itself and elsewhere. The research themes of articles are classified by an automated word-count and clustering method applied to article titles. By contrast, the classification presented in the present paper is guided by JEL codes and increases the level of detail compared to previous studies, for example by distinguishing between content and method and also by focusing on the particular pollution sources and resources investigated. We compare major research themes across the five major field journals, explicitly tracking sub-categories such as different methods for non-market valuation and experimental approaches and exploring the evolution of methodological approaches. Manual screening of articles enables us to provide a detailed analysis of the pollutants and resources covered by *JEEM* articles in the past 40 years.

We classified articles with respect to four major dimensions: content, methods, environmental media (pollutants and resources), and the regional dimension of studies. While cost-benefit analysis and non-market valuation, natural resource economics and environmental policy instruments steadily comprise a large share of articles published until about 10 years ago, a significant shift towards a more diversified array of research areas becomes visible thereafter with climate and energy issues entering the journal more frequently. In addition, an increasing methodological plurality becomes apparent, reflected in a significant shift away from economic theory and towards empirical approaches. Since the 1990s, there has been increasing interest in general methodological improvements of stated and revealed preference methods. Surprisingly, the journal focuses more on the assessment of environmental damages than on the cost of pollution controls. Air pollution and greenhouse gases are the most important environmental media investigated; fisheries, non-renewable resources, and forests are the major resources studied. While most of the publications do not refer to a particular country or region, there is an appreciable focus on North America in the remainder of the articles.

In addition to the four main categories (content, methods, environmental media, and regions), we have been able to explicitly identify several policy-relevant cross-cutting issues such as climate change, renewable energy sources, risk and uncertainty, imperfect information, or interdisciplinary approaches and ecological economics. Besides being classified into the four main categories indicated above, several articles that in principle belong in quite different categories of content and method contribute to an overarching content theme such as climate change, or deal with common methodological challenges, such as imperfect information, risk and uncertainty at different levels. For example, articles classified under the cross-cutting issue of *climate change* may contribute to measuring the external costs of increases in temperature or deal with related topics like forest management and its relevance for carbon sequestration. They may also focus on methodological issues such as discounting.

We also analyze key distinctions in the external perception of major environmental economics journals by comparing the 100 most frequently cited articles in *JEEM*, *Ecological Economics*, *Land Economics*, *Environmental & Resource Economics*, and the *American Journal of Agricultural Economics*. We find that non-market valuation studies play an important role in all the journals considered. Interdisciplinary approaches and ecological economics are encountered most frequently in *Ecological Economics*. While all journals feature a large number of econometric studies, theoretical models are particularly frequent in influential articles published in *JEEM*. Often-cited articles from other journals tend to focus on specific environmental media and concentrate more heavily on particular resources.

Finally, we use citations to analyze *JEEM*'s external influence on leading general-interest economics (A+) journals. Almost 14% of *JEEM* articles get cited at least once in an A+ journal article. *JEEM* articles are continuously cited, indicating the incremental and sustained importance of environmental economics for the field of economics as a whole. A regression analysis shows that a focus on climate change economics, market-based environmental policies, and policy comparisons positively correlate with an A+ citation. This also applies to the use of econometric and statistical methods as well as experimental approaches. Furthermore, A+ citations are negatively correlated with a focus on *water pollution* and *other pollutants* such as pesticides, invasive species, or noise pollution.

The paper is organized as follows: Section 2 explains the classification scheme used for categorization. In section 3, this framework is applied to all *JEEM* articles. A comparison of the five major environmental economics journals' 100 most frequently cited articles follows in section 4. In section 5, we investigate *JEEM*'s external influence. Section 6 concludes.

2. Classification scheme

We drew on ScienceDirect / Scopus to collect all *JEEM* articles published between the first issue in 1974 and 2014. Based on a comprehensive list of all the keywords appended to the articles, we devised the following classification scheme consisting of five main dimensions and a total of 114 items:

1) Content (one out of 50 options)
2) Methods (one or more out of 11 options)
3) Environmental media: pollutants and resources (one or more out of 35 options)
4) Regional dimension (one out of 11 options)
5) Cross-cutting issues (one or more out of 7 options)

We grouped the articles according to the classification scheme. The articles were read and classified independently by two authors at different research institutes to ensure classification reliability. In a first iteration, 15% of the articles were classified in precisely the same way in all dimensions. Deviations were mostly to be found in only one of the five dimensions (e.g., a deviation in methods only). A classification manual with objective rules was created for the second iteration, improving the matching score to 92%. The remaining discrepancies were resolved via mutual agreement after discussion between the analysts. Accordingly, we can confidently assert that any substantial bias caused by measurement errors can be ruled out. Expert classification seems to be more suitable for characterizing the substance of an article in this kind of detail than the classification algorithms based on keyword counts used in similar papers (e.g. Polyakov et al., 2017, Costanza et al. 2016).

The exact options for each of the five dimensions are presented in the following sections.

2.1 Content

First, we formed nine major content groups, largely following the American Economic Association's JEL Classification System (https://www.aeaweb.org/jel/guide/jel.php), as outlined below. However, the JEL Classification System does provide a comprehensive description of research trends in environmental and resource economics, so we extended and enhanced the classification system where necessary. As a result, each of the nine categories is further divided into sub-categories so that ultimately there are 50 content categories altogether. We allocated each article to exactly one content category out of the 50 options. If several categories were addressed in the paper, we opted for the most salient subject matter and study objective. This procedure allows for a detailed comparison of content development over time. The different content groups (indexed with letters A-I) are described in the following.

A Natural resource economics

This content group is squarely based on JEL codes Q2 and Q3, referring to renewable and non-renewable resources respectively. In terms of non-renewable resources, our analysis addresses *ores*, *minerals,* and *biodiversity* individually, thus distinguishing more specific resource types than those suggested by the JEL specification. One reason is that in the last few decades particular resources such as biodiversity have attracted more attention and have attained greater visibility than others. They also require special methods for valuation. Throughout the classification process, we identified the topics of *secondary materials*, *pesticide and anti-bacteria*, and *entropy laws and mass-stability* as recurrent major content in articles and therefore added these as categories under A.3.

A.1 Natural resource economics: renewable resources

Category name	**Typical articles in this category deal with:**
General, methods, demand & supply	Optimal exploitation/management/preservation of unspecific renewable resources; general common-pool resource problems; general determinants for market prices, demand and supply of renewable resources; rent-seeking by suppliers; analysis of imperfect competition
Fishery, aquaculture	Optimal fishery management and policy design; management of (international) common-pool fishing grounds; fishery policy instruments such as individual transferable fishing quotas (ITQs) and others
Forestry	Optimal forestry management and policy design, e.g. optimal timber rotation periods; drivers and development of deforestation, tropical forests
Land	Optimal land utilization and conservation, e.g. regarding crop cycles; prevention of erosion; desertification issues; management of urban sprawl; deterioration of landscapes
Water	Optimal management of surface water, ground water, and waste water by private and public sector; methods for prevention of water pollution; analysis of water markets, estimation of water demand, irrigation technologies
Other	Other applications to renewable natural resources

A.2 Natural resource economics: non-renewable resources

Category name	**Typical articles in this category deal with:**
General, methods, demand & supply	Optimal exploitation/management/preservation of unspecific non-renewable resources; general determinants for market prices, demand and supply of non-renewable resources; rent-seeking of suppliers; analysis of imperfect competition; bidding for extraction rights; irreversible development of resources
Ores	Optimal exploitation/management of ores, especially metals such as iron, copper, zinc; empirical studies on prices and demand/supply
Non-renewable	Optimal exploitation/management of oil, coal, gas and other non-

energy resources	renewable energy sources; empirical studies on prices and demand/supply
Minerals	Applications to minerals, especially rare earth minerals; empirical studies on prices and demand/supply
Biodiversity	Theoretical models of mechanisms for the protection of endangered species; measurement and protection of biodiversity
Other	Other applications to non-renewable natural resources

A.3 Natural resource economics: other natural resources

Category name	Typical articles in this category deal with:
Secondary materials and recycling	Optimal management of secondary materials; specific recycling policies (e.g. taxes and regulations); (international) secondary material markets
Pesticide and anti-bacteria	Optimal pesticide deployment and pest management; issues of increasing antibiotic resistance of bacteria
Entropy laws and mass stability	Discussions about relevance of laws of entropy and mass-stability for natural resource economics; physical constraints in production and consumption
Other	Other applications to unspecified natural resources

B Climate change economics

To this content group we allocated papers addressing the broad issue of climate change (part of JEL code Q54). The use of three different categories enables us to distinguish between research areas in this field, e.g. between preventive and adaptive measures.

Category name	Typical articles in this category deal with:
General methods	Climate change models including central planning, decentralized, and game-theoretic models; discounting issues and net present values; CO_2emission forecasts; carbon footprint, ethical and distributive aspects (e.g. fair burden sharing)
Damages and adaptation	Estimation of global and local damages due to climate change; social cost of carbon; adaptation strategies
Mitigation of climate change	(Global) climate agreements for mitigation, e.g. Kyoto Protocol; analysis of climate policies, e.g. Clean Development Mechanism, carbon taxes/permits; carbon sequestration

C Energy economics

We based this content group on JEL code Q4 (‘Energy’), but our categories distinguish explicitly between different energy-related sectors such as *electricity* or *traffic and transport* in order to identify the sectors that have received special attention from researchers at specific points in time.

Category name	Typical articles in this category deal with:
Primary energy production	Generation of primary energy from oil, coal, gas, nuclear, hydropower, biofuels, wind etc.; analysis of primary energy supply

Electricity	Optimal management and development of power plants and networks; general treatment of electricity (without specific energy source)
Heat	Energy efficiency and insulation standards for houses
Traffic and transport	Development of gas prices; fuel economy standards and taxes; biofuel demand/supply and subsidies; technological adaptations in transport, e.g. hybrid cars
Energy and the macroeconomy, energy forecasting	Macroeconomic developments in energy consumption; forecasting of overall energy demand; energy intensity of an economy, e.g. in relation to GDP

D Costs and benefits of pollution control, non-market valuation

We set up this content group to identify trends in cost-benefit analyses of pollution control and non-market valuation research. The category *general, methodological improvements* is equivalent to JEL code Q51 and cover articles with theoretical considerations as their main content. However, we also wanted to pinpoint the areas in which these methods are applied and therefore included individual categories for major types of pollution and non-market goods (based on JEL code Q53). This expands the JEL framework and enables us to track articles that focus on specific types of pollution.

<table>
<tr><th colspan="2"><u>Category name</u></th><th><u>Typical articles in this category deal with:</u></th></tr>
<tr><td colspan="2">General, methodological improvements</td><td>Introduction/analysis/improvements of methods for non-market valuation (revealed & stated preferences) and cost-benefit analysis; hedonic models; contingent valuation methods (CVM); discrete choice models; household production functions; health valuation; other methods to elicit WTPs for environmental goods; developing appropriate discount rates for valuation; ecosystem services</td></tr>
<tr><td rowspan="9">Methods applied to elicit benefits and damages in:</td><td>Air pollution</td><td>Local air pollutants, e.g. particulate matter, sulfur dioxide</td></tr>
<tr><td>Water pollution</td><td>Oil spills, eutrophication, wastewater leaks, groundwater and surface contamination</td></tr>
<tr><td>Noise</td><td>Aircraft noise control via charges and nighttime flight bans</td></tr>
<tr><td>Hazardous waste</td><td>Pesticide residuals, oil spills on land, chemical waste</td></tr>
<tr><td>Nuclear power</td><td>Nuclear waste, property devaluation due to proximity to nuclear power plant</td></tr>
<tr><td>Solid waste</td><td>Household waste control, e.g. beverage containers</td></tr>
<tr><td>Land degradation</td><td>Erosion and desertification; welfare effects of urban sprawl; landscape degradation</td></tr>
<tr><td>Biodiversity loss</td><td>Species extinction and protection; biodiversity issues, e.g. due to invasive species</td></tr>
<tr><td>Recreational activities</td><td>Estimation of recreation demand, e.g. recreational hunting and fishing or recreational beach and national</td></tr>
</table>

		park visits
	Other	Benefits of mosquito abatement; other applied valuation studies
Measuring the costs of pollution control, estimating abatement costs		Estimation of aggregate marginal abatement cost curves of an industry/country; estimation of aggregate costs of applying a particular policy (e.g. taxes, standards) without consideration of benefits
Other		Other applications to benefits/cost of pollution control

E International economics, innovation, and growth

Based on JEL codes O, Q55, and Q56, this content group is designed to capture research trends in macroeconomics, international economics, and innovation that are connected to environmental economics. Under a separate category, we also investigated whether environmental issues in developing countries (due to rapid industrialization and population growth, etc.) are addressed by research articles.

<u>Category name</u>	<u>Typical articles in this category deal with:</u>
Macroeconomic impacts, growth, and GDP	Models of GDP growth and aggregate consumption; sustainable growth models; Environmental Kuznets Curve, sustainable development, sustainability indicators
Innovation and technological change	(International) technological change and innovation dispersion; models of aggregate production/consumption with explicit focus on the role of technological change
International economic issues	International trade and relocation of pollution; transboundary pollution problems (except for CO_2 emission problems listed in content category *climate change economics*); pollution havens and tax competition; environmental impacts of tariffs; international agreements (if not related to climate change)
Development issues	Environmental impacts of population growth; specific environmental issues in developing countries; economic booms, e.g. due to resource exploitation

F Analysis of environmental policy instruments

We disaggregated the rather general JEL code Q58 ('Government Policy') by distinguishing between articles that focus on *environmental standards* or *market-based approaches* (and policy comparisons) in order to identify trends in the standards vs. taxes/permits debate. Similarly, we included additional categories to gather detailed information on the frequency with which researchers address other environmental policy instruments.

<u>Category name</u>	<u>Typical articles in this category deal with:</u>
Command and control policies, environmental standards	Optimal regulation by different types of standard; compliance and control mechanisms; non-transferable quotas
Market-based	Optimal regulation via market mechanisms, e.g. taxes/subsidies,

approaches, policy comparisons	tradable permits, auctions, conservation payments; comparisons of market-based instruments and environmental standards; payments for ecosystem services, conservation payments
Liability rules	Liability rules for environmental damages; compliance; Coase theorem
Environmental behavior, public goods, voluntary approaches	Environmental attitudes of households; willingness to pay price premiums for eco-friendly products; voluntary provision of public goods; effects of (voluntary) eco-labelling on consumer and producer decisions; voluntary transparency initiatives by firms; behavior by firms in connection with consumer pressure and public information
Political economy aspects	Optimal regulatory authority, e.g. federal vs. state government; lobbying and rent-seeking in politics; bureaucratic decision processes; voting
Other	Other applications to environmental policy instruments

G Environmental management at firm level

To take account of the management dimension in *JEEM*, which is also addressed in the journal's title, we included a category that refers to environmental management decisions and firms' behavior. The papers in question sometimes use JEL classification code L (Industrial Organization).

Category name	Typical articles in this category deal with:
Environmental management at firm level	Pollution control decisions at the firm/sector level, e.g. substitution of inputs or changes in production processes; behavior of firms in response to regulatory measures; Porter hypothesis

H Environmental justice

There is no JEL code Q category that adequately reflects ethics and justice issues. Papers addressing environmental justice would resemble the D3 and D63 codes.

Category name	Typical articles in this category deal with:
Environmental justice	(Intergenerational) distributional justice and equity, e.g. with regard to irreversible resources, philosophical aspects

I Other content

In the final category we assembled all articles that were relatively singular and could not be listed under a common heading. Examples are studies on the role of environmental economics in policy making, general discussions of the role of risk or the efficiency criterion, research trends in environmental economics, or general discussions of datasets.

Category name	Typical articles in this category deal with:
Other content	Other topics not covered by any of the above categories

2.2 Methods

In the second dimension, we allotted each article to at least one of 11 methods in order to analyze how researchers approach the different kinds of content referred to above. Again we started out from the JEL Classification System, which also classifies articles on the basis of their methodologies, for example in category C1 (Econometric and Statistical Methods and Methodology: General), C6 (Mathematical Methods, Programming Models, Mathematical and Simulation Modeling) or Q51 (Valuation of Environmental Effects). We extended and enhanced the classification system to facilitate the identification of research methods applied in environmental economics. Our categories range from theoretical modeling to econometric, simulative, and experimental approaches. To complement the corresponding content group, we also included categories for environmental valuation methods. Since articles often feature combinations of several methods (e.g. theoretical and empirical; theoretical and experimental), we permitted the selection of more than one research method per article in the methods category.

Category name		**Articles in this category use the following methods:**
Theory	Static theory	Theoretical static models, including models with two or three time periods
	Dynamic theory	Theoretical models with infinite time horizons
	Theory of non-market valuation & cost/benefit analysis	Theoretical development/improvement of approaches for non-market valuation or cost/benefit analysis
	Other theory	Verbal descriptions (incl. literature surveys); comments; qualitative analysis
Econometric and statistical methods		Design of new econometric and statistical techniques related to environmental economics problems; application of econometric techniques to real-world datasets; improvement of estimators
Non-market valuation	Hedonic pricing	Hedonic regressions applied to housing or wages
	Other revealed preferences	Household production functions, notably travel-cost method and defensive expenditures method; prices, premiums, donations, and voluntary contributions paid by agents to reveal preferences
	Stated preferences	Evaluation of willingness to pay/accept via surveys, e.g. contingent valuation method, choice experiments
Mathematical and simulation modeling		Computable general equilibrium (CGE) models; input-output models; programming models; Monte-Carlo simulations; evaluation of theoretical models with numerical simulations
Experi-mental	Lab experiments	(Laboratory) experiments within a controlled environment
	Field experiments	(Field) experiments conducted in a natural environment

2.3 Environmental media: pollutants and resources

This dimension indicates whether an article deals with a particular form of externalities or resources, and if so, which one. While some content categories automatically imply particular environmental media (e.g. *forestry* as content implies *forests* as resource), we have also marked the specific pollutant and/or resource for articles with different primary content (e.g. studies with *market-based approaches and policy comparisons* as content discussing taxes on CO_2). The category *none* comprises articles that either do not address particular pollutants or resources or refer to one arbitrary form only (often referring generally to "pollution" or "resource(s)"). Where a particular pollutant or resource was mentioned, we delved deeper into the sub-categories referred to below. For instance, in the case of *air pollution and greenhouse gases,* we selected the category of a particular pollutant (e.g. *NO_X*) if it was explicitly mentioned. If no explicit air pollutant was mentioned, we used the tag *general air pollution*. Specific pollutants that do not match the items listed (volatile organic compounds (VOCs), etc.) are categorized under *other air pollution*.

As articles often feature several pollutants or resources, multiple categories can be selected for each article. The environmental media categories are listed below.

Category name		**Articles are placed in this category if they include**
Air pollution and greenhouse gases (GHG)	Sulfur; NO_X; CO; PM; CFCs; Ozone; CO_2 and general referrals to greenhouse gases (GHG)	Explicit reference to air pollutants (each of the listed air pollutants on the left has its own category)
Air pollution and greenhouse gases (GHG)	General air pollution	General references to air pollution
Air pollution and greenhouse gases (GHG)	Other air pollution	Specific air pollutants not listed above
Water pollution	C-H compounds	Carbon-hydrogen compounds, incl. oil spills
Water pollution	Cl compounds	Chemical compounds with chlorine
Water pollution	Fertilizers	Fertilizer residuals from agriculture; eutrophication
Water pollution	Solid waste	Measurements of total suspended solids; microplastics
Water pollution	Heavy metals	Toxic heavy metals, e.g. arsenic, mercury, lead
Water pollution	General water pollution	General references to water pollution; biological oxygen demand (BOD)
Water pollution	Other water pollution	Specific water pollutants not listed above
Land pollution	Solid waste	Household waste; wastepaper; plastics; waste sites, solid waste collection
Land pollution	Landscape degradation	Erosion; desertification; urban sprawl
Land pollution	Other land pollution	Hazardous waste sites; land pollution according to Toxic Release Inventory; pesticide residuals on land; specific land pollution not mentioned above
Other pollution		Pests, invasive species; diseases; human overpopulation, congestion at recreational sites; heatwaves; noise
Resources	Fisheries	Fisheries and aquaculture; coral reefs

	Forests	Forests of any kind, incl. mangrove forests
	Non-renewables	Oil, coal, gas, minerals, ores
	Recreation, landscape	National parks; natural sites and landscapes; recreational sites, e.g. beaches
	Wildlife, biodiversity	Wildlife (other than fish); biodiversity
	Water as a resource	Ground and surface water; potable water
	Secondary materials, waste recycling	Recyclable materials, e.g. wastepaper, beverage containers, (scrap) metals
	Other	Renewable energy sources, e.g. wind, solar, biofuels; nuclear materials
None		No further specification of a resource or pollutant

2.4 Regional dimension

The last of the four major dimensions is the regional context. For each article we have selected only one regional dimension. Studies that do not apply to a specific region are classified as *general, no regional context*. We select a specific regional dimension whenever an article deals with a certain dataset or a region-specific issue. The regional dimensions are:

- General, no regional context
- U.S., Canada
- Europe
- China
- Middle East
- Rest of Asia
- Latin America, Caribbean
- Africa
- Oceania
- Other region, e.g. at sea
- Multi-region analysis and comparative studies of countries

2.5 Cross-cutting issues

Finally, as explained in the introduction, we have created several important cross-cutting categories in order to encompass articles either contributing to an overarching, policy-relevant issue such as climate change, energy efficiency, renewable energy sources, and nuclear power, or addressing common methodological issues such as risk, uncertainty, and imperfect information. Another cross-cutting category assembles economic approaches of an interdisciplinary and ecological nature. This dimension is a flexible way of "tagging" articles, e.g., in cases where although the content is not classified as *climate change economics,* the article is still related to that issue. Examples are forest management content with respect to carbon sequestration, the performance of particular mitigation policies, or measurement of a respective firm's behavior. Some of these cross-cutting issues also reflect particular JEL-codes which are neither defined through context, nor through methodology. Notably *Risk, uncertainty, imperfect information* reflects JEL-codes D81-D82, *Renewable Energy* and *Energy Efficiency* are largely summarized under Q42, while interdisciplinary approaches are addressed by A12, B5, and Q57.

Category name	**Articles are placed in this category if they include:**
Climate change	Topics/pollutants/resources related to climate change, e.g. the

	mitigation of greenhouse gases or adaptation to damages
Energy efficiency	Topics/resources related to energy efficiency, e.g. efficiency of power generation from different sources or standards for car fuel efficiency
Renewable energy sources	Particular renewable energy sources and/or policies regarding their use, e.g. analysis of (renewable) energy subsidies
Nuclear	Impacts of nuclear power plants, nuclear energy use, or nuclear waste
Risk, uncertainty, imperfect information	Models or narrative descriptions referring to risk, uncertainty, or imperfect information, e.g. uncertainty and imperfect information in pollution regulation, risks due to climate change, health risks etc.
Discounting methods	Explicit analysis of different discounting methods/approaches; models where the simple use of a constant discount rate is not sufficient
Interdisciplinary approaches and ecological economics	Frameworks introducing ecological perspectives into economic analysis, e.g. predator-prey models, ecological footprints, etc.; interdisciplinary approaches from other fields, e.g. psychology, physics, engineering, and philosophy

3. Analysis of *JEEM*

This section contains the descriptive results and the graphs/diagrams obtained by applying the classification scheme presented above to *JEEM*. We classified all 1,672 articles from the period 1974-2014. The annual average number of published articles shows an increasing trend over time (Figure 1). We have chosen to depict developments in absolute figures rather than shares, so as both to display increasing numbers of sub-categories and to make their relative proportions deducible.

