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Relational Environment and Intellectual Roots of 'Ecological Economics': An Orthodox or Heterodox Field of Research?

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Abstract
The way the fields are delineated has been the Achilles' heel of studies analyzing the status and evolution of given scientific areas. Based on van den Besselaar and Leydesdorff's (*Mapping change in scientific specialities; a scientometric reconstruction of the development of artificial intelligence*, 1996) contribution, the authors propose a systematic and objective method for delineating the field of ecological economics assuming that aggregated journal-journal citation relations is an appropriate indicator for the disciplinary organization of the sciences. They found that the relational scientific backbone of ecological economics comprises 7 main journals: *American Journal of Agricultural Economics, Ecological Economics, Environment and Development Economics, Environmental and Resources Economics, Land Economics, Land Use Policy, and Journal of Environmental Economics and Management*. From the 3727 articles published between 2005 and 2010 in the ecological economics field, and the corresponding 142 thousand citations two main outcomes emerged: 1) the intellectual frame of reference is overwhelmed by economists and environmental and resources economists with (renowned) ecological economists relatively underrepresented; 2) the building of an integrative knowledge domain is not apparent: on the one hand, ecological economics is seen to be an 'unbound' heterodox and multidisciplinary field, but on the other hand, and somewhat awkwardly, it is (still) heavily 'bound' by quantitative mainstream/ orthodox methodologies.

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1. Introduction

The core of 'ecological economics' is closely associated with the goal of sustainable development (Costanza and Daly, 1987; Costanza, 1991b; van den Bergh, 2001; Faber et al., 2002). Some authors (e.g., Costanza, 1996; Spash, 2011) believe it constitutes a scientifically valid foundation for economic theory and policy, leading to a better understanding of how humans interact with the natural world.

The breadth of research topics is considered to be one of the strengths of 'ecological economics' and existing contributions accommodate some of the concerns of very different scientific domains (van den Bergh, 2001; Røpke 2004, 2005; Paavola and Fraser, 2011), namely, moral philosophy, politics, ethics, ecology, thermodynamics, economics, biology, natural history and natural sciences. Costanza et al. (1997) find that this makes 'ecological economics' a holistic system approach applicable to the problem of human survival in the biosphere, which is uncertain, complex, and interactive.

The growth of the 'ecological economics' field urges the understanding of its scientific structure. Although there are some valuable studies which offer insights into the developments and characterization of 'ecological economics', they do so mainly from a qualitative approach (e.g., Christensen, 1989; Costanza, 1989; 1991a; 1996; Funtowicks and Ravetz, 1994; Faber et al., 1995; van den Bergh, 2001; Røpke, 2004; 2005; Gowdy and Erickson, 2005; Martinez-Alier and Røpke, 2008; Spash, 2011; Beder, 2011). Few studies explore the field using bibliometric tools to investigate the factors that shape it, and fully tackle the breadth of the domain. Of these, attention is drawn to Costanza and King (1999), Costanza et al. (2004), Ma and Stern (2006), Luzadis et al. (2010), Castro e Silva and Teixeira (2011), and Hoepner et al. (2012). Apart from Ma and Stern (2006) and Hoepner et al. (2012),

all the studies mentioned take *Ecological Economics* (EE) as the reference journal for inquiring into the field, because it is a key resource in 'ecological economics' (Luzadis et al., 2010), and it is a source for influential research in the field (Costanza et al., 2004).

In this paper, we head towards a complementary and holistic understanding of the (evolution) of 'ecological economics' by providing an in-depth and multidimensional bibliometric exercise. We make use of the approach proposed by van den Besselaar and Leydesdorff (1996) to obtain, objectively, the relational environment of 'ecological economics'. This uses aggregated journal-journal citation relations to outline the significant domain, starting from a given baseline journal. As it covers more articles than other relevant journals in the field (e.g., *Journal of Environmental Economics and Management*, *Land Economics*), thus providing a more extensive reference list database from which to build up the field structure and evolution, we chose EE as our 'entrance journal' (van den Besselaar and Leydesdorff, 1996). We then found that 7 journals - *American Journal of Agricultural Economics* (AJAE), *Ecological Economics* (EE); *Environment and Development Economics* (EDE), *Environmental and Resources Economics* (ERE), *Land Economics* (LE), *Land Use Policy* (LUP), and *Journal of Environmental Economics and Management* (JEEM) - constitute the relational scientific backbone of 'ecological economics'. The over 142 thousand citations contained in the almost 4 thousand articles published in these 7 journals in the 2005-2010 period permitted a comprehensive analysis of the 'roots' of 'ecological economics'. Thus, with the focus on the citing-cited relationship of the publishing process we captured the 'genealogy' and the cognitive approaches of the 'ecological economics', showing how it is influenced by other scientific bodies of research.

Given the youth and substantiality of the field (Müller, 2003), this exercise could have major relevance as it might contribute to the better delimitation and theoretical framing of this field of research. A study of this nature further provides valuable insights into the relative roles of authors and domain principles, and into the role of conceptual knowledge in the scientific reasoning of 'ecological economics'.

The present study mostly differs from others (e.g., Costanza and King, 1999; Costanza et al., 2004; Ma and Stern, 2006; Ilge and Schwarze, 2009; Luzadis et al., 2010; Castro e Silva and Teixeira, 2011; Hoepner et al., 2012) in three aspects: (1) the objectivity of the procedure to select the 'relational environment' of 'ecological economics' research; and (2) the novelty of the broad representativeness (seven core journals) and breadth of the research (involving both citing and cited references); (3) a more up to date (2005-2010) empirical analysis of the field. The value of our analyses, however, does not lie in replacing existing contributions in the field but, rather, in supplementing them by their use of scientometric techniques.

Section 2 describes the methodological foundation of the study, to show how 'ecological economics' has been evolving and taking shape. Drawing on the bibliometric exercise, the scientific roots and scope of influence of 'ecological economics' literature are detailed in Section 3. The last section sets out the main contributions of the research.

2. Methodological considerations

2.1. Delineating the field of 'ecological economics' - selecting the relevant set of journals

The way the fields are delineated has been the Achilles' heel of studies analyzing the status and evolution of given scientific areas. In ecology- and environment-related areas, studies have been employing a 'standard approach' where research fields are defined based on the

academic journals specializing in it. For instance, Ma and Stern (2006) used articles published in JEEM and EE as approximations for the fields of environmental and 'ecological economics', and Hoepner et al. (2012) recently extended that study's set by adding the economics journals which are either frequently cited in JEEM or EE or frequently cite them, and focus on environmental and 'ecological economics'. Although quite widely used, this is a rather *ad hoc* procedure.

We are proposing a more systematic and objective method for choosing the journals which delineate the field of 'ecological economics'. Specifically, we closely follow the method proposed and implemented by van den Besselaar and Leydesdorff (1996) in their mapping of the field of artificial intelligence research. These authors, in line with other studies (e.g., Vieira and Teixeira, 2010; Teixeira, 2011), consider that aggregated journal-journal citation relations is an appropriate indicator for the disciplinary organization of the sciences. Accordingly, one would expect strong citation relations within and among journals belonging to a given discipline, and weaker ones with regard to other journals. Moreover, journals in the same 'subject specialty' relate (through citation patterns) to existing knowledge differently from other journals (van den Besselaar and Leydesdorff, 1996).

We use citation relations among journals to delimit the relevant domains, adopting a structural approach to analyze the development patterns. Like van den Besselaar and Leydesdorff (1996), we use a single journal (*Ecological Economics* - EE) as the entry journal, because of its scope specialization ('ecological economics') (Ma and Stern, 2006).

First, all journals that were related to EE were drawn into the analysis. Then the citation matrix obtained was constructed using *Journal of Citation Report* (JCR) data ISI Web of

Knowledge. To accommodate any potential change in the relational mapping of journals we opted to collect and analyze the citation matrixes of the last 10 years for which information was available (2000-2009).

For the entry journal (EE) and year (2000; 2005; 2009), the corresponding 'cited journal data'[1] and 'citing journal data'[2] were gathered manually from the *Journal of Citation Report* (JCR). By combining the 'cited' and 'citing' facets and taking the list of journals that account for at least 0.5% of all citations in each year we obtained the citation environment of EE. The citing matrix[3] was then constructed for each of the years in analysis based on the set of journals that constitutes the EE's citation environment. This is "the active reproduction of the structure of the specialty … [that is,] the aggregation of communications among the scientists involved" (van den Besselaar and Leydesdorff 1996: 418-9).

After transforming the citation matrices into correlation matrices, we factor analyzed these correlation matrices and finally, based on the output of the factor analyses, were able to obtain the set of relevant journals in the field of 'ecological economics' – Figure 1 summarizes the algorithm used.

Like van den Besselaar and Leydesdorff (1996), we consider that the factor for which the entry journal has the highest factor loading represents the subject specialty which we are

[1] Number of times the articles published in a given year (e.g., 2009) in a set of journals were cited in articles published in the entry journal.

[2] Number of times the articles published in a set of journals was cited in the entry journal in a given year (e.g., 2009).

[3] In order to obtain the citation matrix of the entry journal in the year T (2000; 2005; 2009), we had to gather the citing data of each journal in the citation environment of the entry journal – in the case of EE, the average number of journals included in the citation environment was 24 (minimum of 21 in 2008 and a maximum of 27 in 2006). This was done manually and was rather demanding and time-consuming.

attempting to delineate (i.e., 'ecological economics').[4] The other factors resulting from the analysis can be interpreted as the specialties that are relevant or related to the focal specialty.

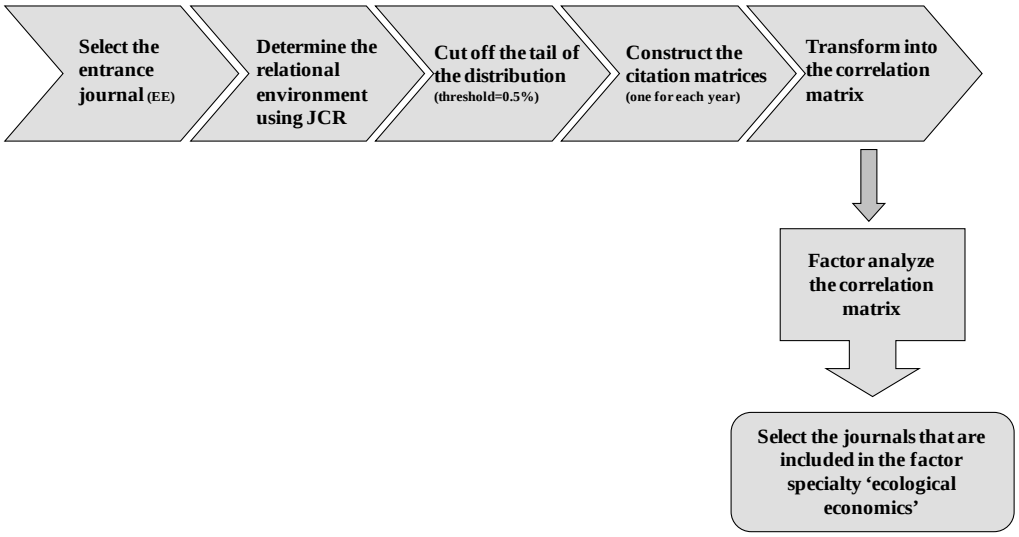


Figure 1: Algorithm employed to find the relevant journal set for the field of ecological economics

Legend: EE – Ecological economics

Source: Adapted from van den Besselaar and Leydesdorff (1996: 418)

Although the output of the factor analysis differs for the periods under analysis, particularly in the first period (2000), it is apparent that for the most recent period (2009) the set of relevant journals associated with 'ecological economics' (i.e., with the Ecological (ECOL) factor loadings - cf. Figure 2), encompasses 7 journals: AJAE (*American Journal of Agricultural Economics*), EE (*Ecological Economics*); EDE (*Environment and Development Economics*), ERE (*Environmental and Resources Economics*), LE (*Land Economics*), LUP (*Land Use Policy*), and JEEM (*Journal of Environmental Economics and Management*). We therefore argue that these 7 journals comprise the 'relational environment' of the field 'ecological economics', and constitute the set of relevant journals to analyze the corresponding intellectual influences (in terms of authors, studies and outlets).

[4] The Appendix (Supplementary Material) provides an example of the citing matrix (Table A1) for the entrance journal EE, in 2009, and the output of the factor analysis (Table A2) for all the years covered (2000, 2005 and 2009).

Factor analysis component	2000	2005	2009
ECOL	**EE**; EV	**EE**; EDE; ERE; LE; JEEM; REE	AJAE; **EE**; EDE; ERE; LE; LUP; JEEM
ENV	AJAE; ERE; LE; JEEM; JEM	JEM; AJAE	BC; CB; EM; JEM;
ECON	QJE; AER	EJ; QJE; AER; JPE	AER; WD
SCIEN	SC; AMB	CB; ES; NAT; SC	NAT; SC

Figure 2: Delineating the field of ecological economics - summary of the factor analysis
Note: The figure was drawn up based on the results detailed in Table A2 in the Appendix.
Legend: AER – American Economic Review; AJAE – American Journal of Agricultural Economics; BC - Biological Conservation; CB - Conservation Biology; EE - Ecological Economics; EDE (Environment and Development Economics), ERE - Environmental and Resources Economics; EM - Environmental Management ; LE - Land Economics; LUP - Land Use Policy; JEEM - Journal of Environmental Economics and Management; NAT - Nature; SC - Science; WD – World Development

2.2. Citation data-gathering procedure

Citations provide a valid and reliable notion of scientific communication (Small, 1978) since they are an unobtrusive measure for the evaluation of scientific performance (Smith, 1981; Bornmann and Daniel, 2008). Even though citing behaviour has many determinants and motivations (Bornmann and Daniel, 2008), it can be taken as the main indicator of scholarly influence within a given specialty (Ravallion and Wagstaff, 2011). Citation analysis is a tool for demarcating the boundary of potentially relevant authors, sources and studies and interpreting the significance of their relationships by facilitating the detection of key documents. Moreover, citations can be a source for the identification of 'invisible colleges' who do research on highly innovative and fundamental issues, and frequently lead and flag where the larger scientific field is moving (Crane, 1972). These colleges are core groups that form research networks strongly connected by their inter-citations, though without being linked by formal organizations (Crane, 1972). Therefore, based on the references of published articles, three separate but complementary rankings were built up for the set of journals and for each journal: 1) the top-50 most cited authors; 2) the top-50 most cited source titles, including journals, books, proceedings of conferences, reports and other documents; and 3) the top-50 most cited studies.

The selected journals that map the field of 'ecological economics' are well established in the milieu of academic work, having started publishing more than 20 years ago. For instance, *Land Economics* (LE) started in 1925 and the *American Journal of Agricultural Economics* (AJAE) was launched around 10 years earlier, in the 1910s (cf. Table 1).

The citation analysis was performed for 3 strands (2000, 2005, and 2009) over a six year window as this timeframe seems appropriate for the procedure to yield informative citation impact data (Moed, 2005). Given that the number of issues per year and the number of articles per issue are quite different for the selected journals, the number of articles published in the period contemplated (2005-2010) also differs. The maximum is 1483 articles published in EE (with 16 issues per year) and the minimum is 211 articles in EDE (with 4 issues per year). ERE publishes 12 issues per year, JEEM publishes 6 and AJAE 5 issues per year.
The 3727 articles published in the selected journals contain 142416 references, with an average of 38.2 references per article - the lowest figure being 27.9 references in AJAE and the highest 44.2 in LUP (cf. Table 1).

Table 1: The set of relevant journals included in the delineation of ecological economics field

Selected journals	Year of creation	Impact Factor 2010	ISI areas (ES – Environmental Sciences EC – Economics– B-Business			2005-2010		
						Number of articles published	Number of references cited	Average citation per article
American Journal of Agricultural Economics (AJAE)	1910	1.233		EC		584	16309	27.9
Ecological Economics (EE)	1989	2.754	ES	EC		1483	64819	43.7
Environment and Development Economics (EDE)	1996	1.623	ES			211	7492	35.5
Environmental and Resource Economics (ERE)	1991	1.297	ES	EC		469	15784	33.7
Journal of Environmental Economics and Management (JEEM)	1974	2.989	ES	EC	B	279	8562	30.7
Land Economics (LE)	1925	1.375	ES	EC		230	8618	37.5
Land Use Policy (LUP)	1984	2.070	ES			471	20832	44.2
All						**3727**	**142416**	**38.2**

Sources: Authors' computation based on data gathered from Scopus database (number of articles and citations) and ISI Web of Science (Impact factor).

Once the key authors had been identified, we could then see whether there were similarities among the journals with regard to the leading or 'influential' authors. Moreover, the top-50 most cited sources and top-50 most cited studies served to analyze the intellectual roots and scientific structure of the selected journals in terms of subject specialties. This provided the fundamental tools to perform an in-depth analysis of the intellectual roots of 'ecological economics'.

3. The scientific roots of 'ecological economics': empirical results

The 3727 articles in analysis cited 71013 distinct authors[5] who received a total of 277252 citations. In particular, the 1483 articles published in EE encompass 64819 cited references that involve 42261 distinct (co)authors who received 128061 citations overall. Regarding the 279 articles published in JEEM, these cited 8562 studies which encompass 6333 distinct (co)authors who received a total of 16078 citations (cf. Table 2).

It is interesting to note that journals differ in the degree of 'concentration' of top-50 authors. At one extreme we have *Environmental and Resource Economics* (ERE) and *Journal of Environmental Economics and Management* (JEEM) in which the top-50 authors' citations represent about 12% of total authors' citations, and at the other stands *Land Use Policy* (LUP), *Ecological Economics* (EE), and *Environment and Development Economics* (EDE) for which the citations patterns are much more atomized, with top-50 authors' citations accounting for 5% (LUP) and 9% (EDE).

[5] Note that the analysis encompasses *all* the authors of the published studies and not only first authors, and all type of sources, not being limited to journal articles.

Table 2: Number of distinct authors and corresponding citations in the selected journals, 2005-2010

	Number of distinct cited authors[**]	**Cited authors' total citations**	**Number (%) top-50 cited authors** [number of citation equal or above X][***]	**Number of citations corresponding to top-50 cited authors**	**% top authors' citation in total citations**
American Journal of Agricultural Economics (AJAE)	11906	30670	52 (0.4) [34]	2769	9.0
Ecological Economics (EE)	42261	128061	51 (0.1) [109]	8565	6.7
Environment and Development Economics (EDE)	7611	14573	50 (0.7) [17]	1303	8.9
Environmental and Resource Economics (ERE)	10804	31235	50 (0.5) [48]	3864	12.4
Journal of Environmental Economics and Management (JEEM)	6333	16078	56 (0.9) [25]	2073	12.9
Land Economics (LE)	7650	16356	54 (0.7) [22]	1650	10.1
Land Use Policy (LUP)	20571	40386	51 (0.2) [26]	1889	4.7
All	**71013**	**277252**	**50 (0.07) [216]**	**15655**	**5.7**

Note: [**]given the existence of authors with the same surname but with initials that cannot be standardized (authors sometimes appear with one initial and at others with two or more initials), it is likely that the count of distinct authors and their citations contain an error through over-counting the number of distinct authors and undercounting each author's citations; [***]In some journals instead of 50 (top) authors we have a few more as the 50th item has several authors with an equal number of citations.

Source: Authors' computation based on data gathered from the Scopus database.

We proceeded to assemble the top-50 most cited authors in the area of 'ecological economics' as a whole (cf. Table 3) and for each 'ecological economics' outlet (see Table A3 in Appendix). This provided a reasonably inclusive picture of the influential authors in the field. The top-50 most cited authors represent a negligible percentage in the overall set of authors (0.07%) but the corresponding citations (15655 citations) account for 5.7% of the total (see Table 3). There is another group of 154 authors who are not included in the top-50 authors but who might also be considered highly influential as each has 100 or more citations (cf. Table 3).

A particular group of 80-100 very productive and highly cited scholars can be singled out from the 204 listed in Table 3 (marked in Table 3 with grey light colour) who might form what Crane (1972), Price (1986), and, more recently, Zuccala (2006), called an 'invisible college'. Such a college consists of informal clusters of authors who belong to the social group of a subject specialty and collaborate in several ways beyond national and institutional boundaries, driving the research in a cumulative process of theory generation (Fujigaki,

1998). This group of productive elite scholars share the same motivations for performing research within each field and new knowledge is communicated both formally and informally. Moreover, these scholars dominate the research front advances due to their published output, which makes the invisible college more detectable through citation analysis (Zuccala, 2006; Zuccala and van den Besselar, 2009). Yet the connections that emerge from citations are not only intra-scientific field, they are also transversal across several areas, connecting scientific theories beyond field dissimilarities (Small, 1998, 1999).

Distribution of authors' citations is, however, highly skewed, in keeping with what has already been noted in other fields of science (Seglen, 1992; Albarrán and Ruiz-Castillo, 2011). About 57% of the authors received only 1 citation whereas a set of 204 authors, who represent 0.3% of the total number, covering 13.4% of all citations, were cited 100 or more times. This shows that the bulk of authors only contributes minimally to the research field. Comparing the distribution of authors' citation of each journal, (see Table A3 in Appendix), the top-50 authors list betrays noticeable discrepancies in the skewness of the distribution: it is most evident in ERE (0.5% authors account for 12.4% citations) and JEEM (0.9% authors with 12.9% citations) and least evident in LUP (0.2% authors with 4.7% of citations). Beyond the problem of uncited and seldom-cited references (MacRoberts and MacRoberts, 2010), this skewness in the citedness distribution and the existence of field-dependent systematic dissimilarities in citedness are deemed by some authors to be pertinent shortcomings for using article citation to evaluate individual scientists or research groups (Seglen, 1992). But tour work aims to obtain a picture of the most influential authors on a global basis, not to evaluate scientists.

Table 3: Top cited authors in ecological economics field

Rank	Author	#*	Prize	Rank	Author	#*		Rank	Author	#*	Rank	Author	#*
1	**Costanza, R.**	**523**	P	**58**	Grossman, G.M.	208		**124**	Lusk, J.L.	131	**181**	Fehr, E.	110
2	**Hanley, N.**	**520**	-	**59**	Oates, W.E.	208		**125**	Ravetz, J.R.	131	**182**	Giljum, S.	110
3	**Hanemann, M.W**	**471**	P	**60**	Heal, G.	207		**126**	Frey, B.S.	130	**183**	Haab, T.C.	110
4	**Dasgupta, P.S.**	**470**	P	**61**	Scarpa, R.	207		**127**	Cummings, R.G.	129	**184**	Hayes, D.	109
5	**Carson, R.T.**	**459**	-	**62**	Wheeler, D.	205		**128**	Farber, S.	129	**185**	Langford, I.H.	109
6	**Loomis, J.B.**	**452**	P	**63**	Pagiola, S.	200		**129**	Plantinga, A.J.	129	**186**	Squires, D.	109
7	**Shogren, J.F.**	**452**	P	**64**	Spash, C.L.	200		**130**	Ready, R.C.	129	**187**	Sugden, R.	109
8	**Ostrom, E.**	**440**	NP	**65**	Krausmann, F.	194		**131**	Limburg, K.	128	**188**	Babcock, B.A.	108
9	**Bateman, I.J.**	**438**	P	**66**	Norgaard, R.B.	187		**132**	Tilman, D.	128	**189**	Carlsson, F.	108
10	**Pearce, D.W. ΘΘ**	**433**	-	**67**	Krueger, A.B.	186		**133**	Heckman, J.	127	**190**	Deininger, K.	108
11	**List, J.A.**	**414**	P	**68**	Ehrlich, P.R.	185		**134**	d'Arge, R.	126	**191**	Fischer-Kowalski, M.	108
12	**Louviere, J.J.**	**414**	**P**	**69**	Erb, K.-H.	182		**135**	Parry, I.W.H.	126	**192**	Jackson, T.	108
13	Greene, W.H.	409	-	**70**	Jaffe, A.B.	181		**136**	Gowdy, J.M.	125	**193**	Levin, S.	108
14	Kahneman, D.	368	**NP**	**71**	Mitchell, R.C.	177		**137**	Tietenberg, T.H.	125	**194**	Swallow, S.K.	106
15	Adamowicz, W.L.	343	-	**72**	Brown, T.C.	175		**138**	Baumol, W.J.	124	**195**	Faber, M.	105
16	Weitzman, M.L.	321	**P**	**73**	Wu, J.	172		**139**	Khanna, M.	124	**196**	Palmer, K.	105
17	Barbier, E.B.	320	**P**	**74**	Rees, W.E.	171		**140**	Van den Belt, M.	124	**197**	Chavas, J.P.	104
18	Train, K.E.	320	**P**	**75**	Bennett, J.	170		**141**	Brock, W.A.	123	**198**	Van Kooten, G.	104
19	Wackernagel, M.	319	-	**76**	Munda, G.	170		**142**	Kling, C.	123	**199**	Holmes, T.P.	103
20	Daly, H.E.	306	**P**	**77**	Schulze, W.D.	170		**143**	Sanchirico, J.N.	123	**200**	Jones-Lee, M.	103
21	Van Den Bergh, J	301	**P**	**78**	Tversky, A.	170	P	**144**	Laplante, B.	122	**201**	Pattanayak, S.K.	103
22	Hensher, D.	299	**P**	**79**	Copeland, B.R.	169		**145**	Platteau, J.-P.	122	**202**	Fredriksson, P.G.	102
23	Arrow, K.	289	**NP**	**80**	Levinson, A.	169		**146**	Williams, M.	122	**203**	Atkinson, G.	101
24	Stavins, R.N.	285	-	**81**	Martinez-Alier,J.	168		**147**	Neumayer, E.	121	**204**	Janssen, M.A.	100
25	Polasky, S.	283	-	**82**	Boxall, P.C.	166		**148**	Vatn, A.	121			
26	McFadden, D.L.	279	**NP**	**83**	Cropper, M.	166		**149**	Day, B.	120			
27	Färe, R.	272	**P**	**84**	Pimentel, D.	166		**150**	Rozelle, S.	120			
28	Lenzen, M.	271	**P**	**85**	Goulder, L.H.	163		**151**	Anselin, L.	119			
29	Bishop, R.C.	270	**P**	**86**	Wilson, M.A.	163		**152**	Champ, P.A.	119			
30	Tol, R.S.J.	264	**NP**	**87**	Carraro, C.	161		**153**	Geoghegan, J.	119			
31	Folke, C.	251	**P**	**88**	Barrett, C.B.	160		**154**	Lambin, E.F.	118			
32	Boyle, K.J.	250	**P**	**89**	Cameron, T.A.	160		**155**	Wooldridge, J.M.	118			
33	Nordhaus, W.D.	248	**P**	**90**	Carpenter, S.R.	156		**156**	Kolstad, C.D.	117			
34	Swait, J.D.	247	-	**91**	Viscusi, W.K.	156		**157**	Wiedmann, T.	117			
35	Smith, V.K.	240	-	**92**	Bulte, E.H.	154		**158**	Herriges, J.A.	116			
36	Portney, P.R.	239	**P**	**93**	Freeman III, A.	154		**159**	Howitt, R.E.	116			
37	Mäler, K.-G.	236	**P**	**94**	Lovell, C.A.	154		**160**	Rosen, S.	116			
38	Turner, R.K.	236	**P**	**95**	Funtowicz, S.	149		**161**	Slovic, P.	116			
39	Wilen, J.E.	236	**P**	**96**	Walker, B.H.	149		**162**	Grasso, M.	115			
40	Clark, C.W.	235	-	**97**	Chambers, R.G.	148		**163**	Huang, J.	115			
41	Grosskopf, S.	235	**P**	**98**	Howarth, R.B.	147		**164**	Hamilton, K.	114			
42	Bromley, D.W.	227	**P**	**99**	Just, R.E.	147		**165**	Navrud, S.	114			
43	Stern, D.I.	227	-	**100**	Sen, A.K.	147	N P	**166**	Quiggin, J.	114			
44	Taylor, M.S.	226	**P**	**101**	Harrison, G.W.	146		**167**	Rosenberger, R.S	114			
45	Haberl, H.	225	-	**102**	Willis, K.G.	146		**168**	Segerson, K.	114			
46	Wunder, S.	224	-	**103**	Dietz, T.	145		**169**	Hubacek, K.	113			
47	Bockstael, N.E.	223	-	**104**	Newell, R.G.	145		**170**	Randall, A.	113			
48	Solow, R.M.	222	**NP**	**105**	Ferraro, P.J.	144		**171**	Angelsen, A.	112			
49	Zilberman, D.	217	**P**	**106**	Deaton, A.	142		**172**	Feder, G.	112			
50	Poe, G.L.	216	**P**	**107**	Hannon, B.	142		**173**	Kristrom, B.	112			
51	Mendelsohn, R.	215		**108**	Knetsch, J.L.	142		**174**	Selden, T.M.	112			
52	de Groot, R.	214		**109**	Cole, M.A.	141		**175**	Wang, H.	112			
53	Hausman, J.A.	214		**110**	Stiglitz, J.E.	140	N P	**176**	Hoekstra, A.Y.	111			
54	McConnell, K.E.	214		**111**	Nijkamp, P.	137		**177**	Johnston, R.J.	111			
55	Ayres, R.U.	210		**112**	Porter, M.E.	137		**178**	Peters, G.	111			
56	Daily, G.C.	210		**113**	Xepapadeas, A.	137		**179**	Pizer, W.A.	111			
57	Perrings, C.	210		**114**	Alberini, A.	136		**180**	Dinar, A.	110			