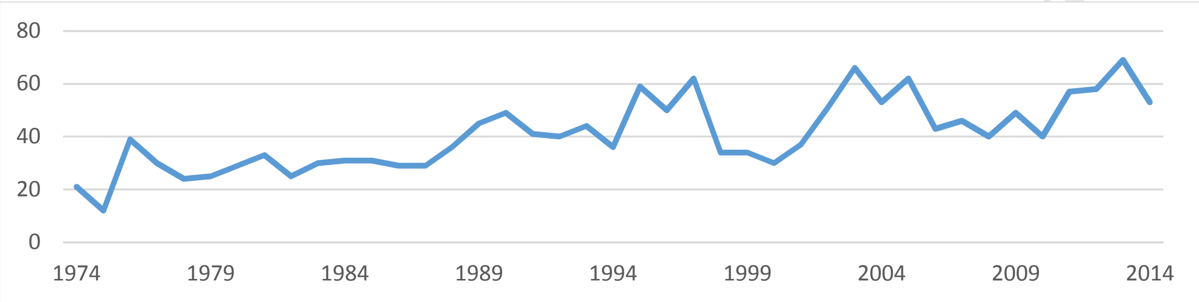

Figure 1: Number of annual publications in JEEM between 1974 and 2014.

For each individual dimension we indicate the general development over the whole observation period 1974-2014 and discuss major findings and research trends. An additional pie chart shows the total number of articles per sub-category over the whole time range. In a second step we explore sub-categories of each dimension in more detail. Although information is available for each year, we have elected to look at the overall period in terms of decades (1974-1984, 1985-1994, 1995-2004, and 2005-2014). There are two reasons for this. First, it makes the diagrams easier to interpret. Second, our aim is to investigate whether the magnitude of the individual dimensions is independent of the decades. Decade-clustering is necessary for non-parametric Chi-squared tests designed to obtain a minimum number of observations per sub-category.[2] The null hypothesis is that the number of publications in each sub-category is evenly distributed over time, i.e. across decades. The corresponding p-values are reported in the captions of each figure. For example, the p-value (<0.001) in Figure 2 implies that the number of articles in the different sub-categories varies significantly over the four decades. In the category *natural resource economics – renewable resources,* by contrast, the amplitudes of the sub-categories shown in Figure 4 do not vary significantly over the decades (p-value: 0.236).

3.1 Content

Figure 2 shows the breakdown of articles into nine major content groups throughout the existence of *JEEM*. In line with the findings of Brookshire and Scrogin (2000) for the period 1974-1998, the main topics are *costs and benefits of pollution control,* non-market valuation (486 articles in all), *natural resource economics* (451 articles in all), and *analysis of*

[2] Throughout this section 3 we use the term "significant" to refer to an overall significant Chi-squared test statistic (see Online-Appendix B). We also indicate where a certain article dimension contributes substantially to the Chi-squared value. The Chi-squared test yields Chi-values for each sub-category/decade cell from which we can infer the cell's contribution to the test result.

environmental policy instruments (421 articles in all). Together they consistently constitute more than 70% of the articles published per volume up to 2008.

Thereafter, however, a significant (p-value <0.001) shift towards a more diversified array of research areas becomes apparent.[3] From the 1990s onwards, *JEEM* has become a platform for novel issues such as international pollution problems, technological change, and growth. After the 1992 Rio Conference, *climate change economics* found its way into the journal, consistently gaining in prominence (56 articles in all) and achieving a share of 17% of all articles by 2014. Other expanding subjects are *energy economics* issues (50 articles in all) and *environmental management at firm level (35 articles in all)*, the latter facilitated by the increasing availability of microeconomic datasets.

Only nine articles focus on the ethical issues involved in environmental economics, while ten articles resisted group classification in terms of content. The Chi-squared test shows that the presence of sub-categories varies significantly (p-value: <0.001) over time. Accordingly, we can reject the null hypothesis that sub-categories are evenly distributed across the four decades.

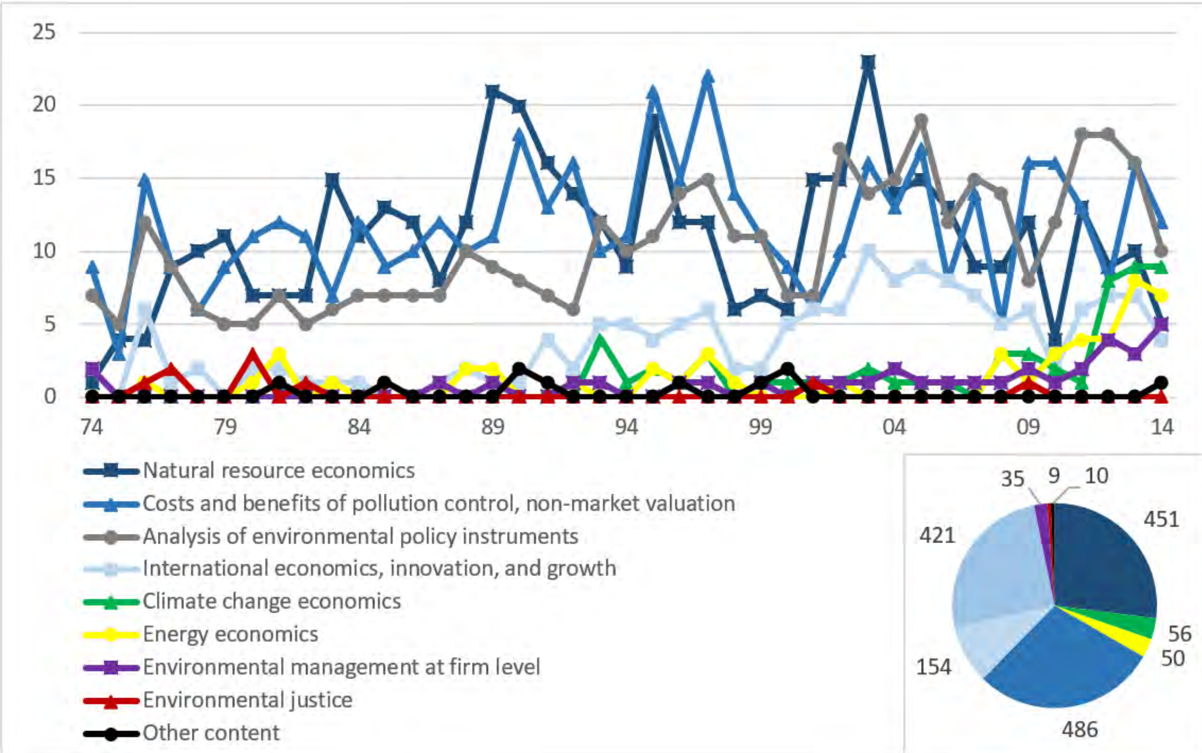

Figure 2: Classification of JEEM *articles by content (one per article, N=1,672, p-value: <0.001).*

Next we take a closer look at each major sub-category, beginning with *natural resource economics*.

[3] At the one percent significance level, the Chi-squared test rejects the null hypothesis that the evolution of content groups is independent of time.

A Natural resource economics

We divide the overall content of *natural resource economics* into the sub-categories *renewable resources*, *non-renewable resources,* and *other natural resources* (Figure 3). During the 1970s and 1980s, an era marked by oil crises and resource scarcity, studies on *renewable* and *non-renewable resources* make up a large percentage of the articles. Over the course of time, we find greater interest in *renewable* (277 articles in all) than *non-renewable resources* (126 articles in all) asserting itself. Changes in sub-category volume over time are significant (p-value: <0.001 in Figure 3). After the 1970s, studies on *other natural resources* (48 articles in all), mostly devoted to secondary materials, recycling, and antibiotics and pesticide issues, declined substantially.

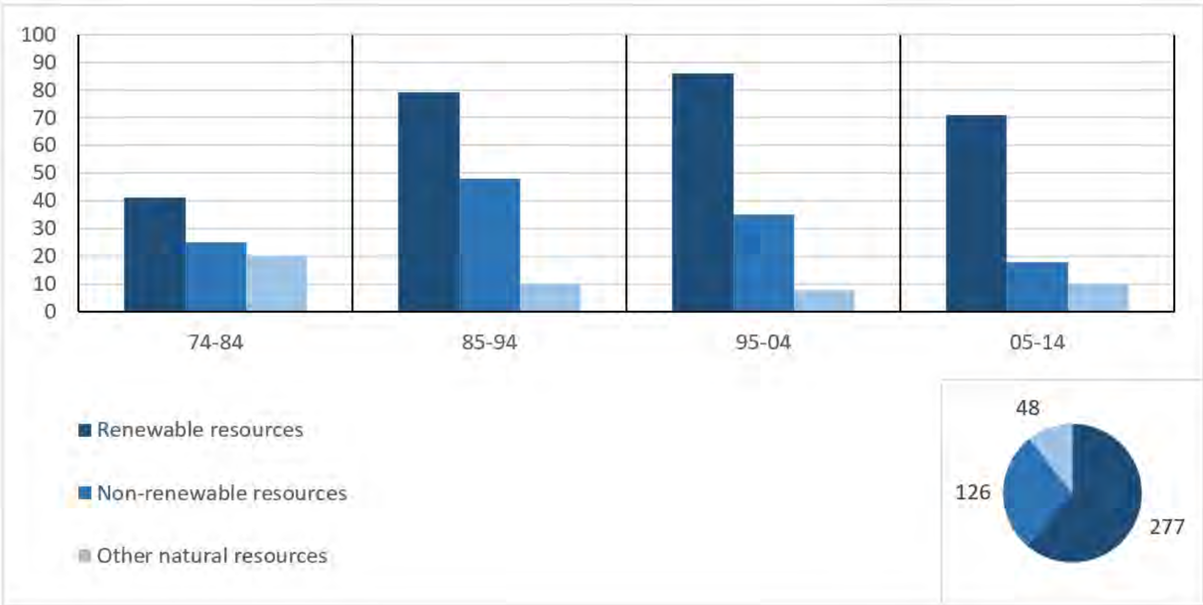

Figure 3: Natural resource economics (one per article, N=451, p-value: <0.001).

A.1 Natural resource economics: renewable resources

Fisheries are the renewable resource that the journal focuses on most assiduously (Figure 4). The subject has been of unremitting importance (102 articles in all) since the seminal paper by Clark and Munro (1975). *Forestry* comes second. It was especially relevant in the 1980s and 1990s but declined afterwards. Polyakov et al. (2017) observe a similar decline of interest in *forestry* in *Environmental and Resource Economics* between 1991 and 2015. Other important fields are the management of *water* and *land* resources, the latter looming large in this century. Only 20% of articles analyze renewable resources *in general* without homing in on a particular resource (such as *fishery*). The constitution of the categories does not vary significantly over the four decades (p-value: 0.236).

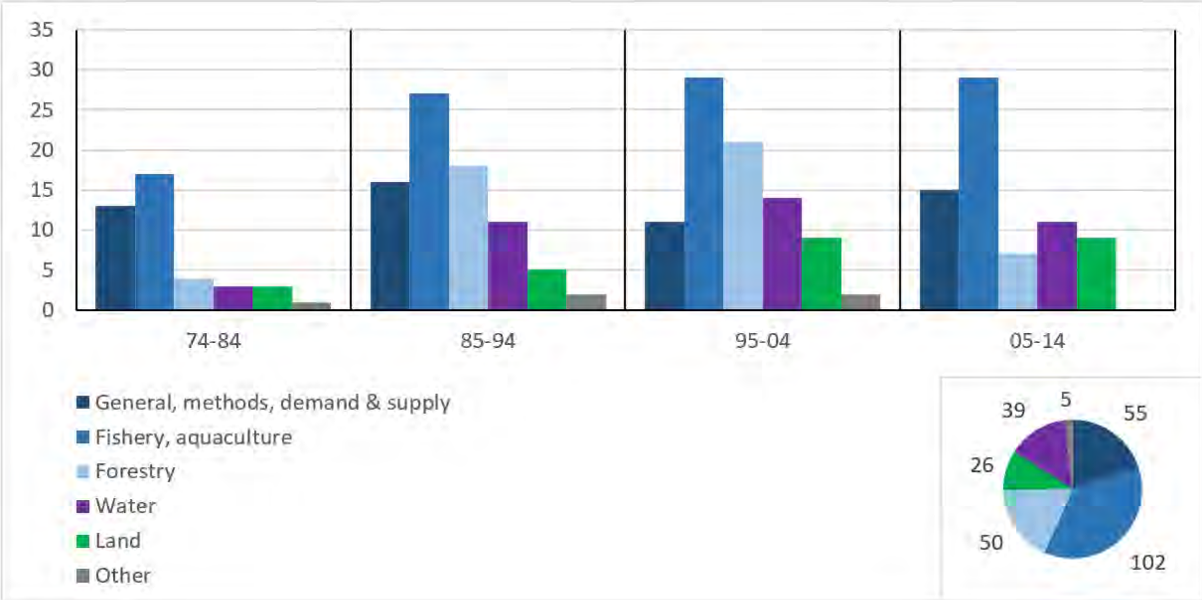

Figure 4: Natural resource economics – renewable resources (one per article, N=277, p-value: 0.236).

A.2 Natural resource economics: non-renewable resources

In contrast to *renewable resources*, the majority of articles on *non-renewable resources* address *general* aspects of non-renewable resource management (68 articles in all) without referring to a specific resource (Figure 5). *Non-renewable energy resources, minerals,* and *ores* are more conspicuous in the first three decades, when resource scarcity was a prominent issue in the literature. As the 21st century approaches, the number of articles on *biodiversity* (e.g. the extinction of species) increases (20 articles in all), and the overall compositional changes are statistically significant at a five percent level (p-value: 0.023).

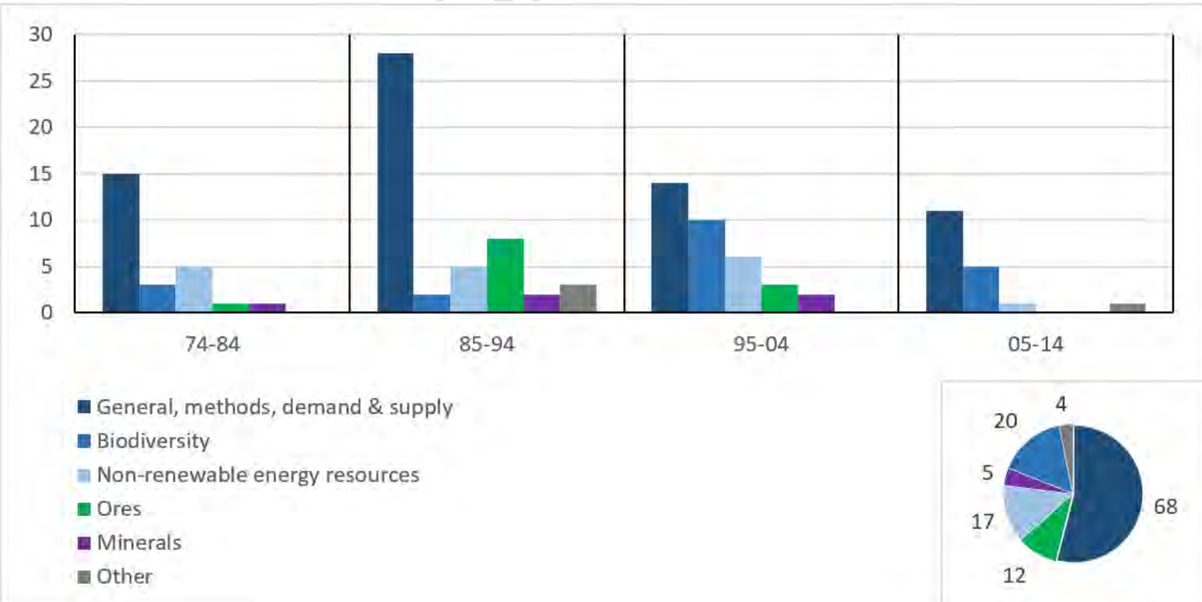

Figure 5: Natural resource economics – non-renewable resources (one per article, N=126, p-value: 0.023).

A.3 Natural resource economics: other natural resources

Other natural resources (48 articles in all) mostly covers articles on *secondary materials and recycling*, especially during the journal's first decade (15 out of 25 articles in all). The remaining subjects are the use of *pesticide and antibiotics* (12 articles in all), *mass stability and entropy laws* (7 articles in all), and *other resources* (4 articles in all). We do not show a separate figure here due to the small number of cases.

B Climate change economics

The potential threat of climate change due to anthropogenic greenhouse gas emissions is addressed in *JEEM* at an early stage, the first article on the subject being published in 1981 (by co-founder V. Kerry Smith). Nonetheless, the issue only became an integral part of the journal after 1992, when the Rio Conference took place. Publications on the subject peak remarkably after 2012: 26 out of all the 56 climate change economics articles are published from 2012 to 2014 . In Figure 6 we omit the time dimension due to the novelty of the content and insignificant variation (p-value: 0.166) in sub-category shares over the last two decades, when the majority of articles were published.[4] One half of these studies (27 articles in all) address particular strategies for *mitigating* climate change and aspects of policy instruments designed to abate greenhouse gas emissions. The other half is divided up between *general methods* of investigation, such as game-theoretic analyses for dealing with global public bads or discounting issues and assessments of *damages through climate change and adaptation strategies*.

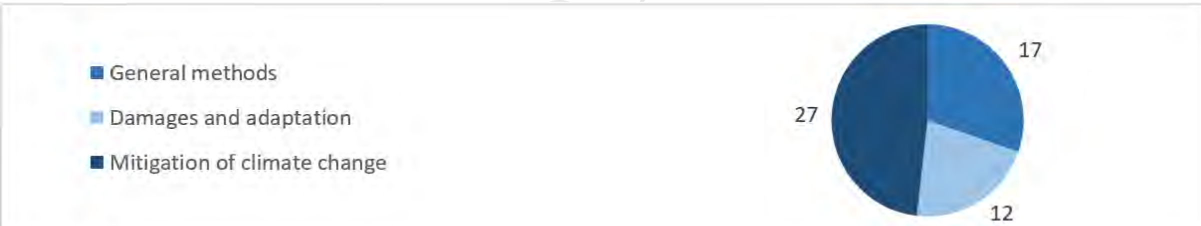

Figure 6: Climate change economics (one per article, N=56, p-value: 0.1668).

C Energy economics

Despite the obvious links with resource scarcity, studies on *energy economics* play a minor role in the journal (50 articles in all). Of the three energy usage sectors addressed (electricity, heat, transport), issues related to *traffic and transport* outnumber the others (27 articles in all).[5] Examples are studies on the effects of fuel efficiency standards or biofuel policies proposed since 1995 (Figure 7).

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[4] We omit the first two decades in the Chi-squared test as only 6 of the 56 climate change economics articles were published in that period.

[5] One reason may be that other influential energy economics journals exist, notably *The Energy Journal*, *Energy Economics*, *Energy Policy*, and several journals specializing in utility management and policy. By contrast, transport journals focus more on the increasing efficiency of transport and on congestion problems than on environmental issues.

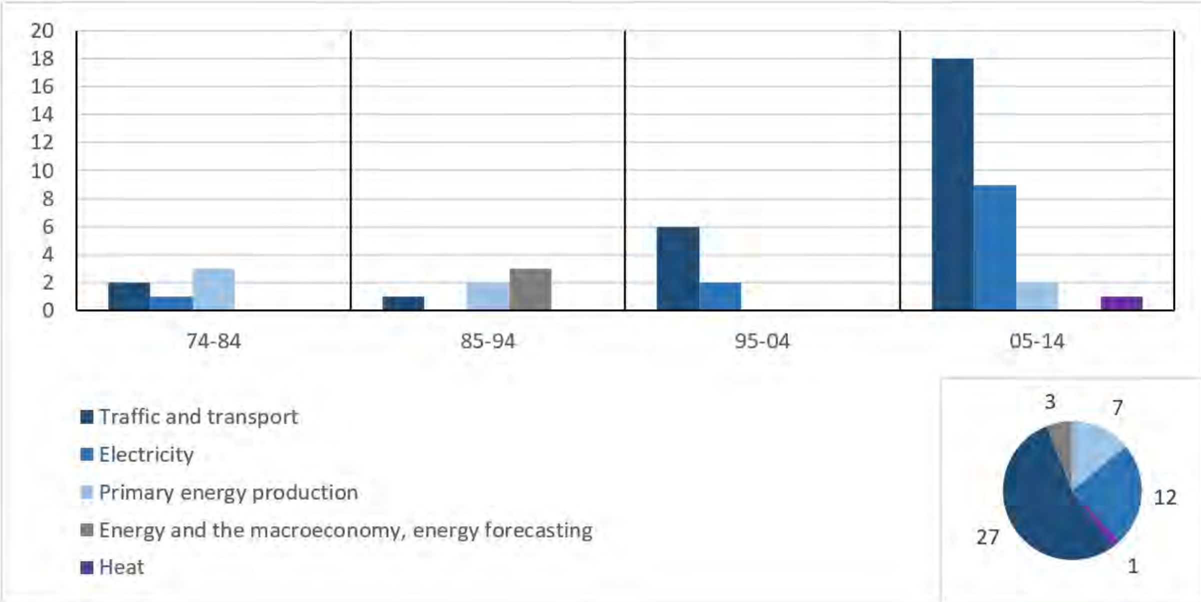

Figure 7: Energy economics (one per article, N=50, p-value: <0.001).

In the last decade, *electricity* generation issues have also gained importance. In all, there are fewer than ten studies on *primary energy production* and *macroeconomic* analyses. Despite its major importance for fossil fuel use, there is only one study on the *heating* sector. The quantitative variation of sub-categories over time is statistically significant (p-value: <0.001).[6]

D Costs and benefits of pollution control, non-market valuation

In this content group, we further distinguish the categories *general, methodological improvements,* and *applied methods* (case studies) as well as studies on the *costs of pollution control* (Figure 8). These categories display a statistically significant shift over time (p-value: <0.001). In *JEEM*'s first decade, most articles focus on *applied methods,* with long-lasting special emphasis on *air pollution* (e.g. health risks from particulate matter) and the value of *recreational activities* (Figure 9).[7] Since then, there has been significantly greater interest in *general and methodological improvements*, e.g. improvements to the stated or revealed preference method (263 articles in all). To our surprise, studies assessing *the costs of pollution control*, including estimates of particular abatement cost functions, do not figure at all prominently in the journal (34 articles in all), which focuses more on the assessment of environmental damages rather than on costs.

[6] Given the small number of cases, we use 2-decade periods instead of 1-decade periods for the Chi-squared test, and we also group the sub-categories *primary energy production*, *heat* and *energy and the macroeconomy* into a single category.

[7] For the sake of clarity, Figure 9 is shown without a time dimension. However, the respective Chi-squared test still refers to the decade structure and shows no significant variation over time (p-value: 0.102).