Note: * Citations obtained by summing all the author's citations in the 7 journals [in total we have 71013 distinct authors who received 272252 citations – about 57% of the authors received only 1 citation whereas 204 authors, who represent 0.29% of the total authors, were cited 100 or more times, accounting for 13.4% of the total citations]; Dark grey area represents the top-50 most cited authors in ecological economics; Light grey area represents all the authors that form the (in)visible college of ecological economics; ΘΘ died in 2005.
Source: Authors' computation based on data gathered from the Scopus database.

None of the top-50 authors in each of the seven journals in our set show up in all the top-50 authors lists of the seven journals (see Table A3).

The most transversally and widely cited author is Michael William Hanemann (professor of Agricultural and Resources Economics at University of California, Berkeley USA), who ranks 3rd in the overall top-50, and appears in 6 of the 7 selected journals (all except LUP). Eight other top authors are found in the top-50 of 5 journals and have in common the fact that they all are listed in the top-50 of *Land Economics* (LE). Five of them are environmental and resource economists - Edward B. Barbier (University of Wyoming, USA); Ian J. Bateman (University of East Anglia, UK.); Nick Hanley (University of Stirling, Stirling Management School, Scotland); John A. List (University of Chicago, USA); Jason F. Shogren (University of Wyoming, USA). The research interests of the other three are related to econometrics - William H. Greene (New York University Leonard N. Stern School of Business, USA)[6] –, psychology and public affairs - Daniel Kahneman (Woodrow Wilson School of Public and International Affairs, USA), and consumer choice modeling - Jordan J. Louviére (University of Technology Sydney, Australia).

The evidence relating to the author Robert Costanza (Portland State University, USA) is quite puzzling. Despite being a highly influential ecological economist, ranking 1st in the overall top-50, having contributed to theory-building in the field of 'ecological economics', particularly by promoting the field as a sustainability and biodiversity science (Solomon, 2007), he only appears in the top-50 of EE and is modestly ranked in all the other journals.

[6] Econometricians are highly cited in the ecological economics field given the specialty structure of the domain linked with methods and requiring rigorous ecological-economics modeling.

This discrepancy in the citedness of the top-50 authors in the different journals seems to suggest that within the 'ecological economics' environment there is a reasonable level of specificity of the strategic research topics with respect to the global context of each outlet. The top-10 most cited authors, who achieved 4600 citations for the whole database of journals in 'ecological economics' in the period (2005-2010), received 400 or more citations each. These authors can be classified according to Zuccala and van den Besselar's (2009) terminology as 'stars' and include those who won awards for outstanding contributions in their areas of research, although they did not have such a score in citations.

Most of the top-10 most cited[7] authors have an economics background and/or environmental and resource economics expertise. Only ecologist Robert Costanza (Portland State University, USA) and economist Sir Partha Dasgupta (University of Cambridge, UK), figure as *ecological* economists. Robert Costanza, co-founder and past-president of the *International Society for Ecological Economics* (ISEE), was chief editor of the society's journal *Ecological Economics* (EE) from its inception until 2002. Sir Partha Sarathi Dasgupta is Frank Ramsey Emeritus Professor of Economics and was the chairman of the Beijer International Institute of Ecological Economics in Sweden between 1991 and 1997. Although he was a mainstream economic theorist, he is considered highly influential in 'ecological economics' because of his outstanding contribution to valuing natural capital (Hassan, 2008), and was awarded the esteemed Zayed International Prize for Scientific and Technological Achievements in Environment for his contributions to scientific research and eco-friendly technologies.

It could be argued that as the majority of the leading authors in the 'ecological economics' field are economists or environmental and resource economists, this might mean (in terms of their

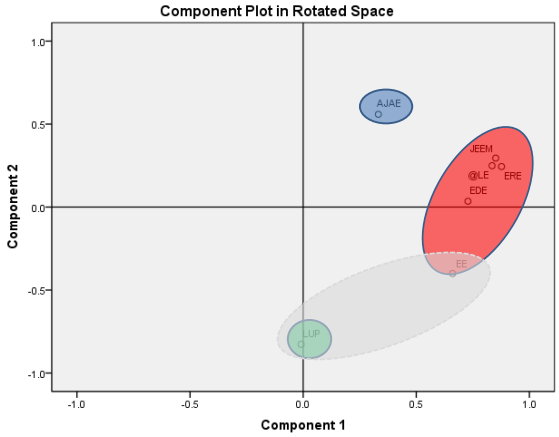
[7] We excluded from the top10 analysis the deceased author David W. Pearce (1941-2005), who was Emeritus Professor in the Department of Economics, University College London (UCL). He was a pioneer of Environmental Economics.

influence in shaping scientific arguments) that 'ecological economics' runs deep with (environmental and resource) economics as a core intellectual frame of reference. But when we extended the list and include the top-50 cited authors or the 204 authors (i.e., those with 100 and more citations) the multidisciplinary facet of the background of the most influential scholars in the field becomes clear.

Multidisciplinarity and specialization might also be assessed through an additional analysis of the degree of 'similarity' between journals' rankings of top-cited authors. Such an analysis, based on a factor analysis of the rankings of the 226 authors that figure in the top 50 list of each journal, is likely to unveil some hidden common characteristics related to their scientific intellectual structures. The output of factor analysis (Figure 3) reveals that the selected journals form 3 distinct groups. The largest one comprises *Environment and Development Economics* (EDE), *Environmental and Resource Economics* (ERE), *Journal of Environmental Economics and Management* (JEEM), and *Land Economics* (LE), with *Ecological Economics* (EE) also included, but at the boundary of this group. Another group has only one journal, the *American Journal of Agricultural Economics* (AJAE), which loads shorter on the first component meaning it is narrower in focus. The third group, at quite a distance in terms of similarity in the authors' ranking from AJAE and the first group, also has only one journal, *Land Use Policy* (LUP), which, despite its apparently wider focus, seems to reveal a tenuous but nonetheless real pattern of association with EE.

The analysis suggests that the field of 'ecological economics' might comprise one (in)visible college which includes distinct specializations or subject specialties (Teixeira, 2011). Indeed, as stressed by Price and Beaver (1966), separate and relatively unconnected groups seem to

exist in what would otherwise turn out to be a single invisible college, which challenges the solidity of detecting the structure of an invisible college.



Factor analysis output - Rotated Component Matrix

	Component 1	Component 2
ERE	0.877	0.244
JEEM	0.851	0.295
LE	0.835	0.249
EDE	0.728	0.035
EE	0.660	-0.400
AJAE	0.332	0.559
LUP	-0.009	-0.827
% variance explained	**46.7**	**19.5**

N=226 authors; Extraction Method: Principal Component Analysis; Rotation Method: Varimax with Kaiser Normalization.

Figure 3: Similarities among the selected set of entrepreneurship journals with regard to influential authors

Note: The rankings of all (226) top-50 most cited authors of each selected journal were subjected to a factor analysis on these journals' author rankings.

Legend: AJAE - American Journal of Agricultural Economics; EE - Ecological Economics; EDE - Environment and Development Economics; ERE - Environmental and Resource Economics; JEEM - Journal of Environmental Economics and Management; LE - Land Economics; LUP - Land Use Policy

Source: Authors' computation.

Subject specialty

Journals are the most convenient entry point into a problem domain to the extent that their formal connectedness through bibliographic citations can be analyzed structurally through multivariate statistical methods. So they are expected to reveal the connectivity structure of the scientific domain (Price, 1986; Leydesdorff, 1987; Vieira and Teixeira, 2010) as they provide a major platform for members in the research community to publish and communicate their research to the entire domain.

Research undertaken within a subject specialty is usually composed of research topics/subtopics wherein groups of authors operate according to their strategic scientific interests and shared body of knowledge (Zuccala, 2006). It is easier to distinguish different research disciplinary domains at a macro level, but at a lower level, indeed, at the level of the different specialties, topics or subtopics within a specialty, it is harder to delimitate the edge

(Van Raan, 1997). Aware of this shortcoming and knowing that delineation of scientific specialties will always have to take into account an uncertainty due to the blurred nature of the specialty itself, for each of the 7 journals that constitute the ecological field we computed the top-50 cited sources (see Table A4) and for the whole set we classified each source according to ISI scientific areas (se Figure 4). Our argument here is that each scholarly journal stands for a journal oeuvre representing cited articles published in a given time frame, just as an author's name represents his/her cited work. We drew on factor analysis to statistically ascertain the level of similarity in the distribution of the sources' rankings among the journals to detect the pattern of association, in other words, to detect the structure in the relationships between the cited journals.

Table 4: Brief account of the number of distinct sources and corresponding citations in the selected journals for the period 2005-2010

	Number of distinct cited sources [% journals]	**Cited sources' total citations** [% journals]	**Number (%) top-50 cited sources**[number of citations equal or above X][**]	**Number of citations corresponding to top-50 cited sources**	**% top sources' citation in total citations**
American Journal of Agricultural Economics (AJAE)	5722 [18.8]	16309 [66.4]	51 (0.9) [40]	7291	44.7
Ecological Economics (EE)	24737 [13.7]	64819 [57.5]	50 (0.2) [109]	20412	31.5
Environment and Development Economics (EDE)	3668 [20.8]	7492 [56.9]	52 (1.4) [15]	2652	35.4
Environmental and Resource Economics (ERE)	5260 [20.3]	15784 [67.7]	52 (1.0) [32]	7286	46.2
Journal of Environmental Economics and Management (JEEM)	2479 [27.4]	8562 [75.3]	50 (2.0) [21]	4791	56.0
Land Economics (LE)	3345 [23.3]	8618 [66.2]	52 (1.6) [19]	3753	43.5
Land Use Policy (LUP)	11097 [18.0]	20832 [51.3]	50 (0.5) [36]	4723	22.7

Source: Authors' computation based on data gathered from Scopus database.

For all the 7 journals, the structure of sources cited points clearly to a significantly greater weight of books, reports, letters, proceedings, and other non-published documents that were classified as 'others' (cf. Table 4). This weight is 72.6% (minimum) in the case of JEEM and 86.3% (maximum) in the case of EE. But when we consider the volume of citations instead of items the importance of journal sources is much more pronounced. We can see in the third

column of Table 4 that the percentage of journal sources in total citations ranges from 51.3% in LUP and 75.3% in JEEM.

It is interesting to note that the degree of concentration of top cited sources in terms of citations is much higher in the *Journal of Environmental Economics and Management* (JEEM), where top-50 sources' citations are 56.0% of the total, than in *Land Use Policy* (LUP) or *Ecological Economics* (EE), where the respective figures are 22.7% and 31.5%. Overall, the top-50 most cited sources that represent the field of 'ecological economics' yield a total of 132 different sources (cf. Table 5).