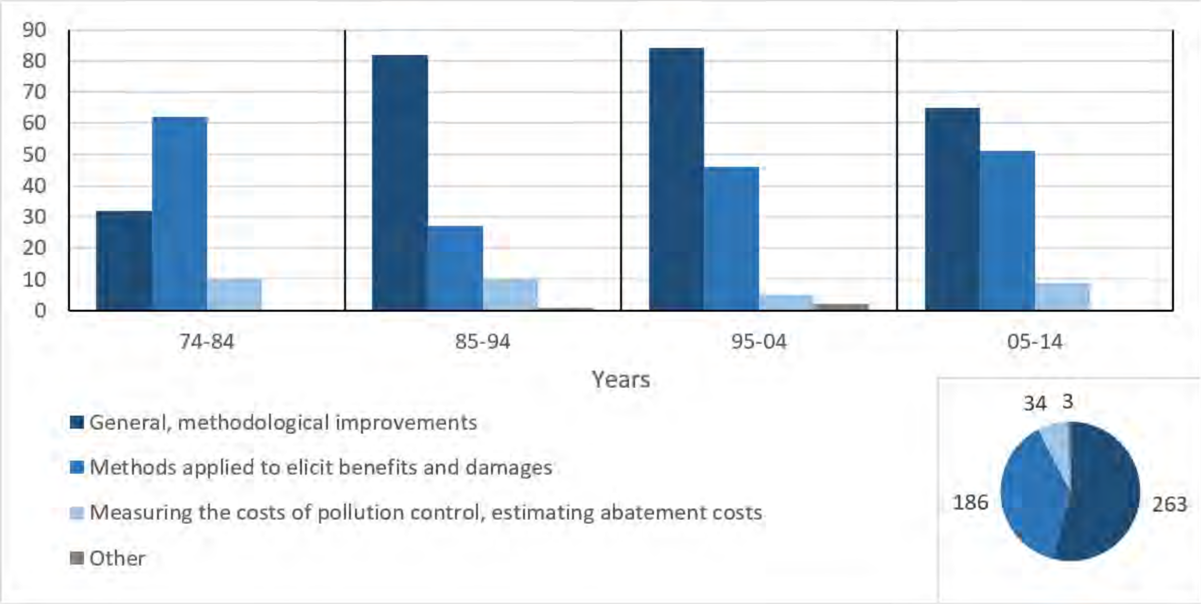

Figure 8: Costs and benefits of pollution control, non-market valuation (one per article, N=486, p-value: <0.001).

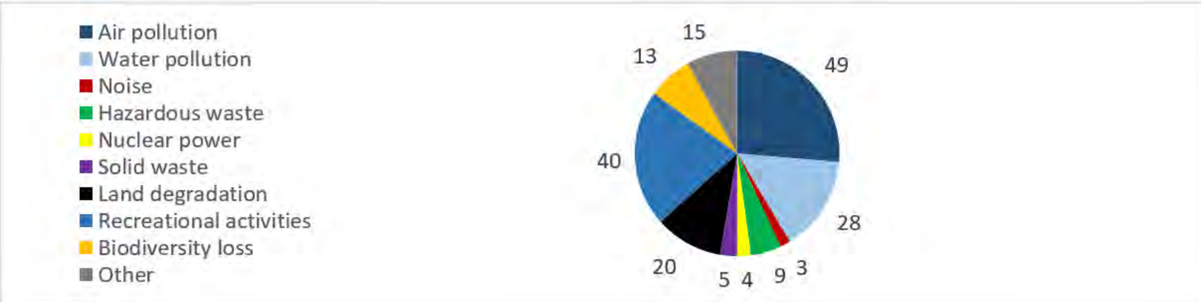

Figure 9: Costs and benefits of pollution control, non-market valuation - methods applied to elicit benefits and damages (one per article, N=186, p-value: 0.102).

E International economics, innovation, and growth

The presence of research on *international economics, innovation, and growth* in connection with environmental economics has increased since the 1990s, with a specific focus on *international economic issues* (73 articles in all) such as international environmental agreements and trade-related pollution (Figure 10). This agrees with the increase of `trade and investment` content in *Environmental and Resource Economics* established by Polyakov et al. (2017). *Macroeconomic impacts*, such as growth model applications to resources and environmental pollution, and especially *innovation and technological change* studies increased in prominence after *JEEM*'s 30th anniversary. However, particular *development issues* such as the energy consumption patterns in developing countries play only a minor role (11 articles in all). Given that cases of environmental pollution tend to be more severe in these countries and environmental regulation less commonplace, this is another surprising finding. One reason may be the scant availability of relevant data for developing countries.

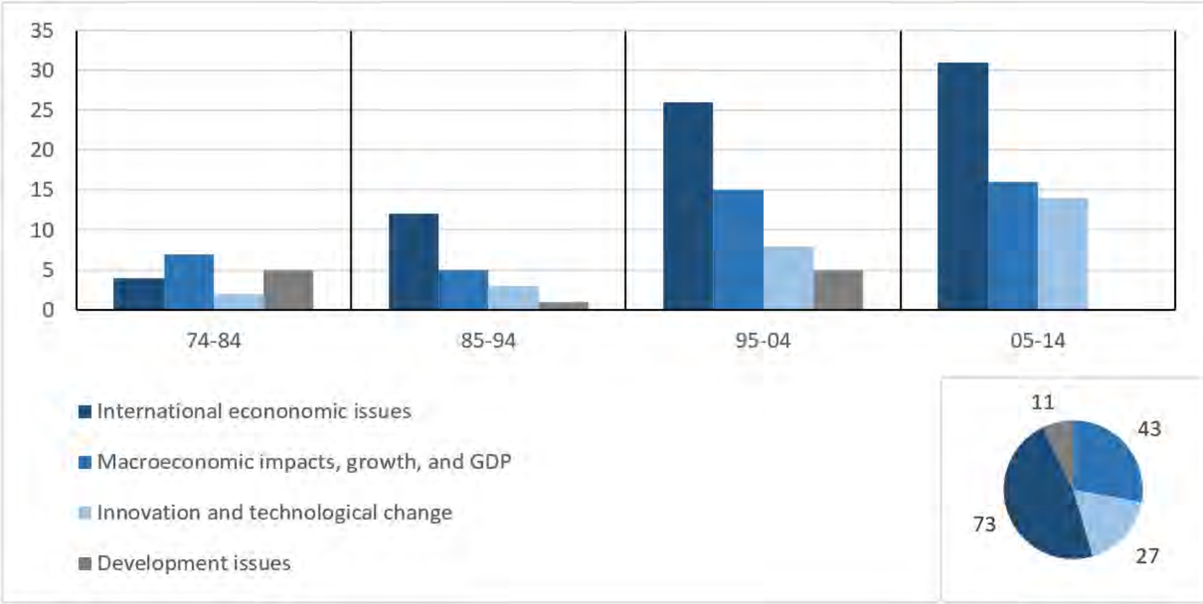

Figure 10: International economics, innovation, and growth (one per article, N=154, p-value: 0.011).

F Analysis of environmental policy instruments

The third major content group, the *analysis of environmental policy instruments*, displays a strong bias (220 articles in all) towards *market-based approaches and policy comparisons* (Figure 11). The minor role of c*ommand and control policies, environmental standards (60 articles in all)* goes hand in hand with a paradigm shift in environmental policymaking. Alongside classical environmental economics instruments, two new aspects have come in for an upsurge of interest during the journal's last two decades: first, voluntary pollution control by producers and pro-environmental behavior and attitudes *on the part of* consumers (cf. our category *environmental behavior, public goods, voluntary approaches*) - again, we find overlap with Polyakov et al. (2017) and their reference to the rising popularity of articles on 'Voluntary environmentalism' in *ERE* between 1991 and 2015 - and second, *political economy aspects* of environmental regulation. Driven by these developments, the changes in category structure over a period of decades are statistically significant at a five percent level (p-value: 0.047).

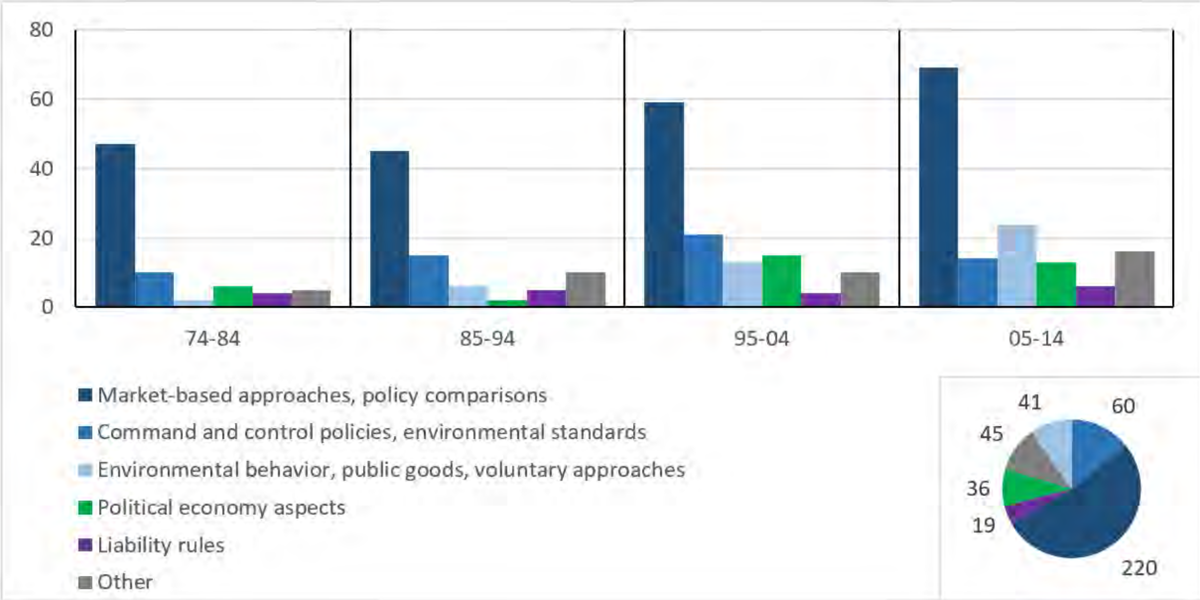

Figure 11: Analysis of environmental policy instruments (one per article, N=421, p-value: 0.047).

3.2 Methods

Theoretical models (1,042 articles in all) are the most common methodology discussed in *JEEM* articles (Figure 12); other methods have played only a minor role for most of the time. As the turn of the century approaches, increasing methodological plurality becomes apparent, driven by a significant shift towards *econometric and statistical methods* (447 articles in all) over the four decades in question. This is in line with Hamermesh's (2013) observations on an increasing proportion of empirical work among the top three A+ economics journals over time.[8] During the 1990s, non-market valuation methods increased in popularity. In the last decade, *mathematical and simulation modeling* has proved to be another important methodology (172 articles in all). In *JEEM*'s first years, simulation methods were mainly input-output analyses. Later the category still figured prominently in the journal, extending to more elaborate approaches such as computable general equilibrium (CGE) modeling. In 1982 the first *laboratory experiment* was published, and the experimental approach has grown in prominence ever since (50 articles in all), especially in the context of *non-market valuation* and the *analysis of environmental policy instruments*. Since their introduction in 1988, *field experiments* have gradually stepped up their showing in the journal. In the following, we discuss the sub-categories *theoretical methods* and *non-market valuation methods* (203 articles in all) in more detail.

[8] His sample comprises *American Economic Review (AER)*, *Journal of Political Economy (JPE)*, and *Quarterly Journal of Economics (QJE)* between 1963 and 2011.

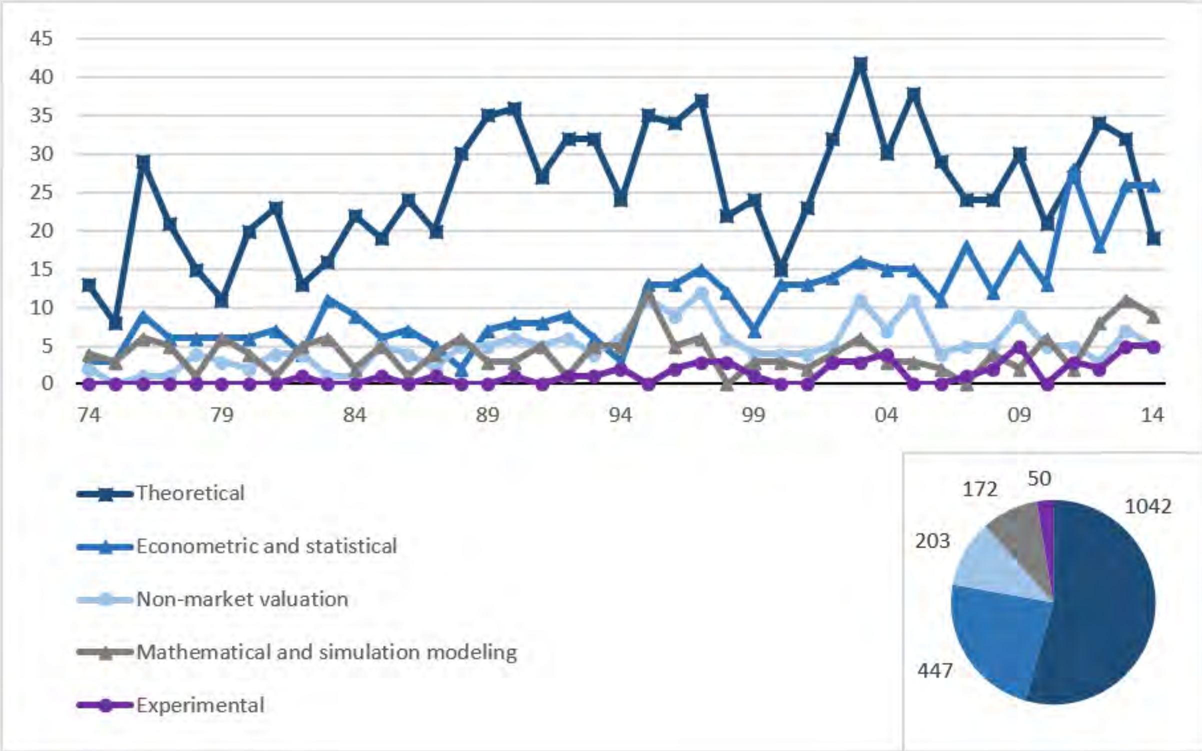

Figure 12: Methods utilized for analysis (one or more per article possible, N=1,914, p-value: <0.001).

Theoretical methods

For the analysis of problems such as resource scarcity, the journal's first two decades feature *dynamic theory models* (up to infinite time periods) rather than *static theory models* (with up to three time periods) (Figure 13). *Static theory models* (443 articles in all) are typically used to analyze regulatory instruments. Overall, both methods are equally represented. *Theoretical foundations of non-market valuation and cost-benefit analysis* (154 articles in all) rank third with a peak during the 1990s. Since then, articles classified as *other theories*, including purely verbal descriptions, have disappeared from the journal.

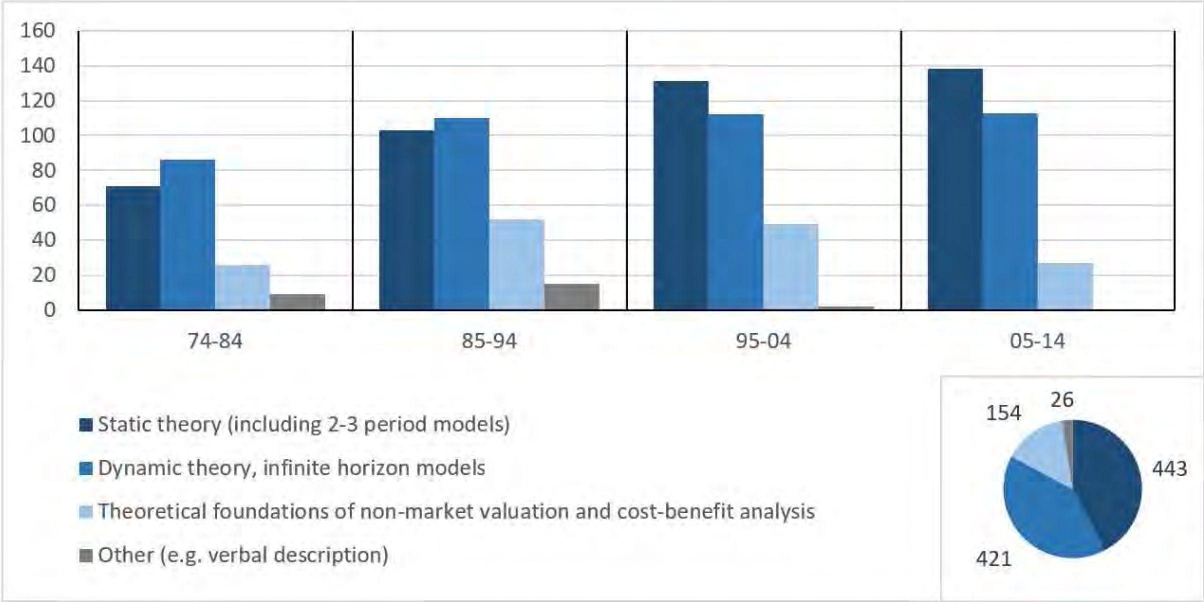

Figure 13: Theoretical methods (one or more per article possible, N=1,044, p-value: <0.001).

Non-market valuation methods

Non-market valuation has become an increasingly prominent method in *JEEM* with a peak in the third decade stimulated by the Exxon Valdez oil spill of 1989 and contingent valuation studies for damage assessments (Carson et al. 2003). The most common method is the *stated preferences approach* (120 articles in all) using surveys for contingent valuations or choice experiments (Figure 14).

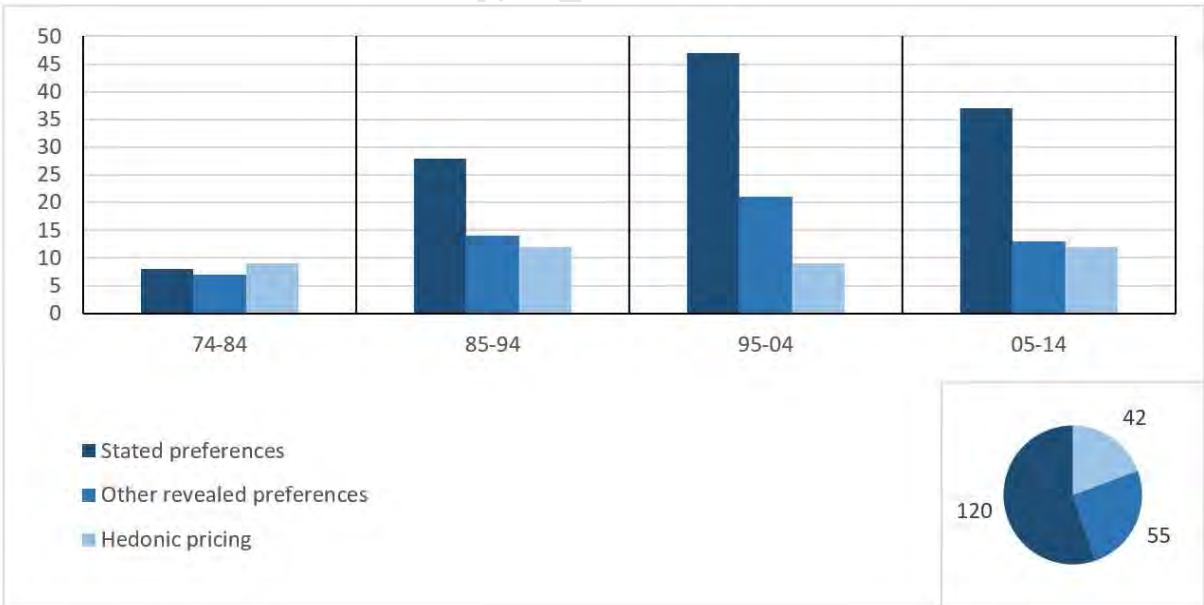

Figure 14: Non-market valuation methods (one or more per article possible, N=217, p-value = 0.114).

Runner-up is the *revealed preferences approach* (55 articles in all). Here the travel-cost method is the one most frequently applied. Contrary to the findings of Polyakov et al. (2017) for *Environmental and Resource Economics*, we find no increase of *recreational activities* studies in *JEEM* since the 1990s. Although present since the journal's first issue in 1974, *hedonic pricing* (42 articles in all) is the least frequently applied method for non-market valuation. Typical research interests are the amenity values of air pollution or health risks. This result is surprising given a variety of high-profile hedonic pricing papers in A+ journals in recent years (e.g. Chay and Greenstone 2005).[9] Possibly, JEEM is the preferred outlet for stated and other revealed preferences studies, e.g. travel-cost methods, whereas hedonic pricing papers have been successfully placed in general interest journals.

3.3 Environmental media: pollutants and resources

Next we investigate whether articles deal with particular forms of environmental media. In all, more than half of the articles do indeed address particular pollutants or resources (Figure 15). The ratio between pollutants and resources evens out and becomes more or less equal in the second and third decades. Since the late 2000s, the number of studies on *air pollution and greenhouse gases* has grown significantly (263 articles in all). *Land pollution*, including solid and toxic wastes, and *water pollution* play a minor role. *Other pollutants* such as pesticides or invasive species are not consistently relevant over all the four decades. Changes throughout this period are statistically significant (p-value: <0.001).

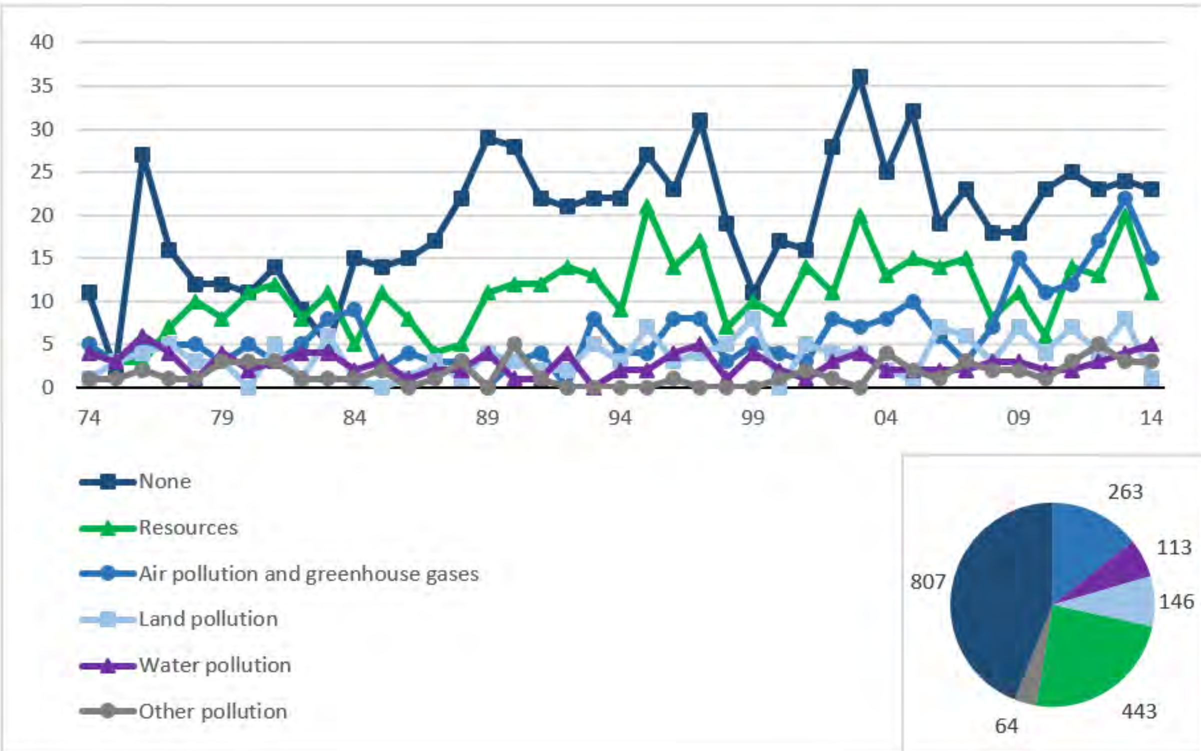

Figure 15: Environmental media: pollutants and resources (one or more per article possible, N=1,836, p-value: <0.001).

Air pollution and greenhouse gases

[9] Further, the seminal paper on hedonic prices and implicit markets by Rosen (1974) is among the 25 most cited general-interest economics journal articles between 1970 and 2005 (Kim et al. 2006).

In the journal's first two decades, studies on *air pollution and greenhouse gases* emphasize local air pollutants only, notably *sulfur*, *particulate matter, nitrogen oxides (NO_X),* and *ozone* (Figure 16). With the publication of the First Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) in 1990 and the creation of the United Nations Framework Convention on Climate Change (UNFCCC) in 1992, the last two decades show a significant shift towards *CO_2 and general references to greenhouse gases* (95 articles in all).[10] Nonetheless, there is no fall in the number of studies on local air pollutants as air pollution problems are still persistent in the current century despite various environmental policy efforts. Only 14 articles explicitly discuss *other air pollution*, such as volatile organic compounds.