The reliance of 'ecological economics' on economics is obvious. Indeed, all the most cited journals are economics related outlets (according to ISI). The roots of the relational environment of 'ecological economics' are highly dependent on orthodox economics journals, in particular some of the 'Blue Ribbon' group (*American Economic Review*, *Quarterly Journal of Economics*, *Econometrica*, *Journal of Political Economy*, and *Review of Economics and Statistics*). Environmental studies is also a key stepping stone for the 'ecological economics' field of research. Among the most cited sources in the 2005-2010 data frame are core environmental studies journals: EE with 7386 citations, followed by JEEM with 4485 citations, AJAE with 3550 citations, and LE with 2487 citations.[8]
Analyzing the scientific categories (according to ISI) of the 132 journals that are included in the top-50 sources of each journal that constitutes the relational environment of 'ecological economics', we realize that this field requires insights from a multitude of dissimilar subjects characterized by an uneven distribution of the different areas.

[8] Table A4 in the Appendix lists all the top-50 most cited sources for each journal, ordered by ranking of citations.

Table 5: Top cited journals in ecological economics field

Global Rank	Source	Total citations	No. journals in top50	Global Rank	Source	Total citations	No. of journals in top50
1	Ecological Economics (EE)	7386	7	**45**	Journal of Economic Behavior and Organization	301	3
2	Journal of Environmental Economics and Management (JEEM)	4485	7	**46**	Ecological Applications	295	1
3	American Journal of Agricultural Economics (AJAE)	3550	7	**47**	BioScience	288	2
4	Land Economics (LE)	2487	7	**48**	Agricultural Systems	279	3
5	American Economic Review*	2252	7	**49**	International Economic Review*	265	5
6	Environmental and Resource Economics (ERE)	2247	7	**50**	Energy Journal	259	3
7	Journal of Political Economy*	1385	7	**51**	European Review of Agricultural Economics	258	2
8	Econometrica*	1309	6	**52**	Ecological Modelling	252	2
9	Science	1198	7	**53**	Environmental Management	247	2
10	World Development	1058	7	**54**	European Journal of Operational Research	246	1
11	Review of Economics and Statistics*	968	6	**55**	Journal of Rural Studies	244	1
12	Quarterly Journal of Economics*	872	6	**56**	RAND Journal of Economics	238	3
13	Journal of Public Economics	860	6	**57**	Climatic Change	236	2
14	Energy Policy	856	5	**58**	Oxford Economic Papers	227	3
15	Land Use Policy (LUP)	800	2	**59**	Review of Agricultural Economics	226	1
16	Review of Economic Studies*	677	6	**60**	Global Environmental Change	221	2
17	Economic Journal	673	6	**61**	Applied Economics	218	2
18	Nature	655	6	**62**	AMBIO	208	2
19	Journal of Environmental Management	635	5	**63**	Forest Ecology and Management	207	2
20	Journal of Econometrics	622	6	**64**	Canadian Journal of Economics	207	3
21	Journal of Economic Perspectives	583	6	**65**	Journal of Economic Dynamics and Control	205	2
22	Environment and Development Economics (EDE)	567	5	**66**	Economic Development and Cultural Change	204	3
23	Agriculture, Ecosystems and Environment	519	3	**67**	Urban Studies	197	2
24	Journal of Economic Literature	498	6	**68**	Journal of Environmental Planning and Management	194	1
25	Resource and Energy Economics	497	5	**69**	Agricultural and Resource Economics Review	191	2
26	Conservation Biology	448	4	**70**	Management Science	188	2
27	Landscape and Urban Planning	447	1	**71**	Australian Journal of Agricultural and Resource Economics	188	2
28	Water Resources Research	438	5	**72**	Environmental Science and Technology	185	1
29	Agricultural Economics	394	5	**73**	Journal of Applied Econometrics	180	3
30	Economics Letters	387	6	**74**	Economic Systems Research	176	1
31	Proceedings of the National Academy of Sciences USA	369	3	**75**	Natural Resource Modeling	176	3
32	European Economic Review	365	5	**76**	Transportation Research	176	1
33	Journal of Risk and Uncertainty	349	4	**77**	Journal of Business and Economic Statistics	175	2
34	Energy Economics	342	3	**78**	Energy	172	1
35	Journal of Agricultural and Resource Economics	342	2	**79**	Canadian Journal of Agricultural Economics	172	1
36	Journal of Urban Economics	329	3	**80**	Forest Policy and Economics	172	1
37	Journal of Development Economics	327	3	**81**	Scandinavian Journal of Economics	171	3
38	Journal of Industrial Ecology	322	1	**82**	Journal of Regional Science	165	1
39	Marine Resource Economics	317	5	**83**	Journal of Cleaner Production	162	1
40	Journal of Law and Economics	317	4	**84**	Forest Science	162	1
41	Journal of Agricultural Economics	316	3	**85**	Journal of Marketing Research	161	3
42	Environment and Planning	313	3	**86**	Society and Natural Resources	159	1
43	Biological Conservation	308	2	**87**	Journal of International Economics	158	3
44	Journal of Economic Theory*	308	4	**88**	Journal of Farm Economics	158	1

(…)

Global Rank	Source	No. of citations	No. of journals	Global Rank	Source	No. of citations	No. journals
89	Economic Inquiry	157	2	**111**	Soil and Tillage Research	107	1
90	Southern Economic Journal	154	2	**112**	Journal of Real Estate Finance and Economics	104	1
91	Food Policy	152	2	**113**	Public Choice	96	1
92	Journal of Finance	150	1	**114**	Geoforum	94	1
93	Journal of Economic Surveys	147	1	**115**	Annals of the Association of American Geographers	91	1
94	Environmental Science and Policy	146	1	**116**	Journal of American Statistical Association	90	2
95	Regional Science and Urban Economics	143	1	**117**	Journal of the American Planning Association	87	1
96	Journal of Agricultural and Applied Economics	139	2	**118**	International Tax and Public Finance	82	1
97	Landscape Ecology	136	1	**119**	Sociologia Ruralis	79	1
98	Landscape Research	136	1	**120**	Journal of Hydrology	79	1
99	Marine Policy	136	1	**121**	Agribusiness - An International Journal	74	1
100	World Bank Economic Review	132	1	**122**	Empirical Economics	72	1
101	Journal of Applied Ecology	129	1	**123**	World Bank Research Observer	72	1
102	Journal of Productivity Analysis	127	1	**124**	Economic Theory	71	1
103	Journal of Policy Analysis and Management	124	1	**125**	Journal of Futures Markets	66	1
104	Contemporary Economic Policy	121	1	**126**	Marketing Science	65	1
105	Journal of Development Studies	120	1	**127**	Proceedings of the Royal Society of London	65	1
106	Environment and Behavior	116	1	**128**	Journal of Environmental Psychology	64	1
107	Journal of Industrial Economics	115	1	**129**	Land Degradation and Development	62	1
108	Canadian Journal of Fisheries and Aquatic Science	113	1	**130**	Economic and Political Weekly	59	1
109	Journal of Regulatory Economics	110	2	**131**	Area	48	1
110	Development and Change	110	1	**132**	Transaction of the Institute of British Geographers	47	1

Note: The references/citations in the papers published in each selected journal in the period 2005-2010 (approximately 85 thousand citations) were gathered from the Scopus database. These references were treated separately for each journal. The references were first harmonized, in terms of sources' titles; then we calculated how often each source title appeared and thus obtained the relevant citations. Journals represent around ¼ of all sources with a corresponding citation share of 72%. This table was compiled by summing the top-50 journal titles in each of the 7 journals. This gave 132 distinct source titles covering 58 133 citations (representing approximately 3% of all journals and 68% of all journal citations). * Blue Ribbon journals.
Source: Authors' computation based on data gathered from the Scopus database.

The journals matched to a given ISI subject area are themselves portraying various theoretical approaches and so their coverage and scope make them multidisciplinary. A more detailed study of the structure of the different categories for each of the 7 selected journals suggests that the intellectual roots and structure of 'ecological economics' disclose a large reliance on well-established fields of research, particularly in economics and environmental sciences[9] (cf.

[9] It includes the ISI subject categories 'Environmental Sciences'; 'Environmental Studies'; 'Engineering, Environmental'.

Figure 4), and to a lesser extent in 'biology and natural resources'[10] and 'regional and urban studies'.[11] The dependence on economics is particularly acute in AJAE (63%) and JEEM (57%) but it is also quite high in ERE (53%), LE (48%) and EDE (46%).

LUP has a rather different structure from JEEM and AJAE as it relies on more diversified core subject areas. Only LUP and EE show any similarity with regard to the relative weight of 'environmental sciences' and the relative additional importance of this category compared with 'economics'. Furthermore, 'ecology' clearly weighs more in these journals than in other outlets, although they are not very significant (8.2% and 6.8%, respectively). Both are relatively more multidisciplinary than AJAE or JEEM (because of the greater weight of categories apart from economics). In the overall picture, 'regional and urban studies' is an area of relatively more interest to LUP (9.6%), LE (9.6%) and EDE (7.5%), whereas 'business & management'[12] stands out in AJAE (9.7%) followed by LE (6.8%).

The subject 'mathematics'[13] stands out in AJAE (11.3%) as the second area this journal relies on, followed by JEEM (7.9%) and ERE (6.1%) but it is not represented in LUP. Finally it is noted that across the 7 journals, 'biology and natural resources' represents a small portion of the scientific interests for the top 50 journals in each outlet. It is more evident in LUP (11%) followed by EE (8.2%), JEEM (7.9%) and drops to 1.6% in AJAE where 'multidisciplinary sciences'[14] has the same weight. Like the previous one, this latter area has a quite small importance across the outlets, with LUP leading (12.3%), followed by EDE (7.5%) and EE (6.8%), JEEM, LE and ERE all with approximately 3%.

[10] It covers 'Biology'; 'Biodiversity Conservation'; 'Fisheries'; 'Forestry'; 'Limnology'; 'Marine & Freshwater Biology'; 'Water Resources' ISI subject areas.

[11] It covers 'Planning & Development' and 'Urban Studies' ISI subject areas.

[12] It encompasses ISI subject areas: 'Business'; 'Business, Finance'; 'Management'; 'Operations Research & Management Science'.

[13] It encompasses these ISI areas: 'Social Sciences, Mathematical Methods' and 'Mathematics, Interdisciplinary Applications'.

[14] It comprises theses ISI subject areas: 'Multidisciplinary Sciences'; 'Geosciences, Multidisciplinary'; 'Agriculture, Multidisciplinary'; 'Psychology, Multidisciplinary'.

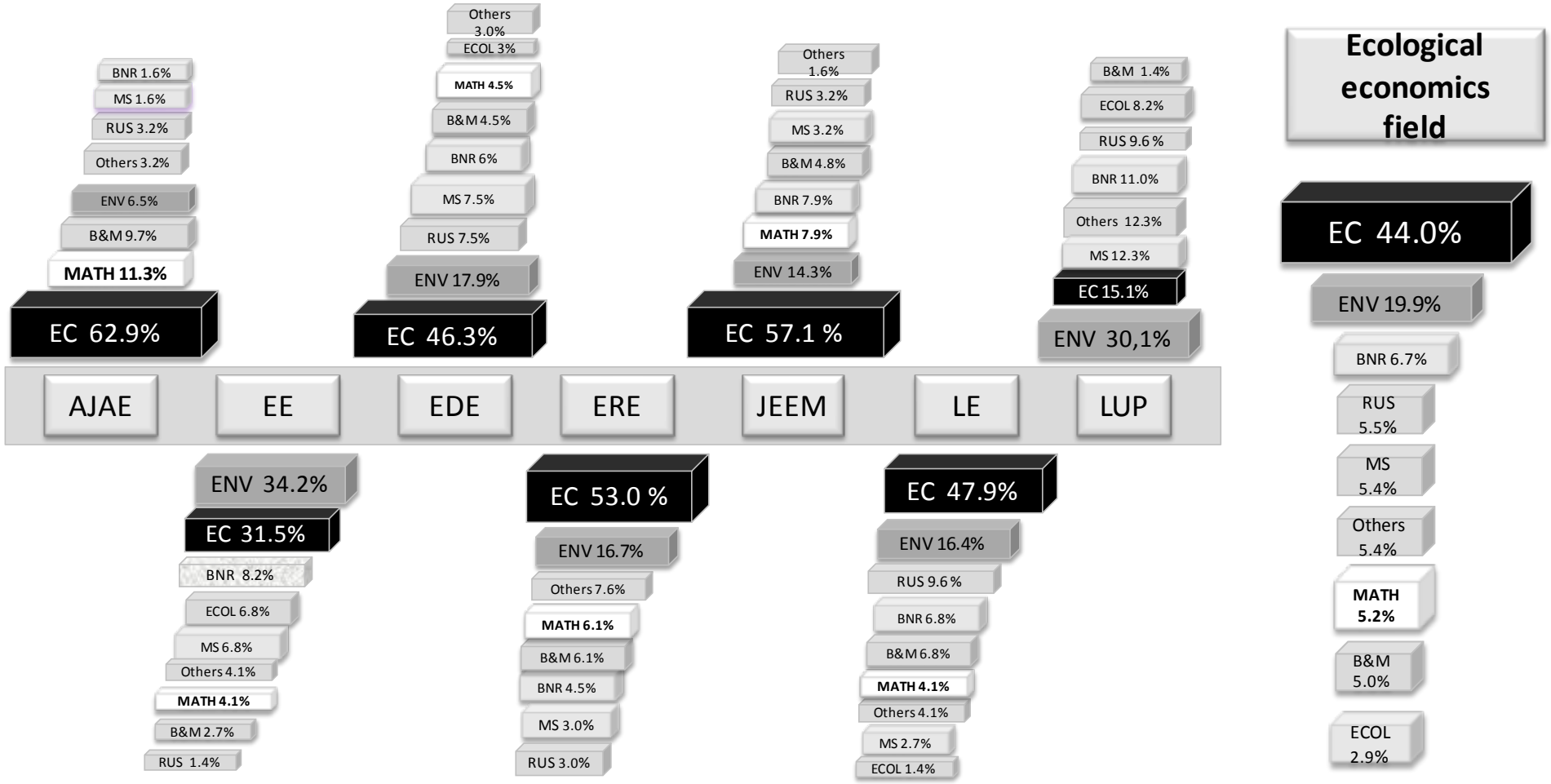


Figure 4: Intellectual roots of the field of ecological economics, by source and overall

Note: For each of the 7 selected journals the top-50 most-cited sources were computed and thereafter classified based on the ISI subject categories.