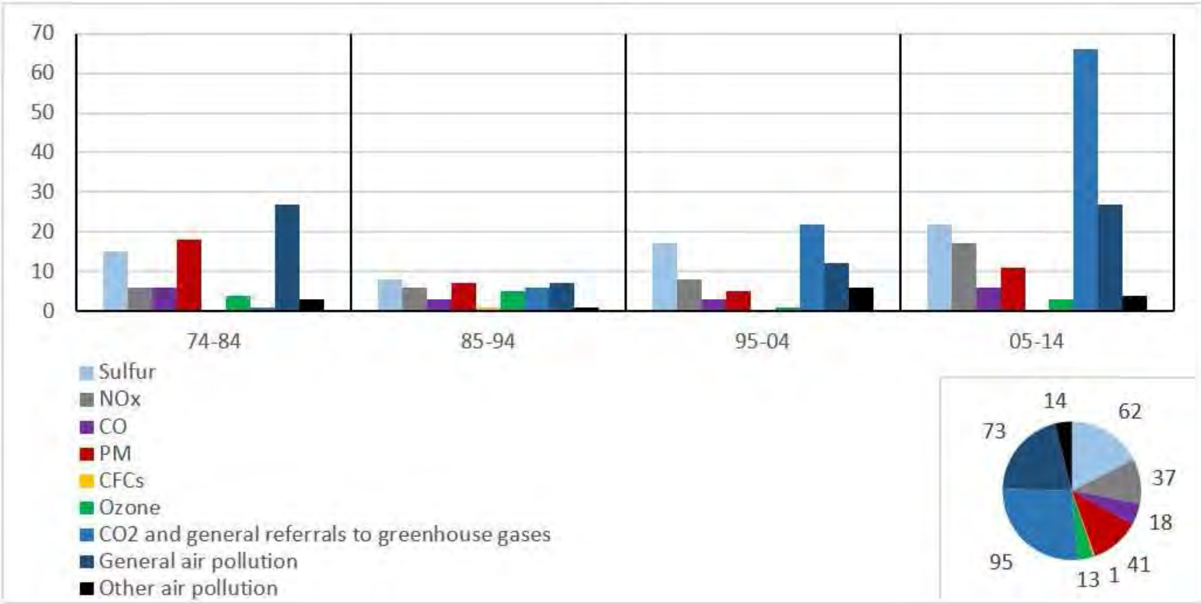

Figure 16: Environmental media - air pollution (one or more per article possible, N=354, p-value: 0.016).

Water pollution

The category structure for *water pollution* studies is fairly constant over time (p-value: 0.370) so that a static pie-chart is sufficient for its representation (Figure 17). Most applied studies investigate *general water pollution* problems (84 articles in all) without specifying pollutants or metering general indicators for water quality (such as the biological oxygen demand). A minor proportion explores particular kinds of pollution such as damages from *fertilizers* or oil spills (*C-H compounds*).

[10] Given the small number of cases, we apply the Chi-squared test for differences across *general air pollution*, *CO_2 and general references to greenhouse gases* and an aggregate of all local air pollutants. We further restrict the test to the last two decades, since *CO_2 and general references to greenhouse gases* only found their way into the journal in its third decade.

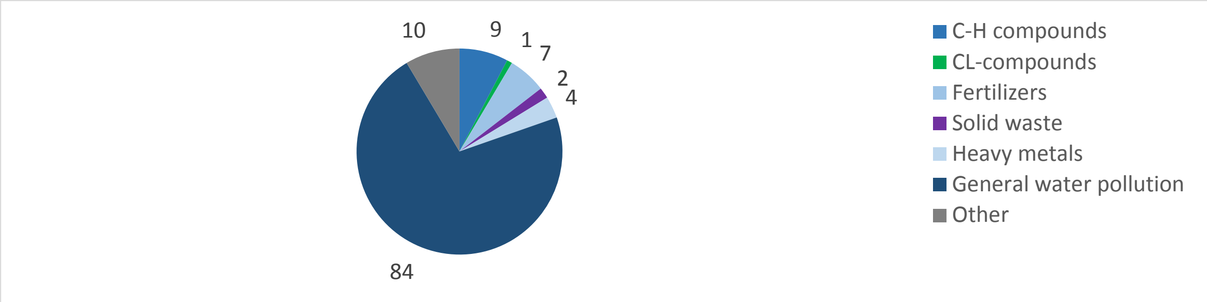

Figure 17: Environmental media - water pollution (One or more per article possible, N=117, p-value: 0.370).

This relative paucity is surprising given that oil spills (Exxon Valdez, Deepwater Horizon, etc.) are usually among the environmental catastrophes that receive top-level media attention and hence major public awareness.

Land pollution

Interest in the different forms of *land pollution* varies significantly over time (p-value: 0.004; Figure 18)[11]. *Degradation of landscapes* is a major category (63 articles in all), its prominence in the 2000s coinciding with an increasing number of studies on wildlife habitats. Studies on *solid waste* peaked in the 1970s, while since the 1990s interest in *other land pollutants* such as hazardous wastes has been greater. This coincides with the introduction of the Toxic Release Inventory (TRI) in the United States in 1987, part of a policy requiring firms to disclose their pollution data to the public.

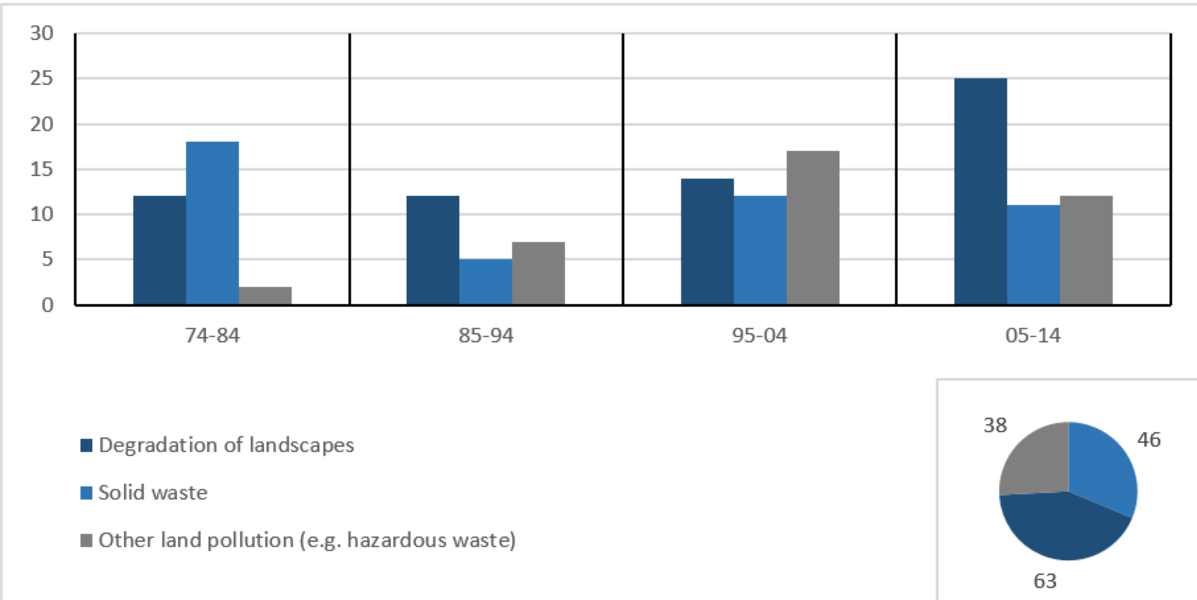

Figure 18: Environmental media - land pollution (one or more per article possible, N=147, p-value: 0.004).

Resources

[11] We report the p-value for a Chi-squared test over decades. The same test for a comparison between the first and second two-decade period is also significant at the five percent level.

To a large extent, Figure 19 resembles the findings in Figures 4 and 5, since articles with a focus on a particular natural resource are typically classified for the same resource in the environmental media dimension. *Fisheries* and *forests* are the renewable resources receiving the greatest emphasis (140 and 73 articles in all, respectively), followed by *recreation and landscape* (55 articles in all). Most studies on w*ildlife and biodiversity* and on *water as a resource* were published in the third decade. Studies on *non-renewables*, e.g. fossil fuels and minerals, are more conspicuous in the 20th century, whereas the 21st century shows an increase in *other resources* such as biofuels and renewables (11 out of 14 articles in all). There is also a revival of interest in *secondary materials and waste recycling* in this period. Changes over the four decades are significant (p-value: <0.001)

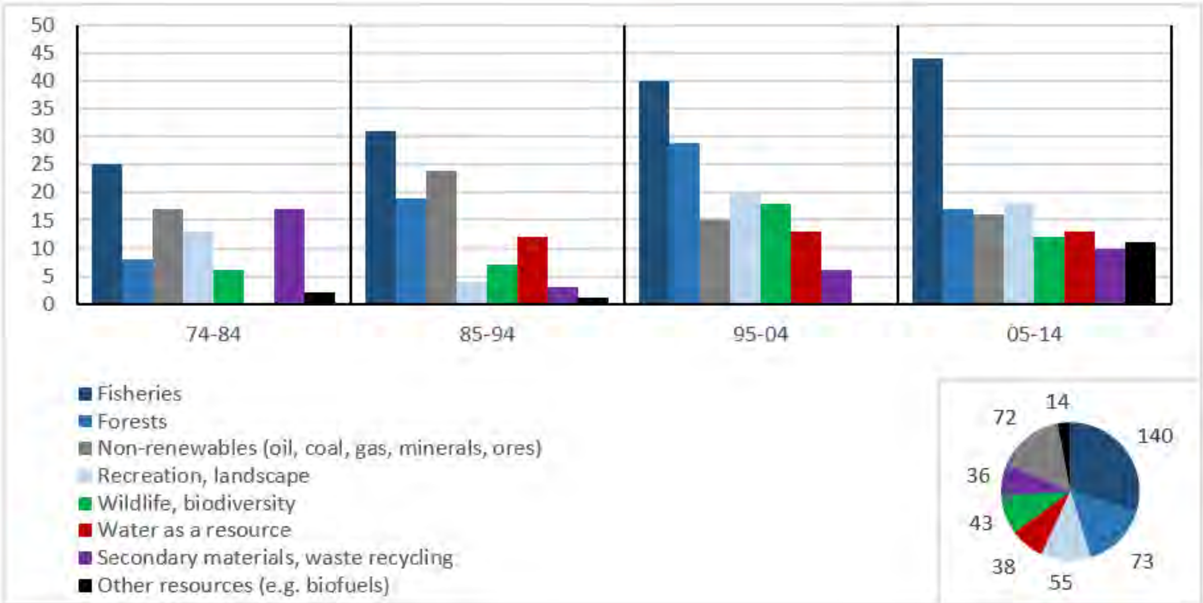

Figure 19: Environmental media - resources (one or more per article possible, N=471, p-value: <0.001).

3.4 Regional dimension

Most *JEEM* publications (56%) do not restrict themselves to any particular country or region (Figure 20). Of the others, 73% focus on the *U.S. and Canada* (537 articles in all), with specific references to *other countries* remaining rare until the 1990s (19 out of 194 articles in all). Since then, *Europe* has slowly established itself as another major research region (Figure 21), while *Asia*, *Oceania*, *Latin America* and *Africa* also figure more prominently in the studies.[12] The rise of the *Chinese* economy is reflected by the greater attention accorded to it in *JEEM* articles after 2005.

[12] Due to scarcity of observations, the Chi-squared test is for two-decade time periods (1974-1994; 1995-2014), while *Middle East* and *Other Regions* are aggregated.

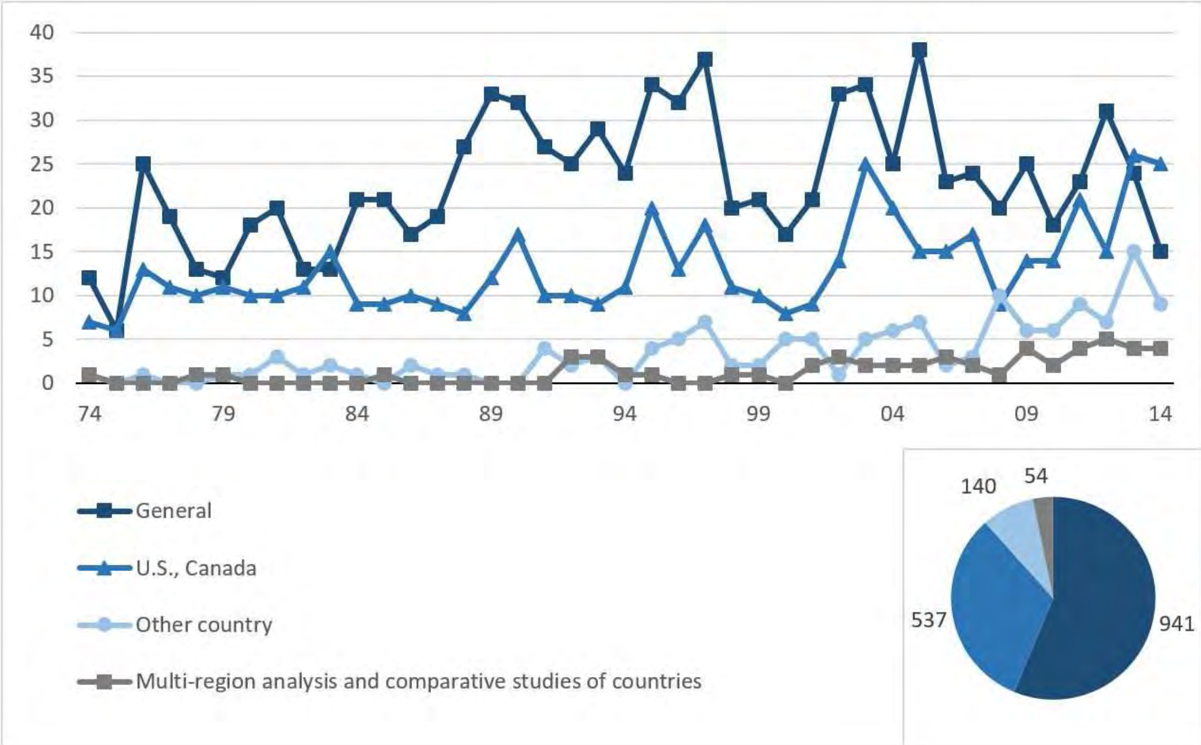

Figure 20: Regional dimension (one per article, N=1,672, p-value: <0.001).

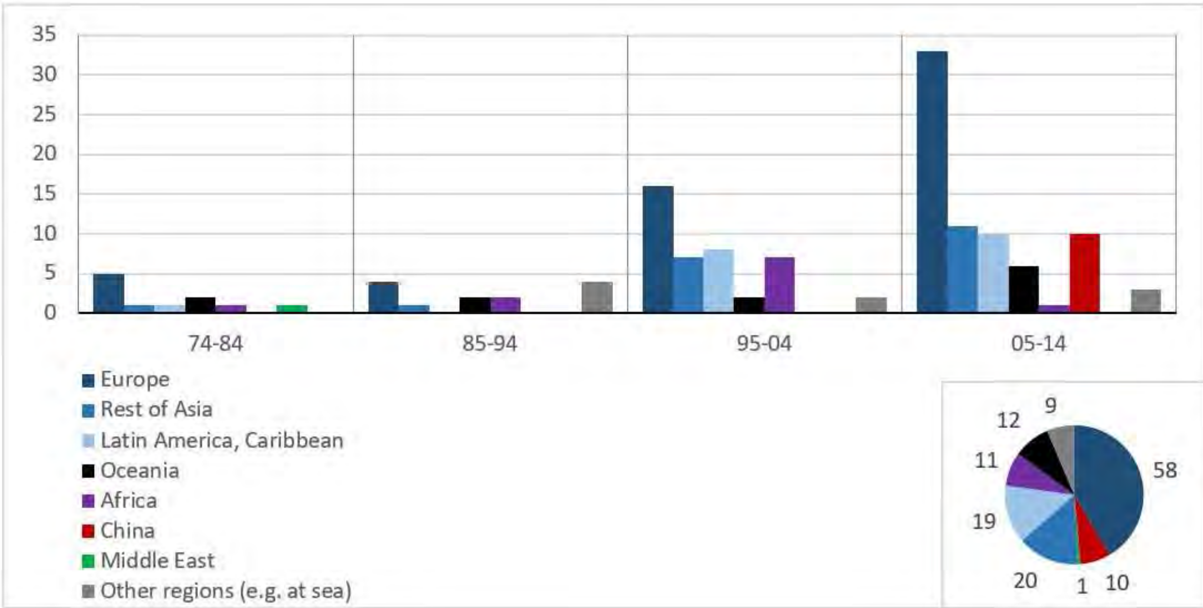

Figure 21: Regional dimension – other country (one per article, N=140, p-value: 0.008).

3.5 Cross-cutting issues

Figure 20 shows that the implementation of *risk, uncertainty, imperfect information* – mostly in theoretical models - is the cross-cutting category most frequently applied in the journal (287 articles in all).

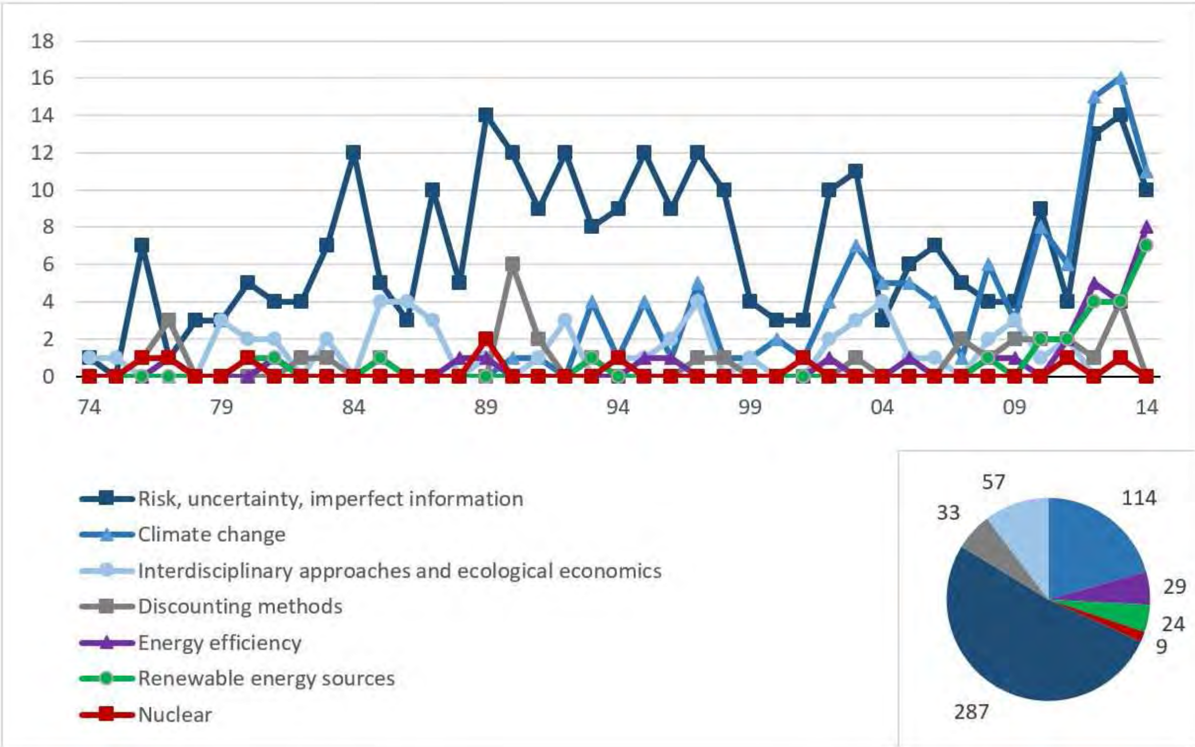

Figure 22: Cross-cutting issues (one or more per article possible, N=553, p-value: <0.001).

Interdisciplinary approaches and ecological economics figure regularly but to less of an extent (57 articles in all). Articles on *discounting methods,* e.g. in cost-benefit analysis, only appear sporadically. Articles pertaining to *renewable energy sources* and *energy efficiency* have become significantly more prominent in the latter decades. The same applies to *climate change* issues (114 articles in all), suggesting a recent research orientation switch towards these interrelated fields. *Nuclear* energy issues turn up rarely and sporadically, as discussion on this topic is mainly driven by the sciences and engineering disciplines.

4. Comparison with other major field journals

After the in-depth analysis of *JEEM* content in the previous section, we now transfer the classification scheme to other publications pertaining to environmental and resource economics. We investigate the dimensions that shape the perception of a journal within the research community and whether a journal is particularly associated with certain research areas. For that purpose, we selected the five major field journals dealing with environmental and resource economics. We implemented the same procedure as for *JEEM* and undertook our classification with respect to the five categories presented in section 2. However, due to resource constraints we restricted our comparison to the 100 most frequently cited articles per journal from the Reuters Web of Science citation count as of February 2016. This creates a certain bias, as some topics may attract more attention than others, and it does not precisely reflect journal policy. However, it may still be a reasonable proxy for characterizing different environmental and resource economics journals. The journals selected are:

- *Journal of Environmental Economics and Management* (*JEEM*)
- *Ecological Economics* (*EE*)
- *Environmental & Resource Economics* (*ERE*)
- *Land Economics* (*LE*)
- *American Journal of Agricultural Economics* (*AJAE*)[13]

Since its first issue was published in 2014, we did not include the *Journal of the Association of Environmental and Resource Economists (JAERE)*.

Again we made use of the non-parametric Chi-squared test. A significant p-value implies that the appearance of sub-categories varies significantly across the 100 most cited articles of the five journals. Before we show the results obtained by applying the classification scheme, we briefly compare the citation time frame for each journal's most successful publications.

4.1 Time dimension

For a better understanding of the time dimension, we analyzed the publication and citation years of the respective articles. Figure 23 illustrates the distribution of the publication years among each journal's 100 most cited articles. The year of a journal's foundation is given in parentheses in the caption. The graph for the journal subsamples suggests that there are two categories, the more firmly established economics field journals *AJAE*, *LE*, and *JEEM* over and against the younger journals *EE* and *ERE*.

[13] Note that a considerable share among the 100 most cited articles in AJAE and LE did not address environmental topics and is thus classified as *Other content* (Figure 25).