Legend: AJAE - American Journal of Agricultural Economics; EE-Ecological Economics; EDE- Environment and Development Economics; ERE- Environmental and Resource Economics JEEM- Journal of Environmental Economics and Management; LE- Land Economics; LUP-Land Use Policy

B&M- Business and Management; BNR- Biology and Natural Resources; EC- Economics; ECOL – Ecology; ENV- Environmental Issues; MATH- Mathematics; RUS- Regional and Urban Studies; MS- Multidisciplinary Sciences.

With the emphasis on the structure of knowledge in the 'ecological economics' field we merged the subject categories of the journals into one single domain, leaving aside the issue of the epistemological difference of the journals (cf. Figure 4).

We realize that of the ISI subject areas, 'economics' (44%) is the basic intellectual pillar of the field. Together with 'environmental sciences' (20%) and 'biology and natural resources' (7%) it accounts for more than 70% of the structure of the field. This means that 'ecological economics' is largely drawn from these three pillars that sustain theory-building.

The history of the evolution of 'ecological economics' as reported by diverse authors (e.g., Costanza et al., 1997a; Røpke, 2005; Neff and Corley, 2009) suggests that 'ecological economics' is also rooted in ecology and concepts such as resilience and co-evolution. One would expect this area to be of greater importance, but if we look at the field as it is defined in our study, ecology has a faint significance (3%) in shaping the field. Even if we focus on EE, which places greater emphasis on ecology, the relative importance of this subject does not exceed 7%. This seems to suggest that even though ecology has its place in the emergence of the field it does not appear to have contributed much to further shape the field in terms of sources. Note, however, that ecology/biology concepts are assimilated in an 'ecological economics' cognitive context, and include sustainability, resilience, co-evolutionary development, ecological systems and energy.

Another issue is the shared idea of interdisciplinarity and transdisciplinarity of the 'ecological economics' field (e.g., Costanza, 1991; Costanza and King, 1999; Røpke, 2005; Costanza et al., 2004; Luzadis et al, 2010). It is important to stress that several authors, when they mention the interdisciplinary and transdisciplinary character of 'ecological economics', take

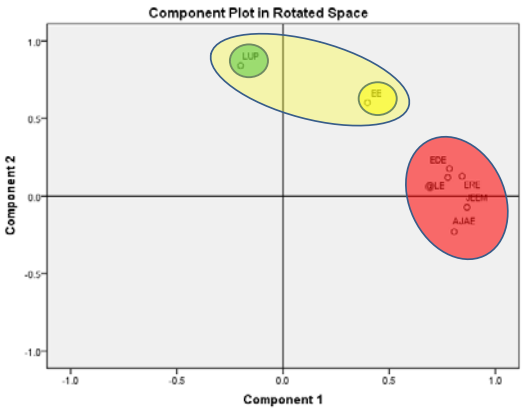
the journal EE as reference, and not the field as we have defined it here. Indeed, the scope and structure of EE may indicate a high degree of multidisciplinarity, which is not so pronounced in other journals such as AJAE or JEEM, nor even in all the 7 journals, that is, in the 'field of ecological economics'.

Our study does not involve examining whether 'ecological economics' constitutes a new field that blurs the once rigid boundaries of the disciplines by means of interdisciplinarity (integrating, linking, blending or else reshuffling), or/and by means of transdisciplinarity (transcending, transforming, or even transgressing, being an improvement on the disciplinary structures that it relies on to establish its own disciplinary agenda). Transdisciplinarity also calls for a context of purpose and relevance, aiming a use or action towards application (Gibbons et al., 1994), but it requires taking additional content and context factors into account. We may nonetheless uncover some interesting findings relating to interdisciplinarity.

At first glance, and taking into account the number of disciplines represented in the 132 top-cited journals in the 'ecological economics' field, based on ISI scientific area, we can roughly say along with Morillo et al. (2003) that both multidisciplinarity and interdisciplinarity are present in the field. Although based mostly on economics, environmental science and environmental studies, a set of different knowledge bases is generating understanding and insight within the field and, informing its lines of argument, reflection and theory and building up a coherent framework. This interdisciplinarity is generally justified by the twin needs to address issues of ever-increasing complexity and breadth and to achieve unified knowledge (Gibbons et al., 1994).

Our results show also that LUP and EE may seem to have a different pattern in terms of the disparity and evenness of the different ISI subject areas on which they rely, particularly compared with AJAE or JEEM. EDE and LE appear quite similar in that regard. Whether these similarities/differences represent different endeavors of scientific conceptual framework is a moot point. We should note that faced with such a diverse overview, factor analysis can be used to uncover major patterns and organize the linear relationships into these patterns.

Assuming that the similarity in the rankings of the top-cited sources for each journal may disclose some attributes common to their scientific intellectual compositions, factor analysis was applied to the rankings of the 132 top-50 most cited sources of each selected journal, for completeness and a better understanding of 'ecological economics'. The output of factor analysis (cf. Figure 5) showed that the selected journals form two distinct groups, one of 5 journals (JEEM, ERE, AJAE, EDE, LE), with JEEM, ERE, AJAE being relatively similar in terms of citation sources, and the other consisting of EE and LUP, which are quite distinct in terms of source citing patterns, especially in comparison with AJAE and JEEM.



Factor analysis output - Rotated Component Matrix

	Component 1	Component 2
JEEM	0.866	-0.073
ERE	0.843	0.128
AJAE	0.806	-0.229
EDE	0.784	0.177
LE	0.776	0.121
EE	0.398	0.604
LUP	-0.199	0.840
% variance explained	**50.4**	**17.0**

N=132 sources; Extraction Method: Principal Component Analysis; Rotation Method: Varimax with Kaiser Normalization.

Figure 5: Similarities between the selected set of ecological economics journals with regard to sources

Note: The rankings of all (132) top-50 most cited sources of each selected journal were subjected to a factor analysis on the journals' sources rankings.

Legend: AJAE - American Journal of Agricultural Economics; EE - Ecological Economics; EDE - Environment and Development Economics; ERE - Environmental and Resource Economics; JEEM - Journal of Environmental Economics and Management; LE - Land Economics; LUP - Land Use Policy

Source: Authors' computation.

The analysis of the top-cited studies advances our understanding of the subject specialty of this field of research and permits a better understanding of the consolidation of a scientific area (Teixeira, 2011) as revealed by the direction of the research. The analysis of highly cited studies is commonly used to shed light on academic priorities (e.g., Costanza et al. 2004; Ma and Stern, 2006; Teixeira, 2011). Walstrom and Leonard (2000) had earlier suggested that the most cited documents would afford insight into the field's core issues and they could be expected to reflect the research issues being tackled in the field as well as the methods being used to investigate those issues. Essential to this argument is the premise that the most significant studies are cited most frequently in recognition of their relevance, in addition to other factors involved in the decision to cite (Aksnes, 2003; Bornmann and Daniel, 2008).

Approximately 92440 studies were identified in the database, corresponding to142479 citations. This represents a body of knowledge that is expected to expand the understanding of the 'ecological economics' domain. Only 20.2% of these studies are cited more than once, accounting for 48.2% of the total citations. Analysis of each outlet (cf. Table 6) shows that a small fraction of studies is cited more than once, ranging from 9.5% in EDE to18.2% in ERE, which is respectively 21.18% and 40.8% of citations. This confirms Aksnes' (2003) findings that citation distributions are skewed as the large majority of studies are never or seldom cited, but a few papers receive a large number of citations.

Analyzing what comprises a seminal contribution in a certain field of research, the low citation threshold reveals huge dispersion within literature, which indicates a low level of consensus (Teixeira, 2011). This lack of consensus is particularly marked in AJAE (9), EDE (5), JEEM (7), LE (6), and LUP (7). This contrasts with EE, regarded by some (Costanza et

al., 2004; Luzadis et al., 2010), as the leading journal in the field. It has a relatively high citation threshold (29 citations) in relation to the top-25 most cited studies.

Table 6: Summary of the number of distinct studies and corresponding citations in the selected journals for the period 2005-2010

	Number of distinct studies	Number of total citations	Top-25 most cited studies			Studies that received more than 1 citation		
			Number (% total studies)	% total citations	Citation threshold**	Number	% total studies	% total citations
American Journal of Agricultural Economics (AJAE)	12850	16316	29 (0,23)	2,37 (387)	9	1940	15,10	33,13 (5406)
Ecological Economics (EE)	45518	64814	25 (0,055)	1,76 (1139)	29	7822	17,18	41,84 (27118)
Environment and Development Economics (EDE)	6525	7494	44 (0,67)	3,87 (290)	5	618	9,47	21,18 (1587)
Environmental and Resource Economics (ERE)	11418	15784	29 (0,25)	3,10 (489)	12	2073	18,16	40,79 (6438)
Journal of Environmental Economics and Management (JEEM)	6674	8579	35 (0,52)	3,87 (332)	7	1014	15,19	34,02 (2919)
Land Economics (LE)	7224	8625	34 (0,47)	3,36 (290)	6	840	11,63	25,98 (2241)
Land Use Policy (LUP)	18019	20867	36 (0,2)	1,55 (324)	7	1827	10,14	22,40 (4675)

Note: ** number of citations X or more. (In some journals instead of 25 (top) studies we have a few more, as the 25th item has several studies with an equal number of citations).

Sources: Authors' computation based on data gathered from Scopus database.

Despite the low rate of citation of the top-25 studies in each outlet (except EE, cf. Table A5 in the Appendix), when we rank the studies at aggregated level (cf. Table 7), it is clear that some works are quite highly cited (more than 100). A good example is the book by Greene, *Econometric Analysis* (rank 1). Greene is an 'outsider' relative to the core field of 'ecological economics' and his work is cited as a tool for methodological and modeling issues, not because the author is an expert in the field. The second most cited study - *Governing the Commons: The Evolution of Institutions for Collective Action*, by Elinor Ostrom. This is another kind of 'outsider' as it is not a leading work on 'ecological economics' since it is more related to institutional economics. Ostrom's contribution is authoritative (Aksnes, 2003) as it states key concepts and theory about the political economy of institutions that have been achieving increased relevance in the economics research agenda. It is frequently cited in the ecological field as it reports widely shared concerns – i.e., the design of durable cooperative

institutions to manage shared resources, the 'commons' – which intersect different areas of knowledge, as institutions make an important difference to policy outcomes. Coase's '*The Problem of Social Cost'* (rank 19) and Hardin's '*The Tragedy of the Commons'* (rank 14) go hand in hand with Ostrom's book.

These widely cited studies which are not directly focused on a discipline broadly are an exception to the general contention that highly-cited studies tend to be specific to a specialty (Small and Griffith, 1974). Only the studies by Costanza et al. (1997) and Freeman III (1993) can truly be regarded as citation classics on 'ecological economics'. Citation classics are studies of extraordinary status in a field (Chubin et al., 1984) that pick up some of the theory's underlying ideas, and the threshold commonly used to define a citation classic is a minimum of 100 citations, including by minor journals (Garfield, 1989). This threshold is standard in other fields of research (e.g., Teixeira, 2011) although disciplines differ as to the average citations and the threshold considered for being a classic study (Aksnes and Sivertsen, 2004). Costanza et al. (2004) classified as classics the most cited studies in the field, even if they lacked the threshold of 100 citations, as they are considered influences that have been important to EE.

As a study ages its contribution is often incorporated into the wider knowledge base. Moed (2005:81) calls this 'obliteration by incorporation'. It did not happen to Hardin who ranks 14 with the classic 'Tragedy of the Commons' that continues to be highly cited, and Georgescu-Roegen who ranks 23. This latter's works were considered highly influential for 'ecological economics' theory-building by previous qualitative studies (e.g., Martinez-Alier, 1987; Costanza et al. 1997a, Martinez-Alier and Røpke, 2008), although there are critics who argue that citations are sometimes biased in favor of certain authors, especially those authors who

enjoy a ‘halo effect’ (May 1977). But the works of other scholars such as Kenneth Boulding, Howard Thomas Odum and William Kapp that have played a part in shaping the discourse in the ‘ecological economics’ field seem, in the words of some authors (e.g., Costanza, 1997a; Berger, 2008; Martinez-Alier and Røpke, 2008) to be half-forgotten contributions as they are not directly cited, although they have been considered seminal to ‘ecological economics’ field. Even if we look at EE or other selected journals, none of them features in the top-50 studies.