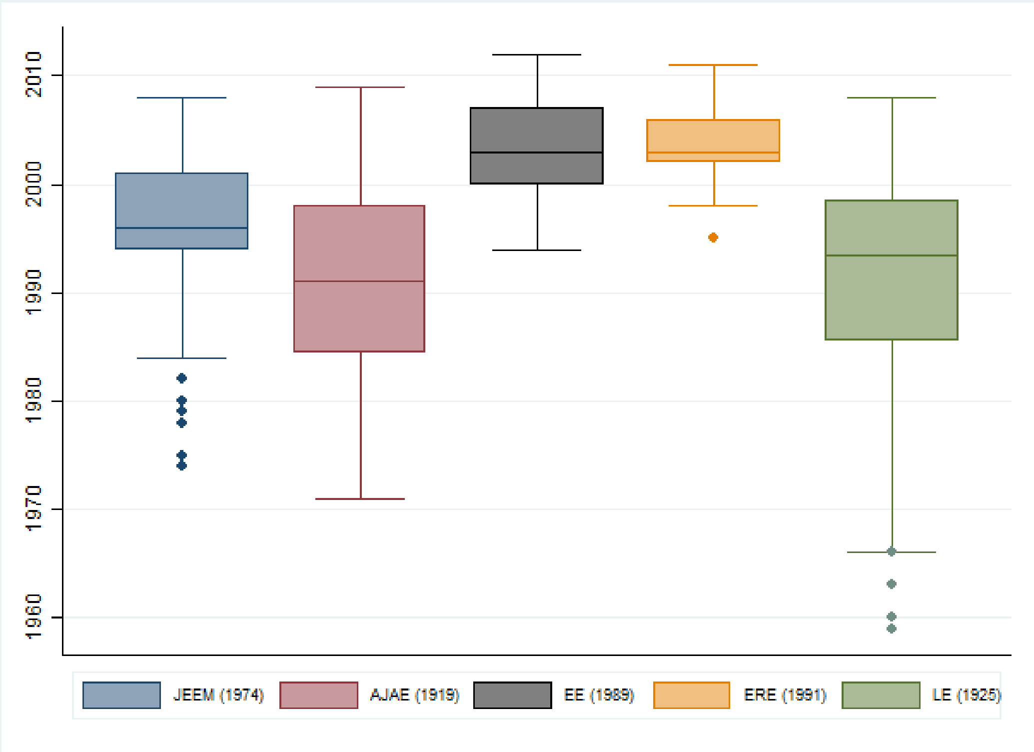

Figure 23: Distribution of the publication years of the 100 most cited articles per journal. The journals' foundation years are given in parentheses. Boxes show the interquartile range and whiskers include all values within 1.5 times the interquartile range as defined by Tukey's Method.

The next step was to count the number of citations for each journal and publication. Accordingly, Figure 24 provides some insight into the most influential eras of each journal by means of the citation count per journal publication year. To take account of the shorter periods of existence for *EE* and *ERE* - and hence more cited publications per year in the last two decades - we divide the yearly citation sum by the amount of articles per year for each journal. The most cited articles from *AJAE*, *JEEM*, and *LE* show almost equal distribution over time, with important *LE* articles figuring from as early as 1959 onwards. *JEEM* has a peak in the mid-1990s, *AJAE* in the 1980s. The 2000s show large citation counts especially for *EE* and to a lesser extent for *ERE*. We now move on to the results obtained from applying the classification scheme.

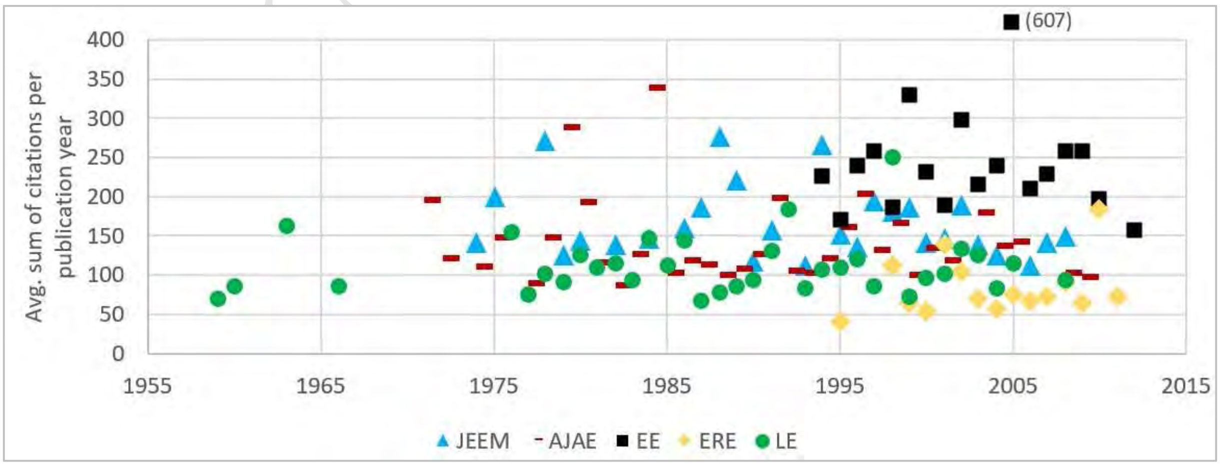

Figure 24: Average sum of citations per publication year among journals 100 most cited articles.

4.2 Content

The content groups of the 100 most cited articles for the five journals are shown in Figure 25. Except for *AJAE* where most articles do not primarily deal with environmental issues,[14] the research areas *costs and benefits of pollution control, non-market valuation* (210 articles in all) receive a large number of citations in the leading field journals. This is in line with the finding by Polyakov et al. (2017) that 'Nonmarket valuation', 'Recreation and amenity', and 'Conservation' are *ERE*'s most frequently cited topic groups. It also confirms the finding by Costanza et al. (2016) that 'Valuation' is the second most frequently published article subject in *EE* between 2004-2014. Besides *costs and benefits of pollution control, non-market valuation*, the most frequently cited articles in *EE* focus on *international economics, innovation, and growth* issues such as international pollution problems and aspects of technological adaptation. The most cited articles on the *analysis of environmental policy instruments* are to be found in *JEEM* and to a lesser extent in *ERE*. While our count for *analysis of environmental policy instruments* in *EE*'s 100 most cited articles is middling, Costanza et al. (2016) report 'Social aspects' and 'Environmental policy and governance' as the most frequently and third-most-frequently counted themes respectively in *EE* between 2004 and 2014. A Chi-squared test indicates that *Climate change economics* figures much more prominently in *ERE* than in other journals.

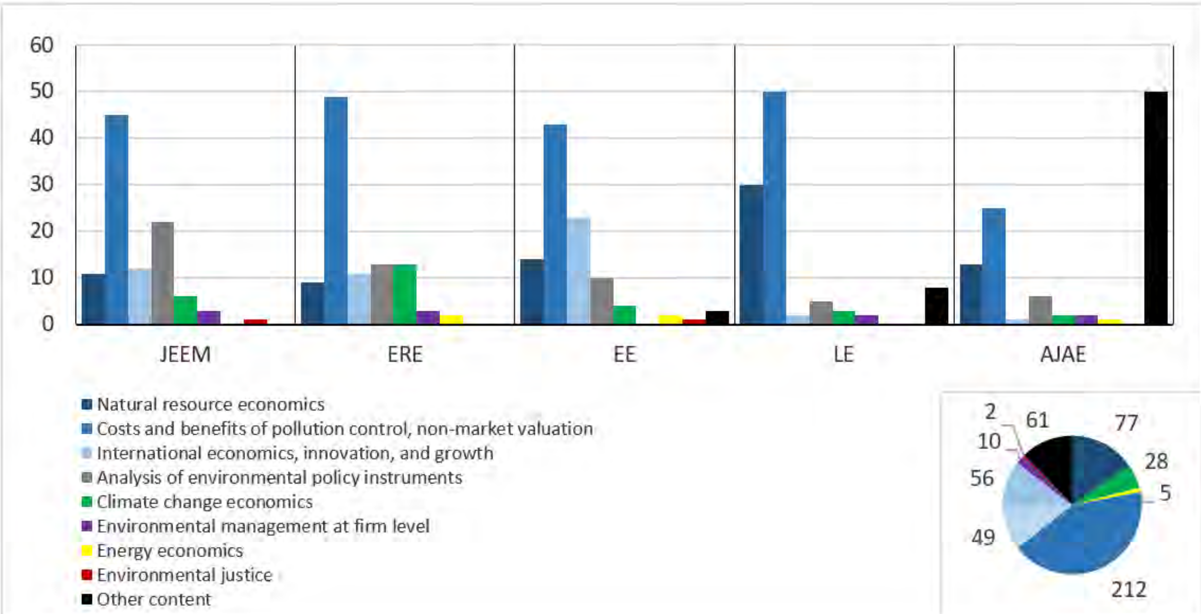

Figure 25: Articles grouped by content (one per article, N=500, p-value: <0.001).

Given the importance of *costs and benefits of pollution control* and *non-market valuation* studies, Figure 26 provides an additional analysis of the sub-categories grouped under this heading. Among the most frequently cited assessments in *JEEM* and *ERE* are *general, methodological improvements,* whereas *applications* dominate in the other journals. Another factor in the significant difference (p-value: <0.001) across journals is the number of applications to *land degradation,* which are more common in *LE* and *EE*, plus the relatively

[14] Typical non-environmental issues are organization of agricultural markets and demand analysis for agricultural products.

high number of studies on *biodiversity loss* in *EE.* Analyses on *air pollution* are mostly found in the 100 most cited articles from *JEEM*.

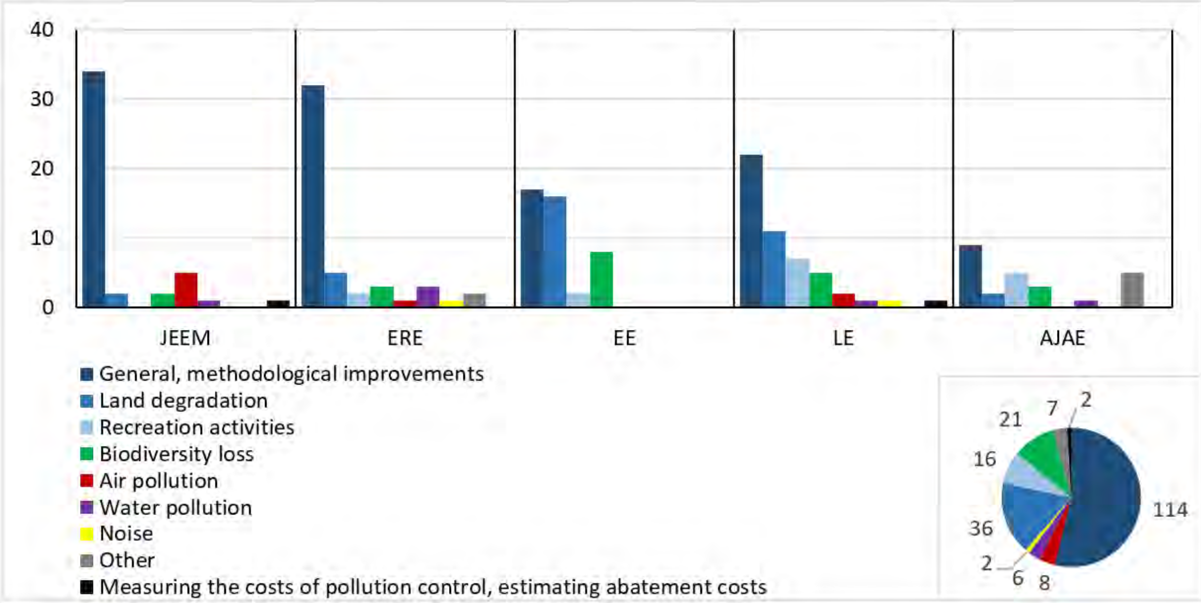

Figure 26: Costs and benefits of pollution control, non-market valuation (one per article, N=212, p-value: 0.001).

4.3 Methods

Figure 27 shows us the methodological range and mix across the journals' most cited articles. A high proportion of *econometric and statistical methods* (180 articles in all) is common to all journals, especially *AJAE*. *Theoretical* models rank second overall, figuring especially prominently in *JEEM*.

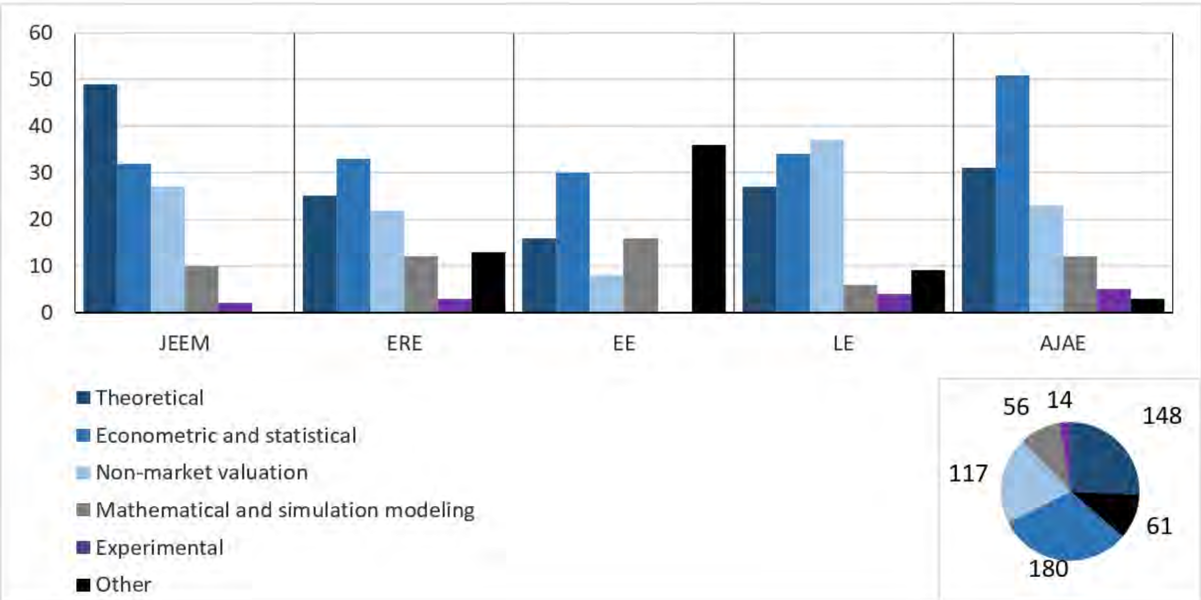

Figure 27: Methods utilized for analysis (one or more per article possible, N=576, p-value: <0.001).

All in all, *non-market valuation* achieves an almost equal rank. It is the most common methodology in *LE*, but also plays an important role in *JEEM*. As Costanza et al. (2016) also point out, 'Statistical/econometric' methods make an insignificant showing in *EE*. We display the *other theory* category separately, given the large number of descriptive treatments and literature reviews among the articles cited from *EE*. *Mathematical and simulation modeling* (including input-output and CGE models) are used in 11% of the articles, for instance in *EE,* where most applications consider the ecological footprint concept. *Experiments* are an emerging method and hence the least widely represented among the 100 most cited articles, with a degree of prominence in *AJAE* and *LE.* Along with *JEEM*, these latter journals display the largest overall number of methodological combinations.

4.4 Environmental media: pollutants and resources

The majority of frequently cited articles in the five journals deals with specific resources or externalities (*air*, *water* or *land pollution*) rather than falling under the *none* option (Figure 28). Among externalities, *air pollution and greenhouse gases* are the most common. Unsurprisingly, articles cited from *LE* are fairly often concerned with *land pollution* issues. *Water* and *other pollution* are of minor importance. The most frequently cited articles in *EE*, *LE*, and *ERE* also focus on specific *resources*.

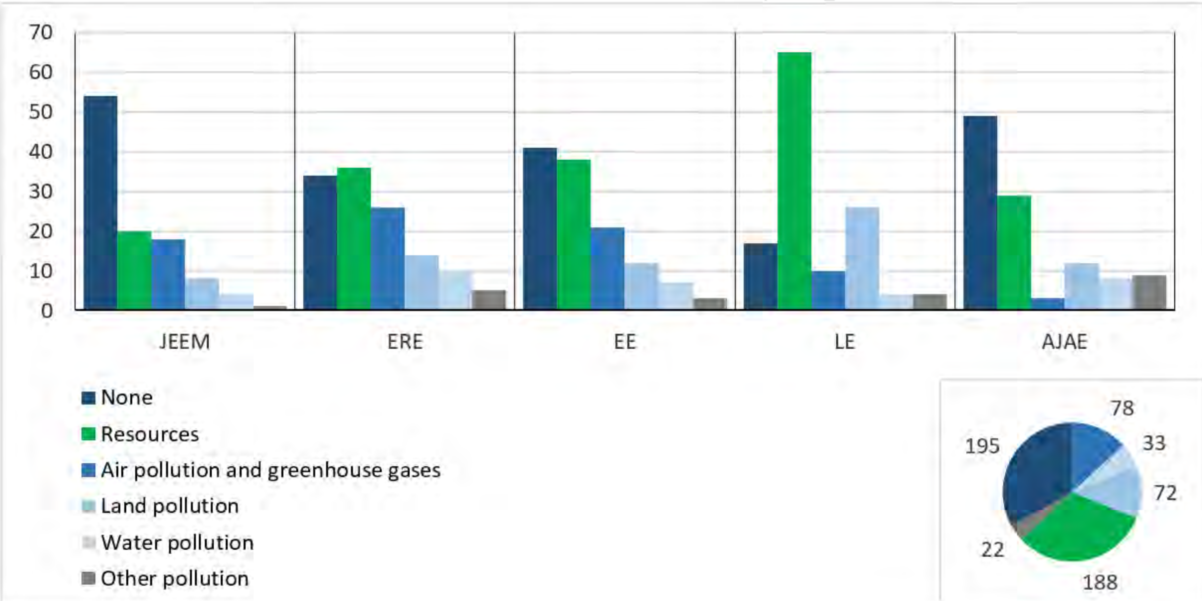

Figure 28: Environmental media: pollutants and resources (one or more per article possible, N=5889, p-value: <0.001).

4.5 Regional dimension

More than 70% of the frequently cited articles in *AJAE* and *LE* are related to specific regions (Figure 29), which applies to only about half of the corresponding articles in *JEEM*, *ERE*, and *EE*. Whereas *AJAE*, *LE,* and *JEEM* are largely geared to the *U.S. and Canada*, *ERE* has also a strong focus on *Europe*. The *EE* articles most frequently cited tend either to be *general* in regional terms or to draw *multi-country comparisons*. The proportion of other regions apart from *Northern America* and *Europe* is equally low and equally mixed in all five journals. Only very few articles on *China* or *other Asian countries* are to be found among the most frequently cited articles.

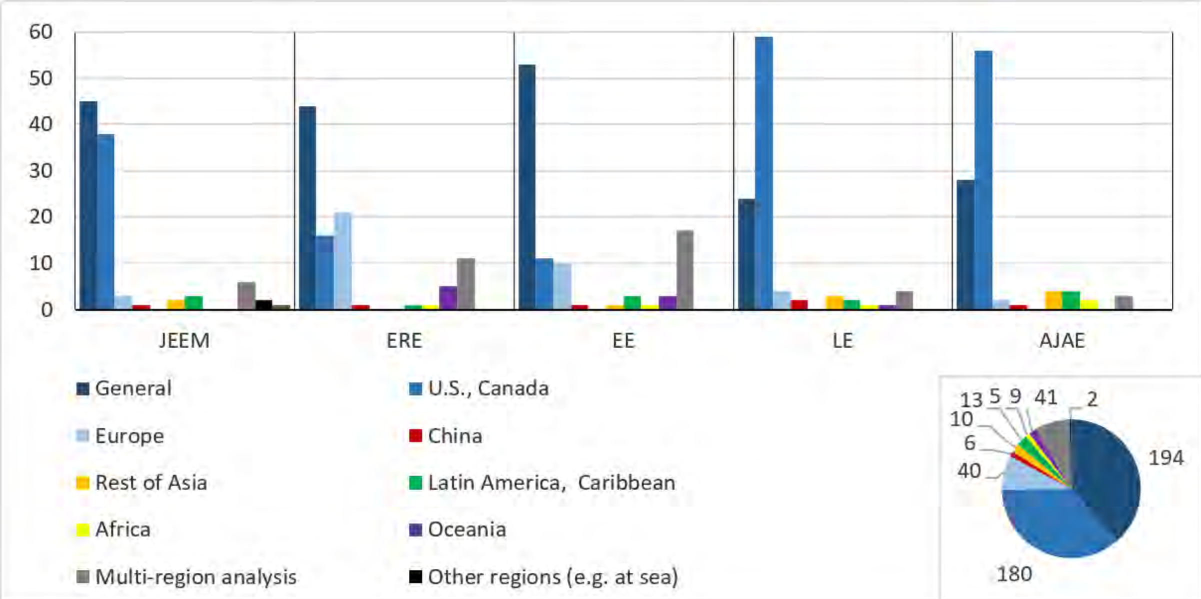

Figure 29: Regional dimension (one per article, N=500, p-value: <0.001).

4.6 Cross-cutting issues

Results for cross-cutting issues vary significantly across journals. Unsurprisingly, we find a large number of *interdisciplinary and ecological economics approache*s in *EE* (Figure 30). Since this category comprises ecosystem services, we are in line with Costanza et al. (2016) in finding that in terms of the citation count this category is the most significant subject matter in *EE*. A high count for *ERE* is also in line with Polyakov et al. (2017), who register an increasing number of citations for *ERE* articles on 'Conservation', including ecosystem services. A further significant contribution to the diversity thus observed stems from the focus of many *AJAE* articles on *risk, uncertainty and imperfect information*, for instance in the context of crop cycle planning or pesticide use by farmers. *JEEM* and *ERE* also score significantly in this category. Furthermore, *ERE* is not only a major platform for all energy-related issues (energy *efficiency*, *renewable energy sources* and *nuclear*) but also the leader in references to *climate change*. Among the most frequently cited *LE* articles, cross-cutting issues do not figure prominently.

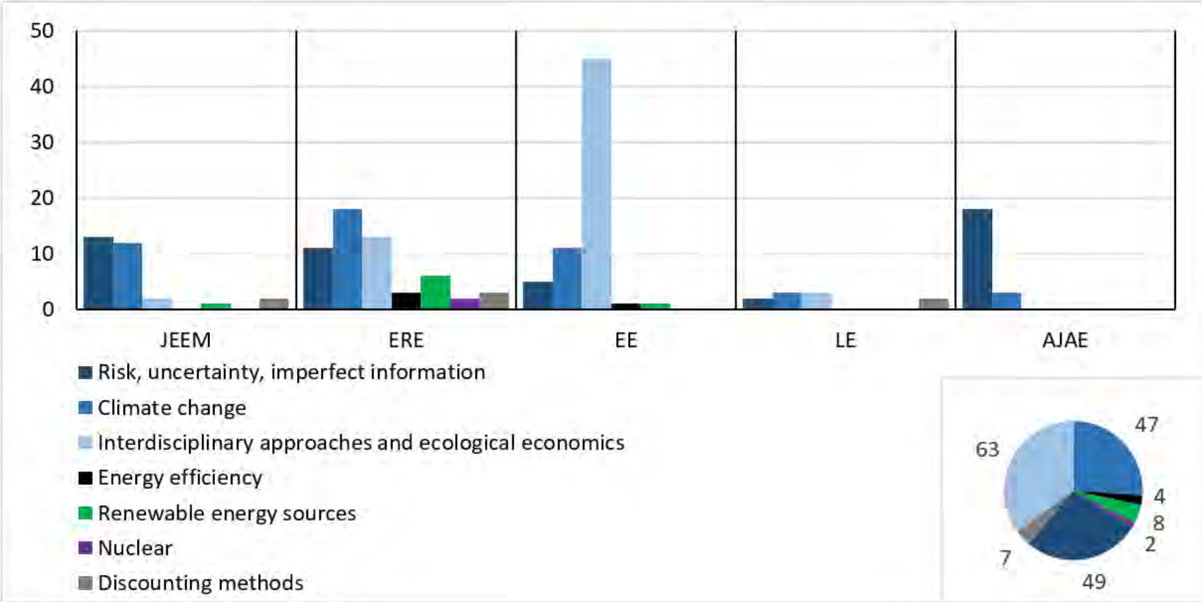

Figure 30: Cross-cutting issues (one or more per article possible, N=180, p-value: <0.001).