Most of the top-50 influential studies are positioned outside ‘ecological economics’ research and were not published in the selected ‘ecological economics’ domain journals. In fact, only 8 studies lie within this boundary: Selden and Song (rank 26) published in JEEM; Hanemann (rank 39), published in AJAE, Train (rank 46) published in LE and five studies were published in EE: De Groot, Wilson and Boumans (rank 27), Van den Bergh and Verbruggen (rank 40), Engel, Pagiola and Wunder (rank 50), Lenzen and Murray (rank 50) and Martinez-Alier, Munda and O’Neil (rank 50). Note that if we take the total aggregate of all studies in the seven outlets instead of the studies corresponding to the full set of the top 50 most cited studies in each journal, only four have been published inside the domain: Selden and Song who ranks 27 and Kahneman and Knetsch who ranks 41 published their work in JEEM; Train who ranks 28 published in LE; De Groot, Wilson and Boumans who rank 33, published in EE.

About 47% of the top-50 cited studies are co-authored which confirms the findings that highly cited documents tend to be co-authored - often by a large number of scientists, with international collaboration - (Margolis 1967; Aksnes, 2003). In fact, most studies that explore the connection between research collaboration and citation impact have pointed out a positive

correlation between the two variables (e.g., Glänzel et al., 1995). A closer look at the background of these authors and their affiliation should shed some light on the cross-disciplinary interaction as collaboration is a common feature of interdisciplinary work (Palmer, 1999).

In short, Table 7 shows that about 55% of the key references are books, 15% are articles published in one of the 7 selected journals and 30% are journal articles published in other, mainly multidisciplinary, journals (*Science, Nature*) or mainstream journals (*Quarterly Journal of Economics, Journal of Law and Economics, Journal of Economic Perspectives, Political economy, Review of Economics and Statistics, World Development*). These findings corroborate the studies by Costanza et al. (2004) and Ma and Stern (2006), although more broadly and not focused on EE as those two were, who showed that the field has been influenced by a corpus of key references mostly located outside the field and predominantly concerning books, reports and government documents other than academic journals. Looking at Table 7, and expanding our analysis to the 316 different studies covering all top-50 cited of the 7 outlets,[15] we find studies spanning a relatively diverse array of subjects that can fall into six major lines of research: 'economics', including general economic and management themes not assigned to other categories; 'environmental and natural resources issues'; 'environmental and natural resources policy and management'; 'growth and sustainability economics'; 'methodological and econometric analysis and modeling', concerning methods and modeling transversal to several areas of research; 'methodological and economic issues of valuation and accounting', including ecosystems and natural resources valuation methods as well as applied valuation issues, and methodological and applied ecological footprint issues, besides green accounting.

[15] Although some studies may have multiple perspectives meaning that they may be assigned to more than one category, we tried to match them to the research area that, in our view, best fits the aims of the document. From this perspective, there is an element of subjectivity in our efforts to be objective.

Table 7: Top cited studies in the ecological economics field

Rank	Study	Type	Nº of distinct journals*	Total citations**	Total agregated citations***
1	Greene, W.H., (1993) Econometric Analysis, , Macmillan New York	B	7	249	249
2	Ostrom, E., (1990) Governing the Commons: The Evolution of Institutions for Collective Action, , Cambridge University Press, Cambridge	B	4	114	127
3	Costanza, R., d'Arge, R., De Groot, R., Farver, S., Grasso, M., Hannon, B., Limburg, K., van den Belt, M., The Values of the World's Ecosystem Services and Natural Capital (1997) Nature, 387, pp. 253-260	J	2	98	105
4	Freeman III, A.M., (1993) The Measurement of Environmental and Resource Values, Theory and Methods , Washington, D.C.: Resources for the Future	B	5	96	103
5	Train, K.E., (2003) Discrete Choice Methods with Simulation, , Cambridge, U.K, Cambridge University Press	B	5	92	96
6	Clark, C.W., (1990) Mathematical Bioeconomics: The Optimal Management of Renewable Resources, , Wiley-Interscience	B	5	84	88
7	McFadden, D., Conditional logit analysis of qualitative choice behavior (1973) Frontiers in Econometrics, , P. Zarembka Ed, Academic Press, New York, NY	B	6	84	84
8	Louviere, J.J., Hensher, D., Swait, J.D., Adamowicz, W.L., (2000) Stated Choice Methods: Analysis and Applications, , Cambridge: Cambridge University Press	B	4	83	94
9	Grossman, G.M., Krueger, A.B., 'Economic growth and the environment' (1995) Quarterly Journal of Economics, 110, pp. 353-377	J	4	82	85
10	Mitchell, R., Carson, R.T., (1989) Using Surveys to Value Public Goods: The Contingent Valuation Method, , Resources for the Future Washington, DC	B	4	79	88
11	(1987) Our Common Future: The World Commission on Environment and Development, , Bruntland G.H. (Ed), Oxford University Press, Oxford	B	3	76	83
12	Arrow, K.J., Solow, R., Portney, P.R., Leamer, E.E., Radner, R., Schuman, H., Report of the NOAA panel on contingent valuation (1993) Federal Register, 58, pp. 4601-4614.	Official daily publication	4	68	73
13	(2005) Ecosystems and Human Well-Being: Synthesis, , Millennium Ecosystem Assessment (MA) Washington, DC: Island Press	B	3	61	62
14	Hardin, G., The tragedy of the commons (1968) Science, 162, pp. 1243-1248	J	3	58	72
15	Wooldridge, J.M., (2002) Econometric Analysis of Cross Section and Panel Data, , Cambridge and London: MIT	B	4	58	79
16	Wackernagel, M., Rees, W., (1996) Our Ecological Footprint: Reducing Human Impact on Earth, , New Society Publishers, Gabriola Island, BC	B	1	57	62
17	Daily, G., (1997) Nature's Services: Societal Dependence on Natural Ecosystems, , Island Press, Washington, DC	B	1	56	66
18	Stern, N.H., (2007) The Economics of Climate Change. The Stern Review, , Cambridge: Cambridge University Press	B	3	53	63
19	Coase, R.E., The Problem of Social Cost (1960) Journal of Law and Economics, 3 (1), pp. 1-44	J	4	51	63
20	Porter, M.E., Van Der Linde, C., Toward a New Conception of the Environment-Competitiveness Relationship (1995) Journal of Economic Perspectives, 9, pp. 97-118	J	3	51	57
21	Rosen, S., ""Hedonic Prices and Implicit Markets: Product Differential in Perfect Competition"" (1974) Journal of Political Economy, 82 (1), pp. 34-55	J	5	51	68
22	Krinsky, I., Robb, A.L., On approximating the statistical properties of elasticities (1986) Review of Economics and Statistics, 68, pp. 715-719	J	4	50	73
23	Georgescu-Roegen, N., (1971) The Entropy Law and the Economic Process, , Cambridge: Harvard University Press	B	1	46	54
24	Bateman, I.J., Carson, R.T., Day, B., Hanemann, W.M., Hanley, N., Hett, T., Jones-Lee, M., Swanson, J., (2002) Economic Valuation with Stated Preference Techniques: A Manual, , Edward Elgar Cheltenham, UK	B	3	44	54
25	Stern, D.I., The rise and fall of the environmental Kuznets curve (2004) World Development, 32 (8), pp. 1319-1339	J	2	43	52
26	Selden, T.M., Song, D., Environmental Quality and Development: Is There a Kuznets Curve for Air Pollution Emissions? (1994) Journal of Environmental Economics and Management, 27 (2), pp. 147-162	J	2	41	50
27	De Groot, R.S., Wilson, M.A., Boumans, R.M.J., A typology for the classification, description and valuation of ecosystem functions, goods and services (2002) Ecological Economics, 41 (3), pp. 393-408	J	1	40	43
28	Daly, H.E., Cobb Jr., J.B., (1984) For the Common Good: Redirecting the Economy Toward Community, the Environment and a Sustainable Future, , Beacon Press, Boston	B	1	36	37

(...)

Rank	Study	Type	Nº of distinct journals*	Total citations**	Total agregated citations ***
29	Baumol, W.J., Oates, W.E., (1988) The Theory of Environmental Policy, 2nd Edn., , Cambridge University Press	B	2	34	69
30	Diamond, P.A., Hausman, J.A., Contingent Valuation: Is Some Number Better Than No Number? (1994) Journal of Economic Perspectives, 8 (4), pp. 45-64	J	2	33	41
31	Landell-Mills, N., Porras, I.T., (2002) Silver Bullet or Fool's Gold? A Global Review of Markets for Forest Environmental Services and Their Impact on the Poor, , London: International Institute for Environment and Development	B	2	33	35
32	Miller, R.E., Blair, P.D., (1985) Input-output Analysis: Foundation and Extensions, , Prentice Hall Englewood Cliffs, NJ	B	1	33	37
33	North, D., (1990) Institutions, Institutional Change and Economic Performance, , Cambridge University Press, Cambridge	B	2	33	34
34	Solow, R.M., Intergenerational equity and exhaustible resources (1974) Review of Economic Studies (Symposium on the Economics of Exhaustible Resources), 41, pp. 29-45	J	2	33	48
35	Sagoff, M., (1988) The Economy of the Earth, , Cambridge University Press Cambridge	B	2	31	34
36	Swait, J., Louviere, J.J., 'The Role of the Scale Parameter in the Estimation and Comparison of Multinomial Logit Models' (1993) Journal of Marketing Research, 30, pp. 305-314	J	2	30	40
37	Vitousek, P.M., Mooney, H.A., Lubchenco, J., Melillo, J.M., Human domination of earth's ecosystems (1997) Science, 277 (5325), pp. 494-499	J	2	30	31
38	Arrow, K., Bolin, B., Costanza, R., Dasgupta, P., Folke, C., Hollig, C., Jansson, B., Levin, S., Mäler, K.-G., Perrings, C., Pimentel, D., Economic Growth, Carrying Capacity and the Environment (1995) Science, 268 (28), pp. 520-521	J	1	29	38
39	Hanemann, W.M., 'Welfare Evaluations in Contingent Valuation Experiments with Discrete Responses' (1984) American Journal of Agricultural Economics, 66, pp. 332-341	J	3	29	46
40	Van den Bergh, J.C.J.M., Verbruggen, H., Spatial sustainability, trade and indicators: An evaluation of the ecological footprint (1999) Ecological Economics, 29, pp. 61-72	J	1	29	31
41	Dixit, A.K., Pindyck, R.S., (1994) Investment Under Uncertainty, , Princeton, NJ: Princeton University Press	B	4	27	38
42	Leontief, W., Environmental repercussions and the economic structure: an input-output approach (1970) The Review of Economics and Statistics, 52, pp. 262-271	J	1	27	28
43	Martinez-Alier, J.,(2002) The Environmentalism of the Poor. A Study of Ecological Conflicts and Valuation, , Edward Elgar, Cheltenham	B	1	27	27
44	Norgaard, R.B., (1994) Development Betrayed. the End of Progress and a Coevolutionary Revisioning of the Future, , Routledge London	B	1	27	31
45	Pearce, D.W., Turner, R.K., (1989) Economics of Natural Resources and the Environment, , Harvester Wheatsheaf, Hemel Hempstead, UK 378 pp	B	1	27	35
46	Train, K.E., Recreation demand models with taste differences over people (1998) Land Econ., 74 (2), pp. 230-239	J	3	27	49
47	Weitzman, M.L., Prices vs. quantities (1974) Review of Economic Studies, 41 (4), pp. 477-491	J	2	27	37
48	Daly, H.E., (1996) Beyond Growth-The Economics of Sustainable Development, , Beacon Press, Boston	B	1	26	27
49	Dasgupta, P.S., Heal, G.M., (1979) Economic Theory and Exhaustible Resources, , Cambridge University Press Cambridge	B	3	26	32
50	Engel, S., Pagiola, S., Wunder, S., Designing payments for environmental services in theory and practice: An overview of the issues (2008) Ecological Economics, 65, pp. 663-674	J	1	25	27
51	Lenzen, M., Murray, S.A., A modified ecological footprint method and its application to Australia (2001) Ecological Economics, 37, pp. 229-255	J	1	25	27
52	Martinez-Alier, J., Munda, G., O'Neill, J., Weak comparability of values as a foundation for ecological economics (1998) Ecological Economics, 26, pp. 277-286	J	1	25	29
53	Meadows, D.H., Meadows, D.L., Randers, J., Behrens II, W.W., (1972) The Limits to Growth, , New York: Universe Books	B	1	25	34

Note: In relation to the papers published in each selected journal in the period 2005-2010, the corresponding references/citations (approximately 142 479) were gathered from the Scopus database. First, the references were harmonized (and the spelling of authors' names, titles and sources was checked); then, the number of times each study appeared was calculated and the respective citations were thus obtained. These top-50 most cited studies represent approximately 0.055% (51/ 92 440) of al the studies and the corresponding citations 2.24% (3 185/142 479) of the total. The studies in the second column are the top-50 that were computed by summing the top-50 studies in each of the 7 journals; *Number of journals in which the study is ranked in top-50; **Citations resulting from the aggregation of the top-50 of each of the 7 journals; *** Citations resulting from the aggregation of all studies of the set of 7 journals.