5. Influence on leading general-interest economics journals

Now that we have compared the subject matter in *JEEM* with that of other major environmental economics journals, we look at the presence of *JEEM* articles in the five most renowned general-interest economics journals. In line with the rankings customarily accorded to them in the literature (Combes and Linnemer (2010), Kalaitzidakis et al. (2003, 2011), Engemann and Wall (2009)), these are commonly referred to as *A+ journals.* Using OLS and ML estimation, we identify article categories that significantly correlate with citation by A+ journal articles. The A+ journals we consider are:

- *American Economic Review*
- *Econometrica*
- *The Journal of Political Economy*
- *The Quarterly Journal of Economics*
- *The Review of Economic Studies*

To measure the impact on these journals, we handsearched the citation list for each *JEEM* article on Science Direct / Scopus as of September 2015 and on Reuters Web of Science Core Collection as of December 2017 to identify citations in articles from A+ journals and the publication year of those A+ articles. [15]

This approach is comparable to the definition of "outward influence" by Costanza et al. (2016) in their study of the most influential publications of the journal *Ecological Economics* in terms of total citations. However, our study differs in that we only count citation in A+ journal articles as the quality measure for article diffusion in the overall field of economics.[16]

5.1 Citation count

Of all 1,672 articles published in *JEEM* between 1974 and 2014, a total of 237 articles (14 %) are referred to at least once in the articles assembled in an A+ journal. Out of these, 66 (28%) of *JEEM* articles are cited more than once, leading to a sum of 365 citations. The average number of A+ citations among the A+ cited articles is 1.54, which is why we prefer a binary dependent variable to count data for the regressions in section 5.2. JEEM's earliest publication years already show a large degree of diffusion into A+ journals, with the number

[15] In an earlier working paper version our data were taken from the Scopus database as of September 2015 which at that point did not include JEEM citations from A+ articles published before the year 1996. We now additionally include the Web of Science Core Collection database as of December 2017 as it covers earlier publication years. However, the databases are frequently updated and our analysis remains subject to limitations of the databases.

[16] One problem in measuring A+ citations arises when instead of referring to articles in a journal, the A+ citations refer to working papers published previously rather than to the article version later published in *JEEM*. To obviate this measurement error, we selected a random sample of at least 10 *JEEM* articles per given year and as of September 2015 searched for a corresponding working paper version via Ideas/RePEc, Google Scholar, ISI Web Of Science as well as the CVs published by authors on their institution websites. We were able to detect working papers on the internet from the year 1995 onwards, but not for previous years. In all we checked 190 *JEEM* articles. For 103 of them we were unable to track down online-published working papers. Of these, 14 were cited in A+ articles, and we consider these cases to be A+ citations of the respective *JEEM* article in our dataset. However, only in 4 of the 103 cases was the working paper cited in the A+ articles without reference to the respective *JEEM* article version. Accordingly, we neglect the eventuality of this posing a potential threat to the accuracy of the analysis.

of references peaking for JEEM articles published in the 1990s. Citations remain at a more or less comparable level for 21st century publications, although the diffusion process may still exhibit some delay.

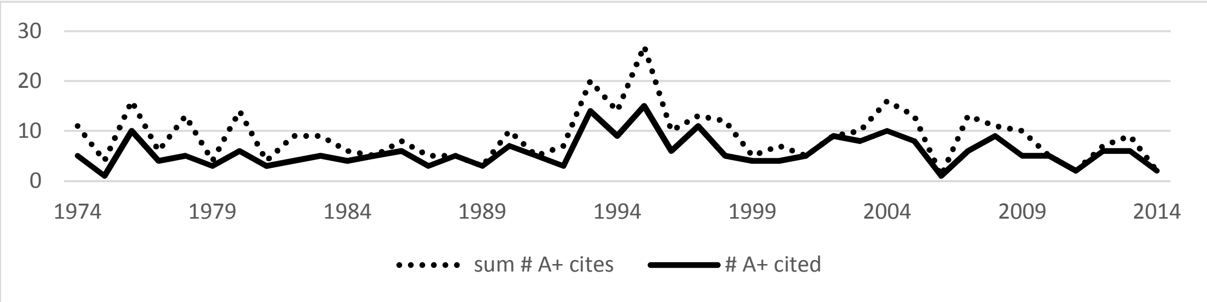

Figure 31: Number of A+ cited articles and sum of A+ citations (reflecting more than one A+ citation per A+ cited article).

In a next step, we establish a time-link between the publication year of citing A+ journal articles and the publication year of the cited *JEEM* articles. Figure 32 shows *JEEM* publication years on the x-axis, while the y-axis shows the publication year of the A+ article containing the citation. Most A+ citations happen shortly after publication of the respective JEEM article which suggests a rather rapid diffusion of research topics. About half of citing A+ articles were published in the 21st century and most of these articles still cite research from JEEM's early decades.

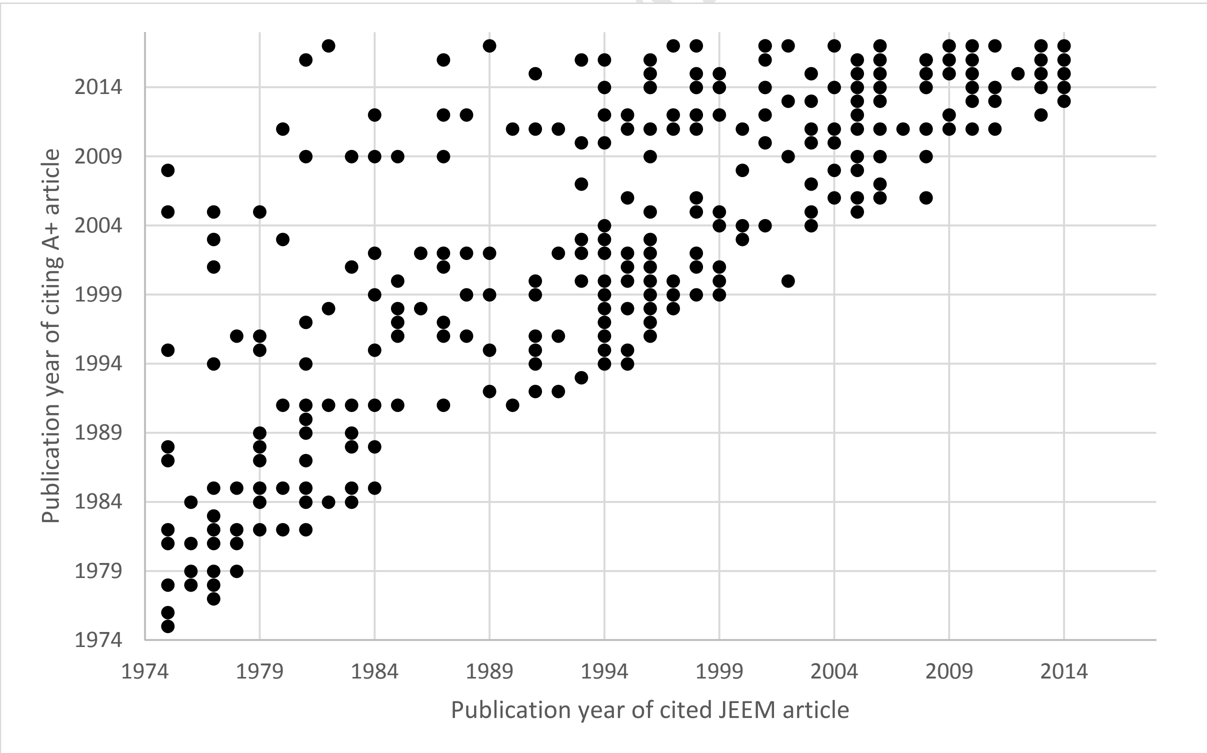

Figure 32: Year of publication in JEEM *and year of citation by A+ articles. The graph does not display cases where there is more than one A+ article from year X citing a JEEM article from year Y.*

5.2 Assessing the importance of article dimensions for A+ citation probability

After describing the overall *JEEM* citation patterns encountered in A+ journals, we now investigate the way in which article dimensions correlate with external influence as expressed by A+ citation status. Of all the 1,672 articles, there are 237 cited by A+ journals for which the dependent variable is equal to one. We have aggregated most sub-categories since many of them contain only a few A+ cited articles. Another reason for aggregation is the collinearity issues that may arise, say, when the content is *fishery* and the classification under environmental media is *fish* as a resource.

We include explanatory dummy variables for content (16), methods (5), environmental media: pollutants & resources (6), regional dimension (5), cross-cutting issues (5), and decades (4) to absorb unobservable influence over time. Finally, we also control for the number of pages per article. Since only dummy variables enter the model (except for the number of pages), we have to omit baseline cases for each dimension. We chose a highly representative article (based on the relative proportion of categories among all *JEEM* articles, see Online-Appendix A) that was published in the journal's most recent decade (2005-2014) with *costs and benefits of pollution control*, *non-market valuation – general methodological improvements* as the baseline category in the content dimension, with a *static theory model* as method, with neither a particular environmental medium (option *none)* nor a particular regional dimension *(*option *general)* and without cross-cutting issues involved.

We used OLS and Maximum Likelihood (Probit)[17] to test the model for robustness of results (Table I). Generally speaking, the linear probability model and ML estimation deliver congruent results for the significant factors. In terms of content, especially the categories *market-based approaches and policy comparisons* as well as *climate change economics* show a positive and significant effect in all three models, increasing the probability for A+ citation (other things being equal) by about more than 12% and 13% respectively, compared to the baseline case. *Non-renewable natural resource economics* and *international economics, innovation, and growth* show positive coefficients that are significant only at the five and ten percent significance level. As for methods, there are consistently significant coefficients for *econometric and statistical methods* and especially *experimental methods* that imply a positive effect compared to *theoretical models*. Only for *air pollution and greenhouse gases,* environmental media articles have a significantly higher likelihood to be cited in A+ journals than articles without focusing on a specific environmental media. We find a negative correlation for *water pollution* and *other pollutants* (such as pesticides) at a high significance level of one percent for the former, and of five percent for the latter. The coefficients for the regional dimension suggest that a specific regional context, with the exception of Northern America, decreases the probability for A+ citation, especially in the case of *multi-country comparisons*. None of the cross-cutting issues shows a significant correlation with A+ citation, which is surprising given the growing general interest in *interdisciplinary approaches and ecological economics*. One final observation is that A+ cited articles tend to have slightly more pages than the average *JEEM* article.

[17] We also ran Logit regressions delivering almost the same results.

One potential source of endogeneity may be the eventuality of *JEEM* article (co-) authors later publishing an A+ article and citing the previous *JEEM* article therein. In that case, the explanatory power of our classification for A+ citation probability might be affected. Accordingly, we refer to cases as "pure self-citation" where the only A+ citation stems from an A+ article by the author (or one of the co-authors) of the *JEEM* article cited. We have not counted them as A+ citations in columns 4-7 of Table I, thus reducing the number of A+ cited articles by 17 from 237 to 220 (-7%). In principle, the coefficients indicate robustness in the estimation results.

Table I: Regression of A+ citation status on (aggregated) article classification categories.

Dependent Variable:	**A+ citation**		**A+ citation, excluding self-citation**	
	OLS	Probit	OLS	Probit
Content				
NRE RENEWABLES	0.033	0.03	0.026	0.021
NRE NON-RENEWABLES	0.101**	0.119**	0.092**	0.102*
NRE OTHER	0.067	0.075	0.068	0.07
CLIMATE CHANGE ECS.	0.136**	0.184**	0.107*	0.146*
ENERGY ECONOMICS	0.049	0.057	0.044	0.053
CBA/NMV APPLIED	0.029	0.03	0.02	0.019
CBA/NMV COST EST.	-0.003	0	0.007	0.011
INT. ECS, INN., GROWTH	0.086**	0.108*	0.072**	0.088*
EPI C&C, STANDARDS	0.011	0.006	0.016	0.011
EPI MARKET-BASED	0.124***	0.142***	0.119***	0.132***
EPI POLITICAL ECON.	0.037	0.05	0.04	0.049
EPI ENV. BEHAVIOUR	0.01	0.015	-0.028	-0.037
EPI OTHER	0.031	0.036	0.039	0.041
FIRM LEVEL MGMT.	-0.001	-0.004	-0.024	-0.043
OTHER	0.048	0.065	0.056	0.072
Method				
ECONOMETRIC	0.074**	0.079**	0.060**	0.059*
NON-MARKET VALUAT.	0.054	0.064	0.038	0.038
SIMULATION MODELS	-0.009	-0.007	-0.025	-0.022
EXPERIMENTAL	0.153**	0.172**	0.124**	0.140*
Pollutant & Media				
AIR POLLUTION & GHG	0.071**	0.061**	0.073**	0.063**
WATER	-0.092***	-0.079***	-0.076***	-0.064***
LAND	0.019	0.017	0.012	0.011
PEST & OTHER	-0.075**	-0.072**	-0.061*	-0.059*
RESOURCES	-0.013	-0.013	0.007	0.006
Regional dimension				
US & CANADA	0.017	0.018	0.022	0.025
EUROPE	-0.055	-0.073*	-0.044	-0.080**
MULTI-COUNTRY	-0.121**	-0.088***	-0.099**	-0.072***
OTHER COUNTRY	-0.069*	-0.059*	-0.080**	-0.067**
Cross-cutting issues				
ENERGY ISSUES	0.048	0.057	0.022	0.024
RISK & UNCERTAINTY	0.022	0.025	0.006	0.009
DISCOUNTING	0.088	0.094	0.066	0.068
INTERDISCIPLINARY	0.045	0.055	0.009	0.017
Other factors				
DECADE 74-84	0.098***	0.116***	0.096***	0.113***
DECADE 85-94	0.091***	0.107***	0.085***	0.099***
DECADE 95-04	0.065***	0.075***	0.061***	0.071***
NO. OF PAGES	0.004**	0.004***	0.004**	0.004**
R^2, Pseudo R^2	0.057	0.073	0.053	0.073
Prob > F , Prob > Chi^2	0.00	0.00	0.00	0.00

*Coefficients for Probit are marginal effects (mfx). N=1,672 (p-values: *** <0.01, ** < 0.05, *< 0.1).*

6. Conclusions

In this paper we have identified the most important trends observable in *JEEM* from 1974-2014 and provided a detailed investigation of the environmental and resource economics research published by the journal in that period. The same classification scheme was also applied to the 100 most frequently cited articles in four other major journals in the subfield. Graphs and diagrams illustrate the content, research methods, environmental media, the regional dimension of the articles, and cross-cutting issues and provide insights into shifts of emphasis within each category.

The assessment points up the recent changes both in *JEEM* and in the environmental and resource economics field, indicating greater content diversity and a shift in research emphasis towards issues posed by climate change and energy usage. The changing complexion of methodological approaches reveals not only the increasing importance of statistical approaches and non-market valuation applications, but also the increasing popularity of experimental methods. Despite a growing focus on greenhouse gases, *JEEM* remains a prime discussion platform for all forms of environmental media and pollution, especially natural resources. Moreover, applications to specific regional contexts seem to have become the standard case for future research. The diffusion of environmental economics research into major general-interest economics (A+) journals and the attendant influence exercised by the characteristics of *JEEM* articles shows that only a small selection of factors appear to be relevant, among them *climate change economics, market-based approaches and policy comparisons*, *econometric and statistical methods,* and *experimental* approaches. By contrast, A+ citations are negatively correlated with a focus on *water pollution* and pesticides and other pollutants.

Speculating on future trends, we would first expect there to be an increasing proportion of papers dedicated to environmental problems in developing countries and countries in transition. This is reflected by a JEEM special issue on environmental economics in developing countries (Jack, 2017). Emerging economies will be of special importance as in these countries economic development goes hand in hand with improved data availability. Secondly, we anticipate a larger number of empirical papers using Big Data, especially on behavior by firms and households. Third, the availability of GIS and satellite data will help to locate pollution sources. High-frequency ambient pollution data can be used to recover emissions from both point and nonpoint sources, and the combination of different kinds of data (economic, geographic, biological and the like) may help different disciplines to collaborate and make interdisciplinary work a more tangible proposition. Fourth, there is a general trend away from lab and towards field experiments when addressing practical issues posed by policy design. However, we do not know whether field experiments will ultimately prevail as they are expensive to conduct and institutional and ethical rules will limit their feasibility. Finally, we expect the continued publication of theoretical papers, albeit to a smaller extent, as both new institutional settings and new behavioral models require rigorous theoretical analyses as a source of hypotheses for empirical work. As humanity approaches the planetary boundaries and has in some cases already crossed those limits due to the rapid growth of human activities (Rockström et al., 2009), the urgent need for environmental and resource economics as a discipline and for journals like *JEEM* and its competitors as research outlets could hardly be plainer.

References

Ahlers, A.L., Hansen, M.H., 2017. Air pollution: How will China win its self-declared war against it? In: Routledge Handbook of Environmental Policy in China*, *. 83-96

Auffhammer, M., 2009. The state of environmental and resource economics: A Google Scholar perspective. REEP 3 (2), 251-269.

Brookshire, D., Scrogin, D., 2000. Reflections upon 25 years of the Journal of Environmental Economics and Management. J. Environ. Econ. Manag. 39, 249-263.

Carson, R., Mitchell, R., Hanemann, M., Kopp, R., Presser, S., Ruud, P., 2003. Contingent valuation and lost passive use: Damages from the Exxon Valdez oil spill. Environ. Resource Econ. 25 (3), 267-286.

Chay, K.Y., Greenstone, M., 2005. Does air quality matter? Evidence from the housing market. J. Polit. Economy 113, 376-424.

Clark, C., Munro, G., 1975. The economics of fishing and modern capital theory: A simplified approach. J. Environ. Econ. Manag. 2 (2), 92-106.

Combes, P.-P., Linnemer, L., 2010. Inferring missing citations: A quantitative multi-criteria ranking of all journals in economics. (Online https://halshs.archives-ouvertes.fr/halshs-00520325 [20.11.2017]).

Costanza, R., Stern, D., Fisher, B., He, L., Ma, C., 2004. Influential publications in ecological economics: a citation analysis. Ecol. Econ. 50 (3-4), 261-292.

Costanza, R., Howarth, R., Kubiszewski, I., Liu, S., Ma, C., Plumecocq, G., Stern, D., 2016. Influential publications in ecological economics revisited. Ecol. Econ. 123, 68-76.

Deacon, R., Brookshire, D., Fisher, A., Kneese, A., Kolstad, C., Scrogin, D., Smith, V.K., Ward, M., Wilen, J., 1998. Research trends and opportunities in environmental and natural resource economics. Environ. Resource Econ. 11 (3-4), 383-397.

Delang, C.O., 2016. China's air pollution problems. Routledge, London.

Engemann, K., Wall, H., 2009. A journal ranking for the ambitious economist. Fed. Reserve Bank St. Louis Rev. 91 (3), 127-39.

Fisher, A., Ward, M., 2000. Trends in natural resource economics in JEEM 1974-1997: Breakpoint and nonparametric analysis. J. Environ. Econ. Manag. 39, 264-281.

Jack, K. (ed.), 2017. Special issue on environmental economics in developing countries. J. Environ. Econ. Manag. 86, 1-310.

Hamermesh, D., 2013. Six decades of top economics publishing: Who and how? J. Econ. Lit. 51 (1), 162-172.

Hoepner, A., Kant, B., Scholtens, B., Yu, P.-S., 2012. Environmental and ecological economics in the 21st century: An age adjusted citation analysis of the influential articles, journals, authors and institutions, Ecol. Econ. 77, 193-206.

Kalaitzidakis, P., Mamuneas, T., Stengos, T., 2003. Rankings of academic journals and institutions in economics. J. Eur. Econ. Assoc. 1 (6), 1346–1366.

Kalaitzidakis, P., Mamuneas, T., Stengos, T., 2011. An updated ranking of academic journals in economics. Can. J. Econ. 44 (4), 1525-1538.

Kim, E.H., Morse, A., Zingales, L., 2006. What has mattered to economics since 1970. JEP 20 (4), 189-202.

Kosnik, L., 2015. What have economists been doing for the last 50 years? A text analysis of published academic research from 1960-2010. Economics: The Open-Access, Open-Assessment E-Journal 9 (2015-13), 1–38.

Ma, C., Stern, D., 2006. Environmental and ecological economics: A citation analysis. Ecol. Econ. 58 (3), 491-506.

Polyakov, M., Chalak, M., Iftekhar, S., Pandit, R., Tapsuwan, S., Zhang, F., Ma, C., 2017. Authorship, collaboration, topics, and research gaps in environmental and resource economics 1991–2015. Enviro. Resource Econ.

Rath, K., Wohlrabe, K., 2016. Trends in economics publications represented by JEL categories between 2007 and 2013. Appl. Econ. Lett. 23 (9), 660-663.

Rockström, J., Steffen, W., Noone, K., Persson, Å., Chapin, F.S. III , Lambin, E., Lenton, T.M., Scheffer, M., Folke, C., Schellnhuber, H.J., Nykvist, B., De Wit, C.A., Hughes, T., Van Der Leeuw, S., Rodhe, H., Sörlin, S., Snyder, P.K., Costanza, R., Svedin, U., Falkenmark, M., Karlberg, L., Corell, R.W., Fabry, V.J., Hansen, J., Walker, B., Liverman, D., Richardson, K., Crutzen, P., Foley, J., 2009. Planetary boundaries: exploring the safe operating space for humanity. Ecol. Soc. 14 (2), 32.

Rosen, S., 1974. Hedonic prices and implicit markets: Product differentiation in pure competition. J. Polit. Economy 82 (1), 34-55.

Schymura, M., Löschel, A., 2014. Incidence and extent of co-authorship in environmental and resource economics: evidence from the Journal of Environmental Economics and Management. Scientometrics. 99 (3), 631-661.

Shogren, J., Durden, G., 1991. The first 15 years: Contributors and contributions to the Journal of Environmental Economics and Management - 1974 – 1988. J. Environ. Econ. Manag. 25, 205-209.

Smith, V.K., 1981. CO_2, climate, and statistical inference: A note on asking the right questions. J. Environ. Econ. Manag. 8 (4), 391-394.

Smith, V.K., 2000. JEEM and non-market valuation: 1974-1998. J. Environ. Econ. Manag. 39, 351-374.

Smith, T.W., Kim, J., Son, J., 2017. Public Attitudes toward Climate Change and Other Environmental Issues across Countries, International Journal of Sociology 47 (1), 62-80.

Online-Appendix A

A.1: Classification of *JEEM* articles and presence in A+ cited articles

Category	# *JEEM* articles (N=1672)		thereof: A+ cited (N=237)	
Content	(abs.)	(%)	(abs.)	(%)
A. Natural resource economics	**451**	**27%**	**60**	**10%**
Renewable resources and conservation (Q2)	277	17%	29	11%
General, methods, demand & supply (Q20, Q21)	55	3%	9	16%
Fishery, aquaculture (Q22)	102	6%	11	11%
Forestry (Q23)	50	3%	3	6%
Land as a renewable resource and its conservation (Q24)	26	2%	1	4%
Water (Q25)	39	2%	5	14%
Applications to other areas: recreational aspects of natural resources (Q26), issues in international trade (Q27), government policy (Q28)	5	0%	0	0%
Non-renewable resources	126	8%	24	19%
General, methods, demand & supply (Q30, Q31)	68	4%	14	21%
Applications to ores	12	1%	5	42%
Applications to non-renewable energy resources (oil, coal, gas)	17	1%	2	12%
Applications to minerals (incl. rare earth minerals)	5	0%	1	20%
Applications to biodiversity	20	1%	2	10%
Other: resources and economic development (Q32), booms (Q33),national and international conflicts (Q34), international trade (Q37), government policy (Q38), other (Q38)	4	0%	0	0%
Other natural resources	48	3%	7	15%
Secondary materials and recycling	25	1%	6	24%
Pesticide and anti-bacteria	12	1%	0	0%
Entropy laws and mass stability	7	0%	0	0%
Other	4	0%	1	25%
B. Climate change economics	**56**	**3%**	**13**	**23%**
General methods	17	1%	4	24%
Damages through climate change and adaptation	12	1%	3	20%
Mitigation of climate change	27	2%	6	22%
C. Energy economics	**50**	**3%**	**10**	**20%**
Primary energy production: resources, oil, gas, petrolium, hydropower	7	0%	1	14%
Electricity	12	1%	2	17%
Heat	1	0%	0	0%
Traffic and transport	27	2%	7	26%
Energy and the macroeconomy (Q43), energy forecasting (Q47)	3	0%	0	0%
D. Costs and benefits of pollution control, non-market valuation	**486**	**29%**	**41**	**8%**
General, methodological improvements	263	16%	28	11%
Methods applied to elicit benefits and damages in	186	11%	27	14%
Air pollution	49	3%	9	18%
Water pollution	28	2%	4	14%
Noise	3	0%	1	33%
Hazardous waste	9	1%	4	44%
Nuclear power	4	0%	0	0%

Solid waste	5	0%	0	0%
Land degradation	20	1%	4	19%
Biodiversity loss	40	2%	2	17%
Recreational activities	13	1%	2	5%
Other	15	1%	0	0%
Measuring the costs of pollution control, estimating abatement costs	34	2%	5	15%
Other	3	0%	0	0%
E. International economics, innovation, and growth	**154**	**9%**	**22**	**14%**
Macroeconomic impacts, growth, and GDP	43	3%	4	10%
Innovation and technological change	27	2%	4	15%
International econonomic issues	73	4%	12	16%
Development issues	11	1%	2	17%
F. Analysis of environmental policy instruments	**421**	**25%**	**64**	**16%**
Command and control policies, environmental standards	60	4%	7	12%
Market-based approaches and policy comparisons	220	13%	44	20%
Liability rules	19	1%	1	5%
Environmental behavior, public goods, voluntary approaches	36	3%	5	11%
Political economy aspects	45	2%	5	14%
Other	41	3%	5	12%
G. Environmental management at firm level	**35**	**2%**	**3**	**9%**
H. Environmental justice	**9**	**1%**	**1**	**11%**
I. Other	**11**	**1%**	**2**	**18%**
Methods				
Theoretical methods	**1,042**	**62%**	**136**	**13%**
Static theory (including 2-3-period models)	443	26%	61	14%
Dynamic theory, infinite horizon models	421	25%	58	14%
Theoretical foundations of non-market valuation and cost-benefit analysis	154	9%	16	10%
Other theory	26	2%	1	4%
Econometric and statistical methods (with market and other data)	**447**	**27%**	**73**	**16%**
Non-market valuation	**203**	**13%**	**28**	**14%**
Hedonic pricing	42	3%	10	24%
Other revealed preferences	55	3%	4	7%
Stated preferences (using surveys)	120	7%	14	12%
Mathematical and simulation modeling	**172**	**10%**	**23**	**13%**
Experimental methods	**50**	**3%**	**12**	**24%**
Lab experiments	43	3%	10	23%
Field experiments	9	1%	2	22%
Environmental media: pollutants & resources				
Pollutants	**586**	**35%**	**66**	**11%**
Air pollution and greenhouse gases	263	16%	55	21%
Sulfur	62	4%	15	24%
NO_x	37	2%	9	24%
CO	18	1%	4	22%
PM	41	2%	13	32%
CFCs	1	0%	0	0%

Ozone	13	1%	4	31%
CO2 and general references to greenhouse gases	95	6%	12	13%
General air pollution	73	4%	13	18%
Other air pollution (e.g. VOCs)	14	1%	2	14%
Water Pollution	113	7%	8	7%
C-H compounds	9	1%	0	0%
CL compounds	1	0%	0	0%
Fertilizers	7	0%	1	14%
Solid waste	2	0%	0	0%
Heavy metals	4	0%	1	25%
General water pollution	84	5%	3	4%
Other water pollution	10	1%	2	20%
Land Pollution	146	9%	22	15%
Solid waste	46	3%	10	22%
Degradation of landscapes	63	4%	7	11%
Other land pollution (e.g. hazardous wastes)	38	2%	6	16%
Other pollutants (e.g. pesticides)	64	4%	4	6%
Resources	**443**	**26%**	**57**	**13%**
Fisheries	140	8%	16	11%
Forests	73	4%	6	8%
Recreation, landscape	55	3%	4	7%
Water as a resource	38	2%	5	13%
Wildlife, biodiversity	43	3%	5	12%
Secondary materials, waste recycling	36	2%	8	22%
Coal	15	1%	2	13%
Oil	40	2%	7	18%
Gas	15	1%	2	13%
Ores	23	1%	7	30%
Minerals	11	1%	5	45%
Other resources (e.g. biofuels)	14	1%	1	7%
None	**807**	**48%**	**110**	**14%**
Cross-cutting issues	**553**	**27%**	**49**	**11%**
Climate change	114	7%	28	25%
Energy efficiency	29	2%	8	28%
Renewable energy sources	24	1%	3	13%
Nuclear	9	1%	1	11%
Risk, uncertainty, imperfect information	287	17%	44	15%
Discounting methods	33	2%	6	18%
Interdisciplinary approaches and ecological economics	57	3%	9	16%
Regional dimension				
General, no regional dimension	**941**	**56%**	**126**	**13%**
Specific regional dimension	**731**	**44%**	**111**	15%
U.S., Canada	537	32%	97	18%
Europe	58	3%	2	3%
China	10	1%	1	10%

Middle East	1	0%	0	0%
Rest of Asia	20	1%	1	5%
Latin America, Caribbean	19	1%	1	5%
Africa	11	1%	0	0%
Oceania	12	1%	2	17%
Multi-region analysis, comparative studies of countries	54	3%	5	9%
Other (e.g. at sea)	9	1%	2	22%

Figures for aggregated categories (e.g. Air Pollution) are not the sum of sub-categories but the number of articles that contain at least one of the sub-categories. Thus we rule out double counting for the aggregated category, e.g. when an article refers to Sulfur and PM, it only counts as one article on Air Pollution, not two.

A.2: Classification scheme for 100 most cited articles in 5 major field journals

Category	Journal				
Content	**JEEM**	**ERE**	**EE**	**LE**	**AJAE**
A. Natural resource economics	**11**	**11**	**14**	**30**	**13**
Renewable resources and conservation (Q2)	10	6	12	27	12
General, methods, demand & supply (Q20, Q21)	**2**	**0**	**9**	**2**	**2**
Fishery, aquaculture (Q22)	**4**	**0**	**0**	**4**	**0**
Forestry (Q23)	**2**	**0**	**2**	**9**	**3**
Land as a renewable resource and its conservation (Q24)	**0**	**0**	**0**	**6**	**5**
Water (Q25)	**1**	**6**	**1**	**6**	**2**
Applications to other areas: recreational aspects of natural resources (Q26), issues in international trade (Q27), government policy (Q28)	**1**	**0**	**0**	**0**	**0**
Non-renewable resources	1	1	1	3	0
General, methods, demand & supply (Q30, Q31)	**1**	**0**	**0**	**1**	**0**
Applications to ores	**0**	**0**	**0**	**0**	**0**
Applications to non-renewable energy resources (oil, coal, gas)	**0**	**0**	**0**	**0**	**0**
Applications to minerals (incl. rare earth minerals)	**0**	**0**	**0**	**0**	**0**
Applications to biodiversity	**0**	**1**	**1**	**2**	**0**
Other: resources and economic development (Q32), booms (Q33),national and international conflicts (Q34), international trade (Q37), government policy (Q38), other (Q38)	**0**	**0**	**0**	**0**	**0**
Other natural resources	0	2	1	0	1
Secondary materials and recycling	**0**	**1**	**0**	**0**	**0**
Pesticide and anti-bacteria	**0**	**1**	**1**	**0**	**1**
Entropy laws and mass stability	**0**	**0**	**0**	**0**	**0**
Other	**0**	**0**	**0**	**0**	**0**
B. Climate change economics	**6**	**13**	**4**	**3**	**2**
General methods	**1**	**5**	**3**	**0**	**0**
Damages through climate change and adaptation	**1**	**4**	**1**	**0**	**0**
Mitigation of climate change	**4**	**4**	**0**	**3**	**2**
C. Energy economics	**0**	**2**	**2**	**1**	**1**
Primary energy production: resources, oil, gas, petrolium, hydropower	**0**	**1**	**0**	**0**	**0**
Electricity	**0**	**0**	**0**	**0**	**0**
Heat	**0**	**0**	**0**	**0**	**0**
Traffic and transport	**0**	**0**	**0**	**0**	**0**
Energy and the macroeconomy (Q43), energy forecasting (Q47)	**0**	**1**	**2**	**0**	**1**
D. Costs and benefits of pollution control, non-market valuation	**45**	**49**	**43**	**50**	**25**
General, methodological improvements	34	32	17	22	9
Methods applied to elicit benefits and damages in	10	17	26	27	16
Air pollution	**5**	**1**	**0**	**2**	**0**
Water pollution	**1**	**3**	**0**	**1**	**1**
Hazardous waste	**0**	**1**	**0**	**1**	**0**
Nuclear power	**0**	**0**	**0**	**0**	**0**
Solid waste	**0**	**0**	**0**	**0**	**0**
Noise	**0**	**0**	**0**	**0**	**0**
Land degradation	**2**	**5**	**16**	**11**	**2**

Biodiversity loss	0	2	2	7	5
Recreational activities	2	3	8	5	3
Other	0	2	0	0	5
Measuring the costs of pollution control, estimating abatement costs	1	0	0	1	0
Other	0	0	0	0	0
E. International economics, innovation, and growth	**12**	**11**	**23**	**2**	**1**
Macroeconomic impacts, growth, and GDP	5	7	15	2	1
Innovation and technological change	3	3	3	0	0
International econonomic issues	4	1	4	0	0
Development issues	0	0	1	0	0
F. Analysis of environmental policy instruments	**22**	**13**	**10**	**5**	**6**
Command and control policies, environmental standards	2	0	1	1	2
Market-based approaches and policy comparisons	13	9	9	4	2
Liability rules	0	0	0	0	0
Environmental behavior, public goods, voluntary approaches	0	0	0	0	0
Political economy aspects	6	4	0	0	2
Other	1	0	0	0	0
G. Environmental management at firm level	**3**	**3**	**0**	**2**	**3**
H. Environmental justice	**1**	**0**	**1**	**0**	**0**
I. Other	**0**	**0**	**3**	**8**	**50**
Methods	123	111	106	119	126
Theoretical methods	**49**	**38**	**52**	**36**	**34**
Static theory (including 2-3-period models)	16	7	4	7	20
Dynamic theory, infinite horizon models	18	12	2	10	6
Theoretical foundations of non-market valuation and cost-benefit analysis	15	7	10	10	5
Other theory	0	13	36	9	3
Econometric and statistical methods (with market and other data)	**32**	**33**	**30**	**34**	**51**
Non-market valuation	**27**	**22**	**8**	**37**	**23**
Hedonic pricing	4	1	1	12	2
Other revealed preferences	3	2	1	7	5
Stated preferences (using surveys)	23	21	6	20	17
Mathematical and simulation modeling	**10**	**12**	**16**	**6**	**12**
Experimental methods	**2**	**3**	**0**	**4**	**5**
Lab experiments	2	2	0	4	3
Field experiments	0	1	0	0	2
Environmental media: pollutants & resources	**119**	**160**	**182**	**141**	**121**
Pollutants	**39**	**68**	**60**	**45**	**33**
Air pollution and greenhouse gases	**18**	**26**	**21**	**10**	**3**
Sulfur	6	3	5	1	0
NO_x	4	2	5	1	0
CO	1	1	2	0	0
PM	3	4	1	2	0
CFCs	0	0	0	0	0
Ozone	0	3	1	0	0
CO2 and general references to greenhouse gases	0	3	1	0	0

General air pollution	0	1	0	1	0
Other air pollution (e.g. VOCs)	10	18	17	3	3
Water Pollution	4	10	7	4	8
C-H compounds	1	1	0	1	0
CL compounds	0	0	0	0	0
Fertilizers	0	4	2	0	5
Solid waste	0	0	1	0	1
Heavy metals	0	0	0	0	0
General water pollution	3	4	7	3	3
Other water pollution	0	1	0	0	0
Land Pollution	8	14	12	26	12
Solid waste	1	1	0	1	0
Degradation of landscapes	2	11	11	23	12
Other land pollution (e.g. hazardous wastes)	5	2	1	2	0
Other pollutants (e.g. pesticides)	1	5	3	4	9
Resources	20	36	38	65	29
Fisheries	6	2	10	10	5
Forests	5	8	9	17	6
Recreation, landscape	3	9	12	28	14
Water as a resource	1	9	6	10	4
Wildlife, biodiversity	2	14	20	12	9
Secondary materials, waste recycling	2	1	0	1	0
Coal	0	3	5	0	0
Oil	1	3	6	0	1
Gas	2	3	5	0	0
Ores	2	0	1	0	0
Minerals	1	0	1	0	0
Other resources (e.g. biofuels)	0	6	6	1	0
None	54	34	41	17	49
Cross-cutting issues	30	55	63	10	21
Climate change	12	18	11	3	3
Energy efficiency	0	3	1	0	0
Renewable energy sources	1	6	1	0	0
Nuclear	0	2	0	0	0
Risk, uncertainty, imperfect information	13	11	5	2	18
Discounting methods	2	3	0	2	0
Interdisciplinary approaches and ecological economics	2	13	45	3	0
Regional dimension					
General, no regional dimension	45	44	53	24	28
Specific regional dimension	55	56	47	76	72
U.S., Canada	38	16	11	59	56
Europe	3	21	10	4	2
China	1	1	1	2	1
Middle East	0	0	0	0	0
Rest of Asia	2	0	1	3	4

Latin America, Caribbean	**3**	**1**	**3**	**2**	**4**
Africa	**0**	**1**	**1**	**1**	**2**
Oceania	**0**	**5**	**3**	**1**	**0**
Multi-region analysis, comparative studies of countries	**6**	**11**	**17**	**4**	**3**
Other (e.g. at sea)	**2**	**0**	**0**	**0**	**0**

Figures for aggregated categories (e.g. Air Pollution) are not the sum of sub-categories but the number of articles that contain at least one of the sub-categories. Thus we rule out double counting for the aggregated category , e.g. when an article refers to Sulfur and PM, it only counts as one article on Air Pollution, not two.

Online-Appendix B

B.1: Chi-squared tests for figures in section 3 (*JEEM* articles)

Key
frequency *expected frequency* *chi2 contribution*

Classification of content in *JEEM* articles (Figure 2)

Sub-category	**Decade**				**Total**
	1	**2**	**3**	**4**	
Natural resource economics	86	137	129	99	**451**
	80.7	102.5	128.4	139.5	**451**
	0.4	11.6	0	11.7	**23.7**
Costs and benefits of pollution control,	104	120	137	125	**486**
non-market valuation	86.9	110.5	138.4	150.3	**486**
	3.4	0.8	0	4.3	**8.5**
Climate change economics	1	5	13	37	**56**
	10	12.7	15.9	17.3	**56**
	8.1	4.7	0.5	22.4	**35.7**
Energy economics	6	6	8	30	**50**
	8.9	11.4	14.2	15.5	**50.0**
	1.0	2.5	2.7	13.7	**19.9**
Analysis of environmental policy	74	83	122	142	**421**
Instruments	75.3	95.7	119.9	130.2	**421**
	0	1.7	0	1.1	**2.8**
Environmental management at	2	4	8	21	**35**
firm level	6.3	8.0	10.0	10.8	**35.0**
	2.9	2.0	0.4	9.6	**14.8**
International economics, innovation	18	21	54	61	**154**
and growth	27.5	35	43.8	47.6	**154**
	3.3	5.6	2.4	3.8	**15**
Environmental justice /	8	4	5	3	**20**
Other content	3.6	4.5	5.7	6.2	**20.0**
	5.5	0.1	0.1	1.6	**7.3**
Total	**299**	**380**	**476**	**517**	**1,672**
	299	**380**	**476**	**517**	**1,672.00**
	25.3	**28.9**	**6.1**	**69**	**129.3**

Pearson Chi2(21) = 129.2836 , Pr = <0.001

No change in significance level even when we omit Climate Change (CCE), as it only enters appears in the third decade

Natural resource economics (Figure 3)

Sub-category	**Decade**				**Total**
	1	**2**	**3**	**4**	
Renewable resources	41	79	86	71	**277**
	52.8	84.1	79.2	60.8	**277**
	2.6	0.3	0.6	1.7	**5.2**
Non-renewable resources	25	48	35	18	**126**
	24	38.3	36	27.7	**126**
	0	2.5	0	3.4	**5.9**
Other resources	20	10	8	10	**48**
	9.1	14.6	13.8	10.6	**48.0**
	13.2	1.5	2.4	0.0	**17.1**
Total	**86**	**137**	**129**	**99**	**451**
	86	**137**	**129**	**99**	**451**
	15.5	**4.2**	**3**	**5.1**	**27.9**
Pearson Chi2(6) = 27.8728, Pr = <0.001					

Natural resource economics – renewable resources (Figure 4)

Sub-category	**Decade**				**Total**
	1	**2**	**3**	**4**	
General, methods, demand & supply	13	16	11	15	**55**
	8.0	15.8	17.0	14.2	**55.0**
	3.1	0.0	2.1	0.0	**5.3**
Fishery, aquaculture	17	27	29	29	**102**
	14.8	29.3	31.5	26.3	**102.0**
	0.3	0.2	0.2	0.3	**1.0**
Forestry	4	18	21	7	**50**
	7.3	14.4	15.5	12.9	**50.0**
	1.5	0.9	2.0	2.7	**7.1**
Water	3	11	14	11	**39**
	5.8	11.1	12.1	10	**39**
	1.3	0	0.3	0.1	**1.7**
Land	3	5	9	9	**26**
	3.8	7.5	8.0	6.7	**26.0**
	0.2	0.8	0.1	0.8	**1.9**
Other	1	2	2	0	**5**
	0.7	1.4	1.5	1.3	**5.0**
	0.1	0.2	0.1	1.3	**1.7**
Total	**41**	**79**	**86**	**71**	**277**
	41	**79**	**86**	**71**	**277**
	6.3	**2.2**	**4.8**	**5.2**	**18.5**
Pearson Chi2(15) = 18.5292, Pr = 0.236					

Non-renewable resources (Figure 5)

Sub-category	**Decade**				**Total**
	1	**2**	**3**	**4**	
General, methods, demand & supply	15	28	14	11	**68**
	13.4	25.7	19.3	9.6	**68.0**
	0.2	0.2	1.4	0.2	**2.0**
Biodiversity	3	2	10	5	**20**
	4	7.6	5.6	2.9	**20**
	0.2	4.1	3.6	1.6	**9.5**
Non-renewable energy resources	5	5	6	1	**17**
	3.3	6.4	4.8	2.4	**17.0**
	0.8	0.3	0.3	0.8	**2.2**
Minerals / ores / other	2	13	5	1	**21**
	4.1	7.9	6.0	3.0	**21.0**
	1.1	3.2	0.2	1.3	**5.8**
Total	**25**	**48**	**35**	**18**	**126**
	25	**48**	**35**	**18**	**126**
	2.3	**7.8**	**5.3**	**4**	**19.3**

Pearson Chi2(9)= 19.3279, Pr = 0.023

Other natural resources (not discussed in the main body of the paper due to the small number of cases)

Sub-category	**Decade**				**Total**
	1	**2**	**3**	**4**	
Secondary materials and recycling	15	2	4	4	**25**
	10.4	5.2	4.2	5.2	**25**
	2	2	0	0.3	**4.3**
Pesticide and anti-bacteria	3	2	2	5	**12**
	5	2.5	2	2.5	**12**
	0.8	0.1	0	2.5	**3.4**
Entropy laws and mass stability/ other	2	6	2	1	**11**
	4.6	2.3	1.8	2.3	**11**
	1.5	6	0	0.7	**8.2**
Total	**20**	**10**	**8**	**10**	**48**
	20	**10**	**8**	**10**	**48**
	4.3	**8.1**	**0**	**3.5**	**15.9**

Pearson Chi2(6) = 15.8800, Pr = 0.014

Figure not shown in main body of the paper.

Climate change economics (Figure 6)

Sub-category	**Decade**				**Total**
	1	**2**	**3**	**4**	
General methods	-	-	1	13	**14**
	-	-	3.6	10.4	**14**
	-	-	1.9	0.7	**2.6**
Damages through climate change and adaptation	-	-	4	8	**12**
	-	-	3.1	8.9	**12**
	-	-	0.2	0.1	**0.3**
Mitigation of climate change	-	-	8	16	**24**
	-	-	6.2	17.8	**24**
	-	-	0.5	0.2	**0.7**
Total	**-**	**-**	**13**	**37**	**50**
	-	**-**	**13**	**37**	**50**
	-	**-**	**2.7**	**0.9**	**3.6**

Pearson Chi2(2) = 3.5937, Pr = 0.166

The first two decades are omitted owing to content novelty, thus omitting 6 articles here.