Table 8 depicts the structure of the most influential studies for ‘ecological economics’ categorized by subject fields. Although 19.3% of the 316 studies are assigned to ‘economics’, 17.7% to ‘environmental and natural resource issues’ and 19.3% to ‘methodological and economic issues of valuation’ if we look at the weight of citations the scenario is different, with the last one standing out with 23.2% following ‘methodological and econometric analysis and modeling’ with 21.9% of the citations. This makes it clear that valuation issues are a core concern in the field, following general methodological and modeling issues, because the specialty structure of the domain is linked with methods and requires rigorous ecological-economics modeling. Although studies on ‘growth and sustainability economics’ represent a little over half of the ones on ‘economics’, they are more cited (16.8%) than the latter (13.2%), which makes clear the concern with sustainability in ‘ecological economics’ already stressed by previous research by Quental and Lourenço (2012), Ma and Stern (2006) and Costanza (1991b), even though these authors were looking at the EE journal, not at the scientific field.

Narrowing the analysis for the top-50 studies, Table 8 shows that the same concern can be broadly found, as the largest number of cited studies (28.3%) and the largest weight of citations (27%) relate to ‘methodological and economic issues of valuation’ (e.g., Costanza, d’Arge, De Groot, Farver, Grasso, Hannon, Limburg van den Belt). This is followed by ‘methodological and econometric analysis and modeling’ (17% of studies, 26% of citations) (e.g., Greene; Train; McFadden) and ‘growth and sustainability economics’ (28.3% of studies, 24.4% of citations) (e.g., Grossman and Krueger; Hardin; Our Common Future). The areas ‘economics’ with 7.5% of studies and 5.1% of citations (e.g., Coase; North; Dixit and Pindyck; Weitzman) and ‘environmental and natural resources issues’ (e.g., Stern; Porter and Van der Linde; Pearce and Turner; Dasgupta and Heal) with 7.5% of studies and 5.8% of

citations are the research areas with less influence on the field, followed by ‘environmental and natural resources policy and management’(e.g., Ostrom; Clark; Baumol and Oates; Sagoff) where 11.3% of studies received 11.8% of citations. From this picture, environmental/natural resources policy and management appear to have only a weak influence on delineating the field. However, it should be noted that this percentage may be somewhat larger in scope and that some studies classified in another research area may have policy and management concerns.

From the perspective of articles published in EE, Castro e Silva and Teixeira’s (2011) finding that ‘policies, governance and institutions’ gained substantial relevance over time, most notably in the final period (2005–2009), is not reflected at the level of the sources in the wider and more comprehensive domain of ‘ecological economics’. Another finding is that a substantial part of the studies on ‘methodological and economic issues of valuation and accounting’ concern indicators and methods traditionally assigned to mainstream economics as contingent valuation method and monetary measures. And others are focused on a new approach to the valuation of environmental goods and to measuring either Green National Product (GNP) or human demand on the Earth's ecosystems (e.g., Table 7, Wackernagel and Rees; Van den Bergh, and Verbruggen). Hence, it can be inferred that at this quantitative level there is not a single transforming new way of valuing environmental and resource goods; instead there is a larger range of alternatives (methods) for tackling the issue, although a formalist methodology limiting the scope of subject matter to the basic principle of commensurability prevails.

In short, it should be noted that 36% of the 316 most cited studies in ‘ecological economics’ (i.e., sources, for scholars working in the field) are assigned to ‘Methodological and economic

issues of valuation and accounting' and 'Methodological and econometric analysis and modeling' and receive 45% of the corresponding citations. When we narrow to the top-50 of the whole set, the picture is even clearer: 45% of the studies and about 53% of citations concern these two topics.

Table 8: Summary of the type and structure of topics assigned to the top-50 studies in each of the 7 selected journals

	316 diferent studies corresponding to the full set of top 50 most cited studies in each journal (1)				Top 50 most cited studies of (1)			
Topics	**Number of studies**	**% of studies with that topic**	**Number of citations correspondin g to that topic**	**% of the total citations of the 316 studies (5015)**	**Number of studies**	**% of studies with that topic**	**Number of citations correspon ding to that topic**	**% of the total citations (2719)**
Economics	61	19.3	664	13.2	4	7.5	138	5.1
Environmental and natural resources issues	56	17.7	568	11.3	4	7.5	157	5.8
Environmental and natural resources policy and management	52	16.5	682	13.6	6	11.3	321	11.8
Growth and sustainability economics	33	10.4	841	16.8	15	28.3	664	24.4
Methodological and econometric analysis and modeling	53	16.8	1098	21.9	9	17.0	706	26.0
Methodological and economic issues of valuation and accounting	61	19.3	1162	23.2	15	28.3	733	27.0

5. Conclusion

The field of 'ecological economics' is increasingly diverse in a variety of issues, methods and interdisciplinary research strategies (Paavola and Fraser, 2011). As it is a domain that crosses disciplinary boundaries, the history of the discipline's assessment and characterization of its knowledge structure is a cornerstone of the science of 'ecological economics' itself.

Our study is based on the premise of van den Besselaar and Leydesdorff (1996) by which it is feasible to define a specialty as the communication network that can be delineated through the analysis of aggregated journal-journal citations. We chose EE as the entrance journal to obtain the set of relevant journals that were included in the field of 'ecological economics', and thus to structure our analysis. The output of the factor analysis differed for the periods under analysis (2000; 2005; 2009), most notably in the first period (2000). Perhaps this was because,

before that date, ‘ecological economics’ was not what van den Besselaar and Leydesdorff (1996:432) call “… an interreading community of scientists”, and was instead in a pre-paradigmatic stage of its path. For the most recent period (2009) the ‘ecological economics’ field was covered by 7 journals: AJAE (*American Journal of Agricultural Economics*); EE (*Ecological Economics*); EDE (*Environment and Development Economics*); ERE (*Environmental and Resources Economics*); LE (*Land Economics*); LUP (*Land Use Policy*), and JEEM (*Journal of Environmental Economics and Management*). These comprise the ‘ecological economics’ ‘relational environment’ for which we analyzed the corresponding intellectual roots (in terms of authors, studies and outlets).

The main outcomes of the present research are worth highlighting.

First, most of the leading authors in the field of ‘ecological economics’ are economists or environmental resources economists, which may suggest that ‘ecological economics’ has a core intellectual frame of reference overwhelmed by (environmental and resource) economics. An additional analysis of the degree of ‘similarity’ between journals’ rankings of top-cited authors reveals that the journals form 3 distinct groups. The largest one consists of *Environment and Development Economics* (EDE), *Environmental and Resource Economics* (ERE), *Journal of Environmental Economics and Management* (JEEM), and *Land Economics* (LE), with *Ecological Economics* (EE) being included, but only at the boundary. Another group includes only one journal, the *American Journal of Agricultural Economics* (AJAE). The third group consists of *Land Use Policy* (LUP), which shows faint associations with EE. This picture suggests that the field of ‘ecological economics’ might embody one (in)visible college which includes distinct specializations or subject specialties.

Second, the most influential sources are based on ‘economics’ (44%), ‘environmental sciences’ (20%) and ‘biology and natural resources’ (7%). ‘Ecological economics’ thus seems to be underpinned by these three basic intellectual pillars, with economics undoubtedly preeminent.

Third the field has been influenced by knowledge mostly located outside the field, and predominantly concerning publications such as books, reports, and government documents other than academic journals. This may suggest two readings: 1) ‘ecological economics’ is still on the way to gaining its own core body of theoretical and applied knowledge; 2) its broad multidisciplinary nature combined with its aims is reflected in the disparity of core influences, and is thus a characteristic of the field. The basic set of journals which delineates the environment of ‘ecological economics’ by 2009 is a necessary but not sufficient condition for drawing conclusions about the maturity of the field in terms of its disciplinary substantive development (van den Besselaar and Leydesdorff, 1996); in other words, to what extent it skilfully embodies and develops knowledge.

As portrayed by the top-50 studies, the area ‘growth and sustainability economics’ stands out as a core topic, encompassing 28.3% of the most cited studies and 24.4% of the corresponding citations. Moreover, ‘ecological economics’ is valuation- and methodology-focused, with 45% of the studies (i.e. sources, for scholars working on the field) and about 53% of citations being assigned to ‘Methodological and economic issues of valuation and accounting’ and ‘Methodological and econometric analysis and modeling’. The area ‘environmental and natural resources policy and management’ does not seem to be a cornerstone of the ‘ecological economics’ line of inquiry.

Most existing studies and authors base their work on a backward look at the field through the eyes of EE (e.g., Spash, 2012; Faber, 2008; Baumgärtner et al. 2008; Norton and Noonan 2007; Røpke, 2005) and argue about the fragility of the field and its internal lack of coherence, alongside the great challenge of advising society and government and contributing to the sustainable life of humans and nature, and is thus a policy-driven, action-orientated discipline (Baumgärtner, 2008; Faber, 2008 Shi, 2004). Moreover, it is argued that ecological economists have themselves not diverged much from the mainstream and that mathematical formalism and quantification, as the focus of scientific rigour, restrict any alternative perspective for the field (Spash, 2012). However, as we have shown in this paper, 'ecological economics' goes beyond the scope of the EE journal, beyond the scope of its founders, and beyond the scope of its supporters. It has its own socio-cognitive life and the multiplicity of interconnected causes that influence its dynamic behavior prevents any simplistic reasoning about its (desirable) evolution and foundation.

Analyzing the global picture of 'ecological economics', first and foremost we can infer that pluralism is a conspicuous label of the field. It was found that the coexistence of different efforts to enhance creative diversity is one of the most original characteristics of 'ecological economics'. This finding is at odds with the views of a typical 'pure' discipline-specific field with its well defined boundaries and inward research tradition. 'Ecological economics' at this level is not based on a well-established corpus of "tools, methods, procedures examples, concepts and theories" (Klein, 1990: 104) that creates identity in the field. An advance on this reasoning is the fact that the field of 'ecological economics' is bounded by a set of journals with alternative perspectives on economics (i.e., mainstream, e.g., JEEM, AJAE, ERE and LE, and heterodox views, e.g., EE). They share most of their knowledge as a combined cognitive and social endeavor that serves to confirm the heterodox and multidisciplinary

nature of the field. At this level, we believe that this does not express fragility but diversity, and pluralism, which is characteristic of heterodox disciplines (Dow, 2008) and inevitably follows from the nature of the subject matter.

At the methodological level, however, this study's findings corroborate the results reported by Spash (2012), Baumgärtner et al. (2008) and Norton and Noonan (2007), with respect to the prevailing monism of orthodox economics, which is heavily reliant on the quantitative side of its target of dealing with nature, and not matching the requirements of value pluralism. Indeed, at roots level and considering the 316 most influential studies, formalist methodology is prevailing and no truly integrated process of evaluating anthropogenic ecological change is apparent. It is suggested instead that the field in itself does not emphasize the building of specific integrative knowledge.

We should also be mindful of the fact that although some authors have regarded 'ecological economics' as being a policy-driven, action-oriented discipline since its foundation, issues on this topic in the most influential studies did not support this claim.

If 'ecological economics' is to attain the status of being a keystone in the decision-making policy arena it has to take care about how its scientific language is interpreted by those at whom it is directed. It has to deal expertly with the questions of ethics, power, judgment, poverty and distribution, in addition to environmental matters, as all these dimensions are at the core of the sustainability process where 'ecological economics' hopes to have a crucial role. Only thus will the translation of the reasoning behind its formalism be possible, and then its influence can be a fact. Most importantly, the characteristics of disparity of subjects, of otherness and of pluralism that seem intrinsic to the identity of the field would by no means

be hampered by the claim of Spash (2012:40) to be saving the field from “arbitrary openness to just everything”. It is clearly time to widen our notion of heterodox discipline and abandon the either/or approach and start believing in the possible reciprocity of heterodox and orthodox thoughts. We must look broadly at how our own work and the work of others can fit together and accomplish the difficult task of acknowledging that we are looking either at one aspect or another of a complex issue that is to breathe new life into improving the chances of human survival on this planet. Indeed, we know full well that the economy is embedded in the natural environment and is subject to the laws of thermodynamics, and we also know that the endeavor is uncertain.