Energy economics (Figure 7)

Sub-category	**Decade**		**Total**
	1 2	**3 4**	
Traffic and transport	3	24	**27**
	6.5	20.5	**27.0**
	1.9	0.6	**2.5**
Electricity	1	11	**11**
	2.9	9.1	**11.0**
	1.2	0.4	**14.3**
Primary energy production / energy and the macroeconomy, energy forecasting / heat	8	3	**11**
	2.6	8.4	**11.0**
	10.9	3.4	**14.3**
Total	**12**	**38**	**50**
	12.0	**38.0**	**50.0**
	14.0	**4.4**	**18.4**

Pearson Chi2(2) = 18.3928, *Pr = <0.001*

Due to the small number of cases, we use two-decade instead of one-decade periods

Costs and benefits of pollution control, non-market valuation (Figure 8)

Sub-category	**Decade**				**Total**
	1	**2**	**3**	**4**	
General, methodological improvements	32	82	84	65	**263**
	56.3	64.9	74.1	67.6	**263**
	10.5	4.5	1.3	0.1	**16.4**
Methods applied to elicit benefits and damages	62	27	46	51	**186**
	39.8	45.9	52.4	47.8	**186**
	12.4	7.8	0.8	0.2	**21.2**
Measuring the cost of pollution control, estimating abatement costs	10	11	7	9	**37**
	8.0	9.2	10.3	9.5	**37.0**
	0.5	0.4	1.1	0.0	**2.0**
Total	**104**	**120**	**137**	**125**	**486**
	104	**120**	**137**	**125**	**486**
	23.4	**12.7**	**3.2**	**0.3**	**39.6**
Pearson Chi2(6) = 39.6333, Pr = <0.001					

Costs and benefits of pollution control, non-market valuation - methods applied to elicit benefits and damages (Figure 9)

Sub-category	**Decade**				**Total**
	1	**2**	**3**	**4**	
Air pollution	25	7	8	10	**50**
	16.6	7.2	12.6	13.6	**50**
	4.3	0	1.7	1	**6.9**
Water pollution	10	6	6	6	**28**
	9.3	4	7	7.6	**28**
	0.1	0.9	0.2	0.4	**1.5**
Land degradation	7	3	4	6	**20**
	6.6	2.9	5	5.5	**20**
	0	0	0.2	0.1	**0.3**
Recreational activities	10	4	16	10	**40**
	13.3	5.8	10.1	10.9	**40**
	0.8	0.5	3.5	0.1	**4.9**
Noise / Solid waste / Hazardous Waste,	10	7	13	19	**49**
Nuclear Power / Biodiversity Loss /	16.2	7.1	12.3	13.4	**49**
Other	2.4	0	0	2.4	**4.8**
Total	**62**	**27**	**47**	**51**	**187**
	62	**27**	**47**	**51**	**187**
	7.6	**1.5**	**5.6**	**3.8**	**18.5**
Pearson Chi2(12) = 18.4693, Pr = 0.102					

International economics, innovation, and growth (Figure 10)

Sub-category	**Decade**				**Total**
	1	**2**	**3**	**4**	
International economic issues	4	12	26	31	**73**
	8.5	10	25.6	28.9	**73**
	2.4	0.4	0	0.2	**3**
Macroeconomic impacts, growth, and GDP	7	5	15	16	**43**
	5	5.9	15.1	17	**43**
	0.8	0.1	0	0.1	**1**
Innovation and technological change	2	3	8	14	**27**
	3.2	3.7	9.5	10.7	**27**
	0.4	0.1	0.2	1	**1.8**
Development issues	5	1	5	0	**11**
	1.3	1.5	3.9	4.4	**11**
	10.7	0.2	0.3	4.4	**15.6**
Total	**18**	**21**	**54**	**61**	**154**
	18	**21**	**54**	**61**	**154**
	14.3	**0.8**	**0.6**	**5.6**	**21.3**
Pearson Chi2(9) = 21.3412, Pr = 0.011					

Analysis of environmental policy instruments (Figure 11)

Sub-category	**Decade**				**Total**
	1	**2**	**3**	**4**	
Command and control policies, environmental standards	10 10.6 0	15 11.9 0.8	21 17.4 0.7	14 20.1 1.9	**60** **60** **3.5**
Market-based approaches, policy comparisons	47 38.6 1.8	45 43.3 0.1	59 63.6 0.3	68 73.5 0.4	**219** **219** **2.7**
Environmental behavior, public goods, voluntary approaches	2 8.2 4.7	6 9.1 1.0	13 13.0 0.0	24 14.7 5.8	**45** **45.0** **11.5**
Political economy aspects	6 6.6 0.0	2 7.3 3.8	15 10.4 2.0	13 11.8 0.1	**36** **36.0** **6.0**
Liability rules	4 3.5 0.1	5 3.8 0.4	4 5.5 0.4	6 6.2 0.0	**19** **19.0** **0.9**
Other	5 7.2 0.7	10 8.1 0.4	10 11.9 0.3	16 13.8 0.4	**41** **41** **1.8**
Total	**74** **74** **7.1**	**83** **83** **6.4**	**122** **122** **3.8**	**141** **141** **8**	**420** **420** **25.2**
Pearson Chi2(15) = 25.2479, Pr = 0.047					

Methods (Figure 12)

Sub-category	Decade				Total
	1	**2**	**3**	**4**	
Experimental	1	7	19	23	**50**
	8.6	11.3	14.7	15.5	**50.0**
	6.7	1.6	1.3	3.7	**13.3**
Econometric and statistical	70	61	131	185	**447**
	76.6	101.1	131.0	138.3	**447.0**
	0.6	15.9	0.0	15.8	**32.3**
Non-market valuation	23	48	73	59	**203**
	34.8	45.9	59.5	62.8	**203.0**
	4.0	0.1	3.1	0.2	**7.4**
Mathematical and simulation modeling	43	38	44	47	**172**
	29.5	38.9	50.4	53.2	**172.0**
	6.2	0.0	0.8	0.7	**7.8**
Theoretical	191	279	294	278	**1,042**
	178.6	235.7	305.4	322.3	**1,042.0**
	0.9	7.9	0.4	6.1	**15.3**
Total	**328**	**433**	**561**	**592**	**1,914**
	328.0	**433.0**	**561.0**	**592.0**	**1,914.0**
	18.3	**25.6**	**5.6**	**26.5**	**76.0**
Pearson Chi2(12) = 76.0471, Pr = <0.001					

Theoretical methods (Figure 13)

Sub-category	Decade				Total
	1	**2**	**3**	**4**	
Dynamic theory	86	110	112	113	**421**
	77.4	112.9	118.6	112.1	**421.0**
	0.9	0.1	0.4	0.0	**1.4**
Theoretical foundations of non-market valuation and cost-benefit analysis	26	52	49	27	**154**
	28.3	41.3	43.4	41.1	**154.0**
	0.2	2.8	0.7	4.8	**8.5**
Other (e.g. verbal descriptions)	9	15	2	0	**26**
	4.8	7.0	7.3	6.9	**26.0**
	3.7	9.2	3.9	6.9	**23.8**
Static theory	71	103	131	138	**443**
	81.5	118.8	124.8	118.0	**443.0**
	1.3	2.1	0.3	3.4	**7.2**
Total	**192**	**280**	**294**	**278**	**1,044**
	192.0	**280.0**	**294.0**	**278.0**	**1,044.0**
	6.2	**14.2**	**5.3**	**15.1**	**40.8**
Pearson Chi2(9) = 40.7908, Pr = <0.001					

Non-market valuation Methods (Figure 14)

Sub-category	**Decade**				**Total**
	1	**2**	**3**	**4**	
Hedonic pricing	9	12	9	12	**42**
	4.6	10.5	14.9	12.0	**42.0**
	4.1	0.2	2.3	0.0	**6.7**
Other revealed preferences	7	14	21	13	**55**
	6.1	13.7	19.5	15.7	**55.0**
	0.1	0.0	0.1	0.5	**0.7**
Stated preferences	8	28	47	37	**120**
	13.3	29.9	42.6	34.3	**120.0**
	2.1	0.1	0.5	0.2	**2.9**
Total	**24**	**54**	**77**	**62**	**217**
	43.0	**54.0**	**77.0**	**62.0**	**217.0**
	6.3	**0.4**	**2.9**	**0.7**	**10.3**

Pearson Chi2(6) = 10.2612, Pr = 0.114

Environmental media: pollutants and resources (Figure 15)

Sub-category	**Decade**				**Total**
	1	**2**	**3**	**4**	
Air pollution	56	31	58	118	**263**
	51.4	57.0	72.3	82.2	**263.0**
	0.4	11.9	2.8	15.6	**30.7**
Land pollution	32	24	42	48	**146**
	28.5	31.6	40.2	45.6	**146.0**
	0.4	1.8	0.1	0.1	**2.5**
None	134	212	233	228	**807**
	157.8	174.9	222.0	252.3	**807.0**
	3.6	7.9	0.5	2.3	**14.3**
Other pollution	18	12	9	25	**64**
	12.5	13.9	17.6	20.0	**64.0**
	2.4	0.3	4.2	1.2	**8.1**
Resources	82	99	135	127	**443**
	86.6	96.0	121.8	138.5	**443.0**
	0.2	0.1	1.4	1.0	**2.7**
Water pollution	37	20	28	28	**113**
	22.1	24.5	31.1	35.3	**113.0**
	10.1	0.8	0.3	1.5	**12.7**
Total	**359**	**398**	**505**	**574**	**1,836**
	359.0	**398.0**	**505.0**	**574.0**	**1,836.0**
	17.1	**22.7**	**9.4**	**21.7**	**71.0**

Pearson Chi2(15) = 71.0098, Pr = <0.001

Environmental media - air pollution (Figure 16)

Sub-category	**Decade**				**Total**
	1	**2**	**3**	**4**	
General air pollution	-	-	12	27	**39**
	-	-	12.3	26.7	**39.0**
	-	-	0.0	0.0	**0.0**
CO2 and general referrals to greenhouse gases	-	-	22	66	**88**
	-	-	27.8	60.2	**88.0**
	-	-	1.2	0.6	**1.7**
Local air pollution (Sulfur / NOx / CO / PM / CFCs / Ozone / Other air pollution)	-	-	25	35	**60**
	-	-	18.9	41.1	**60.0**
	-	-	1.9	0.9	**2.8**
Total	**-**	**-**	**59**	**128**	**176**
	-	**-**	**59.0**	**128.0**	**176.0**
	-	**-**	**3.2**	**1.5**	**8.1**

Pearson Chi2(6) = 4.6027, Pr = 0.100

We restrict the test to the last two decades since CO2 and general references to greenhouse gases made their first appearance in the journal in its third decade.

Water pollution (Figure 17)

<table>
<tr><th>Sub-category</th><th colspan="4">Decade</th><th>Total</th></tr>
<tr><th></th><th>1</th><th>2</th><th>3</th><th>4</th><th></th></tr>
<tr><td>C-H compounds</td><td colspan="2">7</td><td colspan="2">2</td><td>9</td></tr>
<tr><td></td><td colspan="2">4.5</td><td colspan="2">4.5</td><td>9.0</td></tr>
<tr><td></td><td colspan="2">1.3</td><td colspan="2">1.4</td><td>2.7</td></tr>
<tr><td>Fertilizers</td><td colspan="2">4</td><td colspan="2">3</td><td>7</td></tr>
<tr><td></td><td colspan="2">3.5</td><td colspan="2">3.5</td><td>7.0</td></tr>
<tr><td></td><td colspan="2">0.1</td><td colspan="2">0.1</td><td>0.1</td></tr>
<tr><td>General water pollution</td><td colspan="2">43</td><td colspan="2">41</td><td>84</td></tr>
<tr><td></td><td colspan="2">42.4</td><td colspan="2">41.6</td><td>84.0</td></tr>
<tr><td></td><td colspan="2">0.0</td><td colspan="2">0.0</td><td>0.0</td></tr>
<tr><td>Heavy metals</td><td colspan="2">2</td><td colspan="2">2</td><td>4</td></tr>
<tr><td></td><td colspan="2">2.0</td><td colspan="2">2.0</td><td>2.0</td></tr>
<tr><td></td><td colspan="2">0.0</td><td colspan="2">0.0</td><td>0.0</td></tr>
<tr><td>CL compounds / solid waste / other</td><td colspan="2">3</td><td colspan="2">10</td><td>13</td></tr>
<tr><td></td><td colspan="2">6.6</td><td colspan="2">6.4</td><td>13.0</td></tr>
<tr><td></td><td colspan="2">1.9</td><td colspan="2">2.0</td><td>3.9</td></tr>
<tr><td>Total</td><td colspan="2">59</td><td colspan="2">58</td><td>117</td></tr>
<tr><td></td><td colspan="2">59.0</td><td colspan="2">58.0</td><td>117.0</td></tr>
<tr><td></td><td colspan="2">3.3</td><td colspan="2">3.4</td><td>6.7</td></tr>
</table>

Pearson Chi2(4) = 6.7294, Pr = 0.151

Given the small number of cases we use two-decade instead of one-decade periods

Land pollution (Figure 18)

Sub-category	**Decade**				**Total**
	1	**2**	**3**	**4**	
Other land pollution (e.g. hazardous waste)	2	7	17	12	**38**
	8.3	6.2	11.1	12.4	**38.0**
	4.8	0.1	3.1	0.0	**8.0**
Degradation of landscapes	12	12	14	25	**63**
	13.7	10.3	18.1	20.6	**63.0**
	0.2	0.3	1.1	1.0	**2.3**
Solid waste	18	5	12	11	**46**
	10.0	7.5	13.5	15.0	**46.0**
	6.4	0.8	0.2	1.1	**8.4**
Total	**32**	**24**	**43**	**48**	**147**
	32.0	**24.0**	**43.0**	**48.0**	**147.0**
	11.3	**1.2**	**4.3**	**2.0**	**18.9**

Pearson Chi2(6) = 18.9460, Pr = 0.004

Resources (Figure 19)

Sub-category	**Decade**				**Total**
	1	**2**	3	**4**	
Fisheries	25	31	40	44	**140**
	27.4	29.7	41.5	41.5	**140.0**
	0.2	0.1	0.1	0.2	**0.5**
Forests	8	19	29	17	**73**
	14.3	15.5	21.6	21.6	**73.0**
	2.7	0.8	2.5	1.0	**7.1**
Non-renewable energy resources / other resources (e.g. biofuels)	19	25	15	27	**86**
	16.8	18.2	25.5	25.5	**86.0**
	0.3	2.5	4.3	0.1	**7.2**
Recreation, landscape	18	4	20	18	**60**
	11.7	12.7	17.8	17.8	**60.0**
	3.4	6.0	0.3	0.0	**9.6**
Secondary materials, waste recycling	17	3	6	10	**36**
	7.0	7.6	10.7	10.7	**36.0**
	14.1	2.8	2.0	0.0	**19.0**
Water as a resource	0	12	13	13	**38**
	7.4	8.1	11.3	11.3	**38.0**
	7.4	1.9	0.3	0.3	**9.9**
Wildlife, biodiversity	6	7	18	12	**43**
	8.4	9.1	12.7	12.7	**43.0**
	0.7	0.5	2.2	0.0	**3.4**
Total	**93**	**101**	**141**	**141**	**476**
	93.0	**101.0**	**141.0**	**141.0**	**476.0**
	28.8	**14.6**	**11.6**	**1.6**	**56.6**

Pearson Chi2(18) = 56.6355, Pr = <0.001

Country dimension (Figure 20)

Sub-category	**Decade**				**Total**
	1	**2**	**3**	**4**	
General	172 168.3 0.1	254 213.9 7.5	274 267.9 0.1	241 291.0 8.6	**941** **941.0** **16.3**
Multi-region analysis and comparative studies of countries	3 9.7 4.6	8 12.3 1.5	12 15.4 0.7	31 16.7 12.3	**54** **54.0** **19.1**
Other country	11 25.0 7.9	13 31.8 11.1	42 39.9 0.1	74 43.3 21.8	**140** **140.0** **40.9**
U.S., Canada	113 96.0 3.0	105 122.0 2.4	148 152.9 0.2	171 166.0 0.1	**537** **537.0** **5.7**
Total	**299** **299.0** **15.5**	**380** **380.0** **22.5**	**476** **476.0** **1.2**	**517** **517.0** **42.8**	**1,672** **1,672.0** **82.0**
Pearson Chi2(9) = 81.9859, Pr = <0.001					

Regional dimension – other country (Figure 21)

Sub-category	**Decade**				**Total**
	1	**2**	**3**	**4**	
Africa	1 0.9 0.0	2 1.0 0.9	7 3.3 4.1	1 5.8 4.0	**11** **11.0** **9.1**
China / rest of Asia	1 2.4 0.8	1 2.8 1.1	7 9.0 0.4	21 15.9 1.7	**30** **30.0** **4.0**
Europe	5 4.6 0.0	4 5.4 0.4	16 17.4 0.1	33 30.7 0.2	**58** **58.0** **0.7**
Latin America, Caribbean	1 1.5 0.2	0 1.8 1.8	8 5.7 0.9	10 10.0 0.0	**19** **19.0** **2.9**
Middle East / Oceania / other regions	3 1.7 0.9	6 2.0 7.7	4 6.6 1.0	9 11.6 0.6	**22** **22.0** **10.2**
Total	**11** **11.0** **1.9**	**13** **13.0** **11.9**	**42** **42.0** **6.7**	**74** **74.0** **6.4**	**140** **140.0** **26.9**
Pearson Chi2(12) = 26.8974, Pr = 0.008					

Cross-cutting issues (Figure 22)

Sub-category	**Decade**				**Total**
	1	**2**	**3**	**4**	
Climate change	1	7	31	75	**114**
	15	26.4	27.2	45.4	**114**
	13.1	14.2	0.5	19.4	**47.3**
Discounting methods	6	10	3	14	**33**
	4.4	7.7	7.9	13.1	**33.0**
	0.6	0.7	3.0	0.1	**4.4**
Energy efficiency / renewable energy sources / nuclear	7	7	4	44	**62**
	8.2	14.4	43.9	24.5	**62.0**
	0.2	3.8	7.9	15.5	**27.4**
Interdisciplinary approaches and ecological economics	12	17	17	11	**57**
	7.6	13.2	13.7	22.6	**57.0**
	2.6	1.1	0.8	5.9	**10.4**
Risk, uncertainty, imperfect information	47	87	77	77	**287**
	38.0	66.7	66.8	68.8	**287.0**
	2.1	6.2	1.0	1.0	**21.7**
Total	**73**	**128**	**132**	**220**	**553**
	73	**128**	**132**	**220**	**553**
	18.8	**26.2**	**13.3**	**53.4**	**111.7**

Pearson Chi2(12) = 111.6675, Pr = <0.001

B.2: Chi-squared tests for figures in section 4 (100 most cited articles of 5 major field journals)

Key
frequency *expected frequency* *chi2 contribution*

Articles classified by content (Figure 25)

Sub-category			**Journal**			**Total**
	AJAE	**EE**	**ERE**	**JEEM**	**LE**	
Costs and benefits of pollution control, non-market valuation	25 42.4 7.1	43 42.4 0	49 42.4 1	45 42.4 0.2	50 42.4 1.4	**212** **212** **9.7**
Climate change economics	2 5.6 2.3	4 5.6 0.5	13 5.6 9.8	6 5.6 0	3 5.6 1.2	**28** **28** **13.8**
Energy economics	1 1 0	2 1 1	2 1 1	0 1 1	0 1 1	**5** **5** **4**
Analysis of environmental policy instruments	6 11.2 2.4	10 11.2 0.1	13 11.2 0.3	22 11.2 10.4	5 11.2 3.4	**56** **56** **16.7**
Environmental management at firm level	2 2 0	0 2 2	3 2 0.5	3 2 0.5	2 2 0	**10** **10** **3**
International economics, innovation and growth	1 9.8 7.9	23 9.8 17.8	11 9.8 0.1	12 9.8 0.5	2 9.8 6.2	**49** **49** **32.5**
Natural resource economics	13 15.4 0.4	14 15.4 0.1	9 15.4 2.7	11 15.4 1.3	30 15.4 13.8	**77** **77** **18.3**
Environmental justice / Other content	50 12.6 111	4 12.6 5.9	0 12.6 12.6	1 12.6 10.7	8 12.6 1.7	**63** **63** **141.8**
Total	100 100 131.2	100 100 27.4	100 100 28	100 100 24.5	100 100 28.7	**500** **500** **239.8**

Pearson Chi2(28) = 239.7940, Pr = <0.001

Costs and benefits of pollution control, non-market valuation (Figure 26)

Sub-category			**Journal**			**Total**
	AJAE	**EE**	**ERE**	**JEEM**	**LE**	
General, methodological improvements	16	26	17	11	28	**98**
	11.6	19.9	22.7	20.8	23.1	**98**
	1.7	1.9	1.4	4.6	1	**10.7**
Methods applied to elicit benefits and damages / Measuring the costs of pollution control, estimating abatement osts	9	17	32	34	22	**114**
	13.4	23.1	26.3	24.2	26.9	**114**
	1.5	1.6	1.2	4	0.9	**9.2**
Total	25	43	49	45	50	**212**
	25	43	49	45	50	**212**
	3.2	3.5	2.6	8.6	1.9	**19.8**

Pearson Chi2(4) = 19.8164, Pr = 0.001

Methods utilized for analysis (Figure 27)

Sub-category			**Journal**			**Total**
	AJAE	**EE**	**ERE**	**JEEM**	**LE**	
Experimental	5	0	3	2	4	**14**
	3.4	2.6	2.6	2.9	2.8	**14.0**
	1.3	2.6	0.1	0.3	0.5	**4.8**
Econometric and statistical	51	30	33	32	34	**180**
	39.0	33.1	33.8	37.5	36.6	**180.0**
	3.7	0.3	0.2	0.8	0.2	**5.2**
Other (other theory)	3	36	13	0	9	**61**
	13.2	11.2	11.4	12.7	12.4	**61.0**
	7.9	54.7	0.2	12.7	0.9	**76.4**
Mathematical and simulation modeling	12	16	12	10	6	**56**
	12.2	10.3	10.5	11.7	11.4	**56.0**
	0.0	3.1	0.2	0.2	2.5	**4**
Theoretical	31	16	25	49	27	**148**
	32.1	27.2	27.8	30.8	30.1	**148.0**
	0.0	4.6	0.3	10.7	0.3	**15.9**
Non-market valuation	23	8	22	27	37	**117**
	25.4	21.5	219	24.3	23.7	**117.0**
	0.2	8.5	0.0	0.3	7.3	**16.3**
Total	**125**	**106**	**108**	**120**	**117**	**576**
	125.0	**106.0**	**108.0**	**120.0**	**117.0**	**576.0**
	13.3	**74.0**	**0.8**	**25.5**	**11.5**	**125.0**

Pearson Chi2(20) = 124.978, Pr = <0.001

Environmental media: pollutants & resources (Figure 28)

Sub-category	Journal					**Total**
	AJAE	**EE**	**ERE**	**JEEM**	**LE**	
Air pollution	3	21	26	18	10	**78**
	13.9	*16.1*	*16.6*	*13.9*	*17.5*	**78.0**
	8.5	1.4	5.4	1.2	3.2	**19.7**
Land pollution	12	12	14	8	26	**72**
	12.8	*14.9*	*15.3*	*12.8*	*16.1*	**72.0**
	0.1	0.5	0.1	1.8	6.0	**8.5**
None	49	41	34	54	17	**195**
	34.7	*40.4*	*41.4*	*34.7*	*43.7*	**195.0**
	5.8	0.0	1.3	10.7	16.3	**34.1**
Other pollution	9	3	5	1	4	**22**
	3.9	*4.6*	*4.7*	*3.9*	*4.9*	**22.0**
	6.6	0.5	0.0	2.2	0.2	**9.5**
Resources	29	38	36	20	65	**188**
	33.5	*38.9*	*39.9*	*33.5*	*42.1*	**188.0**
	0.6	0.0	0.4	5.5	12.4	**18.9**
Water pollution	8	7	10	4	4	**33**
	6.2	*6.9*	*7.0*	*5.9*	*7.0*	**33.0**
	0.5	0	1.2	0.6	1.3	**3.6**
Total	**110**	**122**	**125**	**106**	**126**	**589**
	110.0	**122.0**	**125.0**	**106.0**	**126.0**	**589.0**
	21.2	**2.6**	**8.5**	**21.0**	**41.0**	**94.3**

Pearson Chi2(20) = 94.3244, Pr = <0.001

Regional dimension (Figure 29)

Sub-category			**Journal**			**Total**
	AJAE	**EE**	**ERE**	**JEEM**	**LE**	
General	28	53	44	45	24	**194**
	38.8	38.8	38.8	38.8	38.8	**194.0**
	3.0	5.2	0.7	1.0	5.6	**15.5**
Multi-region analysis	3	17	11	6	4	**41**
	8.2	8.2	8.2	8.2	8.2	**41.0**
	3.3	9.4	1.0	0.6	2.2	**16.4**
Other country	13	19	29	11	13	**85**
	17.0	17.0	17.0	17.0	17.0	**85.0**
	0.9	0.2	8.5	2.1	10.9	**12.7**
U.S., Canada	56	11	16	38	59	**180**
	36.0	36.0	36.0	36.0	36.0	**180.0**
	11.1	17.4	11.1	0.1	14.7	**54.4**
Total	**100**	**100**	**100**	**100**	**100**	**500**
	100.0	**100.0**	**100.0**	**100.0**	**100.0**	**500.0**
	18.4	**32.2**	**21.2**	**3.8**	**23.4**	**99.3**
Pearson Chi2(12) = 99.0699, Pr = <0.001						

Cross-cutting issues (Figure 30)

Sub-category			**Journal**			**Total**
	AJAE	**EE**	**ERE**	**JEEM**	**LE**	
Climate change	3	11	18	12	3	**47**
	5.5	16.5	14.6	7.8	2.6	**47.0**
	1.2	1.8	0.8	2.2	0.0	**6.0**
Energy	0	2	11	1	0	**14**
	1.6	4.9	4.3	2.3	0.8	**14.0**
	1.6	1.7	10.1	0.8	0.8	**15.0**
Interdisciplinary appraoches	0	45	16	4	5	**70**
and ecological economics /	8.1	24.5	21.8	11.7	3.9	**70.0**
Discounting	8.1	17.2	1.5	5.0	0.3	**32.1**
Risk, uncertainty,	18	5	11	13	2	**49**
imperfect information	5.7	17.2	15.2	8.2	2.7	**49.0**
	26.4	8.6	1.2	2.9	0.2	**37.0**
Total	**21**	**63**	**56**	**30**	**10**	**153**
	21.0	**63.0**	**56.0**	**30.0**	**10.0**	**153.0**
	37.4	**29.3**	**13.6**	**10.9**	**1.3**	**92.5**
Pearson Chi2(12) = 92.4530, Pr = <0.001						