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Table A1: Citing matrix for the entrance journal EE, in 2009

	AM ECON REV	AM J AGR ECON	CONSERV BIOL	ECOL	ECOL ECON	ENERG ECON	ENERG POLICY	ENERGY	ENVIRON DEV	ENVIRON MANAGE	ENVIRON RESOUR ECON	FOREST ECOL MANAG	GLOBAL ENVIRON CH	J CLEAN PROD	J ENVIRON ECON	J ENVIRON MANAG	J IND ECOL	LAND ECON	LAND USE POL	NATURE	P NATL ACAD SCI	SCIENCE	WORLD DEV
AM ECON REV	420	89	3		144	48	112	3	39	2	61	3	2	4	56	16	4	36	12	0	45	21	170
AM J AGR ECON	0	374	3		100	11	31	0	19	26	69	5	5	2	33	54	0	89	46	0	4	0	53
CONSERV BIOL	0	2	728		70	0	0	0	2	129	3	423	18	0	2	77	0	3	19	7	89	29	2
ECO EFFICIEN IND SCI	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ECOL ECON	0	14	24		1101	18	179	36	48	82	106	70	27	71	10	140	66	38	81	0	26	3	12
ENERG ECON	0	0	0		75	403	526	68	0	0	15	0	0	0	0	0	4	0	0	0	0	0	0
ENERG POLICY	0	0	0		145	119	1897	236	2	14	13	10	9	48	3	21	29	0	9	0	4	7	12
ENERGY	0	0	0		26	8	245	599	0	2	0	0	0	35	0	13	7	0	0	0	2	0	2
ENVIRON DEV ECON	0	8	0		50	0	16	3	41	0	23	3	4	4	3	7	0	7	4	0	0	0	3
ENVIRON MANAGE	0	0	13		31	0	6	0	0	272	0	48	6	12	2	104	2	0	19	0	5	3	2
ENVIRON RESOUR ECON	4	16	3		154	18	50	0	38	6	183	0	0	0	53	41	2	33	12	0	5	0	5
FOREST ECOL MANAG	0	0	49		37	0	7	0	2	83	0	2816	5	2	0	34	0	0	15	4	26	6	0
GLOBAL ENVIRON CHANG	0	0	8		39	4	13	2	0	43	4	14	107	6	0	13	0	0	23	4	14	5	0
J CLEAN PROD	0	0	3		46	2	36	21	0	9	0	4	0	503	0	66	41	0	2	0	3	0	0
J ENVIRON ECON MANAG	11	36	6		212	38	62	3	42	18	179	0	2	16	171	75	2	76	25	0	2	0	3
J ENVIRON MANAGE	0	2	10		81	0	21	6	3	95	13	44	8	23	2	608	4	6	46	0	3	2	0
J IND ECOL	5	0	0		121	2	22	5	0	0	0	0	0	52	0	29	224	0	5	0	3	0	0
LAND ECON	8	40	6		126	4	26	0	17	36	83	3	0	3	29	71	0	81	58	0	5	0	8
LAND USE POLICY	0	0	4		73	0	6	0	0	18	0	8	0	7	0	30	0	0	177	0	4	0	11
NATURE	7	2	162		101	5	33	6	3	92	22	243	39	0	9	73	14	7	4	4278	7112	2279	0
P NATL ACAD SCI USA	6	4	120		76	11	22	3	3	53	10	126	33	14	5	26	10	0	10	1574	10846	1199	4
SCIENCE	11	13	320		170	16	99	21	7	159	23	298	94	36	14	123	25	9	21	2457	6600	3387	6
WORLD DEV	3	18	22		133	0	34	4	28	23	17	10	23	4	0	33	0	12	61	0	15	3	377

Table A2: Output of the factor analysis

2000

Rotated Component Matrix(a)

	Component		
	1	2	3
LAND ECON	0,926	-0,230	0,203
ENVIRON RESOUR ECON	0,905	-0,008	0,085
J ENVIRON ECON MANAG	0,889	0,034	0,137
AM J AGR ECON	0,581	-0,209	0,456
J ENVIRON MANAGE	0,294	-0,706	0,297
Q J ECON	0,109	0,973	0,079
AM ECON REV	0,170	0,967	0,074
ENVIRON VALUE	-0,134	0,179	-0,900
ECOL ECON	0,183	-0,222	-0,842
SCIENCE	-0,814	-0,208	0,278
AMBIO	-0,844	-0,180	0,323

Extraction Method: Principal Component Analysis,
Rotation Method: Varimax with Kaiser Normalization,
a, Rotation converged in 5 iterations,

2005

Rotated Component Matrix(a)

	Component				
	1	**2**	**3**	**4**	**5**
RESOUR ENERGY ECON	0,871	0,118	0,357	-0,005	-0,112
LAND ECON	0,848	0,051	0,469	0,184	0,020
J ENVIRON ECON MANAG	0,839	0,276	0,403	0,166	-0,094
ENVIRON DEV ECON	0,819	-0,029	0,186	0,128	0,509
ENVIRON RESOUR ECON	0,774	0,362	0,450	0,170	-0,087
ECOL ECON	0,696	-0,239	0,046	-0,334	-0,092
ECON J	0,072	0,941	0,301	0,082	0,014
Q J ECON	0,071	0,939	0,300	0,094	0,013
AM ECON REV	0,111	0,933	0,305	0,102	0,025
J POLIT ECON	0,102	0,932	0,295	0,101	0,026
ECOL SOC	-0,309	-0,324	-0,888	0,018	-0,013
CONSERV BIOL	-0,316	-0,296	-0,892	0,055	-0,074
NATURE	-0,277	-0,237	-0,915	0,049	-0,085
SCIENCE	-0,274	-0,239	-0,923	0,037	-0,052
J ENVIRON MANAGE	-0,077	-0,774	0,211	0,447	-0,227
AM J AGR ECON	0,499	0,053	0,489	0,391	0,178
WORLD DEV	0,005	0,109	0,096	0,052	0,963
ENERG POLICY	-0,055	-0,060	0,113	-0,930	-0,053
ENVIRON MANAGE	-0,570	-0,583	-0,236	0,223	-0,255
ECOL MODEL	-0,621	-0,342	-0,034	0,067	-0,318

Extraction Method: Principal Component Analysis,
Rotation Method: Varimax with Kaiser Normalization,
a, Rotation converged in 6 iterations,

2009

Rotated Component Matrix(a)

	Component				
	1	**2**	**3**	**4**	**5**
ENVIRON RESOUR ECON	0,958	-0,200	0,059	0,005	0,083
J ENVIRON ECON MANAG	0,924	-0,175	0,121	0,038	-0,105
LAND ECON	0,896	-0,269	0,177	0,109	0,095
ENVIRON DEV ECON	0,849	-0,260	0,305	0,055	0,190
AM J AGR ECON	0,621	-0,253	0,359	0,121	0,010
ECOL ECON	0,572	-0,171	-0,156	-0,011	0,541
LAND USE POLICY	0,151	-0,310	0,093	0,211	0,808
NATURE	-0,249	0,935	-0,138	0,111	-0,130
P NATL ACAD SCI USA	-0,258	0,934	-0,112	0,098	-0,133
SCIENCE	-0,272	0,923	-0,166	0,130	-0,121
WORLD DEV	0,108	-0,227	0,863	0,057	0,266
AM ECON REV	0,334	-0,150	0,762	-0,006	-0,147
ENVIRON MANAGE	-0,536	0,345	-0,489	0,406	0,005
J ENVIRON MANAGE	-0,198	-0,059	-0,504	0,362	0,448
BIOL CONSERV	-0,567	0,132	-0,376	0,346	-0,356
CONSERV BIOL	-0,550	0,303	-0,360	0,341	-0,324
ENERG POLICY	-0,121	-0,129	-0,029	-0,919	-0,017
ENERG ECON	-0,012	-0,114	0,044	-0,937	-0,145
FOREST ECOL MANAG	-0,531	-0,078	-0,230	0,261	-0,378
J CLEAN PROD	-0,161	-0,141	-0,049	0,015	-0,095
J IND ECOL	-0,081	0,021	-0,091	-0,094	0,058

Extraction Method: Principal Component Analysis,
Rotation Method: Varimax with Kaiser Normalization,
a, Rotation converged in 11 iterations,

Table A3: Ranks of the top-50 most cited authors in the papers published in each of the 7 selected ecological economics Journals, 2005-2010

Rank	AJAE		EE		EDE		ERE		JEEM		LE		LUP	
	Authors	Σ of citations	Authors	Σ of citations	Autos	Σ of citations	Authors	Σ of citations	Authors	Σ of citations	Authors	Σ of citations	Authors	Σ of citations
1	Deaton, A.	99	Costanza, R.	458	Dasgupta, P.S.	61	List, J.A.	149	List, J.A.	82	Greene, W.H.	64	Lambin, E.F.	80
2	Just, R.E.	98	Wackernagel, M.	294	Barbier, E.B.	53	Pearce, D.W.	146	Wilen, J.E.	80	Hanley, N.	57	Mather, A.S.	80
3	Zilberman, D.	88	Daly, H.E.	287	Mendelsohn, R.	53	Bateman, I.J.	145	Hanemann, W.M.	63	Bockstael, N.E.	54	Ostrom, E.	63
4	Greene, W.H.	86	Hanley, N.	269	Ostrom, E.	48	Louviere, J.J.	140	Taylor, M.S.	59	Hanemann, W.M.	48	Verburg, P.H.	58
5	Lusk, J.L.	86	Ostrom, E.	267	Tol, R.S.J.	44	Kahneman, D.	124	Carson, R.T.	55	Carson, R.T.	42	Hanley, N.	49
6	Barrett, C.B.	84	Lenzen, M.	264	Dinar, A.	43	Hanemann, W.M.	122	Train, K.E.	55	Plantinga, A.J.	42	Rounsevell, M.D.A.	48
7	Chambers, R.G.	80	Van Den Bergh , J.C.J.C.M.	244	Wunder, S.	34	Shogren, J.F.	122	Smith, V.K.	52	Smith, V.K.	39	Haberl, H.	46
8	Chavas, J.P.	80	Pearce, D.W.	213	Platteau, J.P.	33	Carson, R.T.	117	Weitzman, M.L.	52	McConnell, K.E.	38	Renn, O.	45
9	Shogren, J.F.	80	Dasgupta, P.S.	212	Wheeler, D.	32	Hensher, D.A.	115	Copeland, B.R.	51	McFadden, D.	38	Bromley, D.W.	44
10	Moschini, G.	77	Loomis, J.B.	209	Zilberman, D.	31	Loomis, J.B.	110	Dasgupta, P.S.	51	Adamowicz, W.L.	37	Lowe, P.	43
11	Huffman, W.E.	70	Ayres, R.U.	189	Barrett, C.B.	30	Dasgupta, P.S.	104	Oates, W.E.	49	Boyle, K.J.	36	Deininger, K.	42
12	Irwin, S.H.	70	Folke, C.	184	Pagiola, S.	30	Hanley, N.	91	Clark, C.W.	47	Irwin, E.G.	36	Pretty, J.	42
13	Hayes, D.	69	Haberl, H.	179	Pearce, D.	30	Swait, J.D.	90	Shogren, J.F.	44	Louviere, J.	33	Rudel, T.K.	42
14	Schroeder, T.C.	69	Bateman, I.J.	175	Rozelle, S.	30	Train, K.	90	Sanchirico, J.N.	42	Hensher, D.	32	Veldkamp, A.	42
15	Pope, R.D.	68	Krausmann, F.	171	Stern, D.I.	30	Weitzman, M.L.	86	Bateman, I.J.	39	List, J.A.	32	Feder, G.	40
16	Train, K.	68	Hanemann, W.M.	164	Antle, J.M.	29	Smith, V.K.	84	Goulder, L.H.	39	Bromley, D.W.	31	Scoones, I.	40
17	Goodwin, B.K.	63	Wunder, S.	164	Pender, J.	29	Adamowicz,W.L.	82	Kling, C.	39	Palmquist, R.B.	31	Turner II, B.L.	39
18	Holt, M.T.	58	Carson, R.T.	163	Wilen, J.	26	Bishop, R.C.	78	Stavins, R.N.	39	Spash, C.L.	31	Williamson, I.P.	39
19	Hennessy, D.A.	52	Norgaard, R.B.	162	Hyde, W.	25	Maler, K.-G.	77	Pizer, W.A.	38	Anselin, L.	30	Geoghegan, J.	37
20	Hausman, J.A.	51	Barbier, E.B.	158	Perrings, C.	25	Greene, W.	76	Smith, M.D.	38	Hausman, J.A.	30	Potter, C.	37
21	Louviere, J.	49	Färe, R.	158	Squires, D.	25	Scarpa, R.	74	Polasky, S.	37	Shogren, J.F.	30	Geist, H.	36
22	McFadden, D.	49	Erb, K.-H.	154	Whittington, D.	25	Boyle, K.J.	71	Herriges, J.A.	36	Squires, D.	30	Ilbery, B.	36
23	Alston, J.M.	46	Martinez-Alier, J.	154	Baland, J.M.	24	Poe, G.L.	68	McFadden, D.	36	Stavins, R.N.	30	Marsden, T.	36
24	Fox, J.A.	46	Rees, W.E.	154	Ferraro, P.J.	23	Tol, R.S.J.	65	Parry, I.W.H.	35	Swallow, S.K.	30	Wilson, G.A.	36
25	Kaiser, H.M.	45	Arrow, K.	152	Angelsen, A.	22	Carraro, C.	64	Adamowicz, W.L.,	34	Train, K.E.	30	Webler, T.	35
26	Sumner, D.A.	45	Perrings, C.	149	Greene, W.H.	22	Nordhaus, W.D.	63	Cameron, T.A.	34	Kahneman, D.	29	Castella, J.C.	34
27	Hanemann, W.M.	43	Daily, G.C.	148	Grossman, G.M.	22	Portney, P.R.	63	Costello, C.	33	Portney, P.	29	Folke, C.	34
28	List, J.	43	Stern, D.I.	147	Shogren, J.F.	22	Harrison, G.W.	62	Harrison, G.W.	33	Bateman, I.J.	28	Bateman, I.J.	32
29	Mishra, A.K.	43	Spash, C.L.	144	Arrow, K.J.	20	Heal, G.	61	Newell, R.G.	33	Loomis, J.B.	28	Bruce, J.W.	32
30	Wilen, J.E.	43	Turner, R.K.	144	Copeland, B.R.	20	McFadden, D.	61	Cropper, M.	32	Bishop, R.C.	27	Mortimore, M.	32
31	Griliches, Z.	41	Weitzman, M.L.	143	Ehrlich, P.R.	20	Cummings, R.G.	59	Nordhaus, W.D.	32	Poe, G.L.	27	Moran, E.	31
32	LaFrance, J.T.	41	Adamowicz, W.L.	140	Hanemann, W.M.	20	Stavins, R.N.	58	Viscusi, W.K.	32	Scarpa, R.	27	Nelson, A.C.	31
33	Muellbauer, J.	41	Grosskopf, S.	140	List, J.A.	20	Sugden, R.	58	Bishop, R.C.	31	Swait, J.	27	Angelsen, A.	30
34	Wu, J.	41	Kahneman, D.	139	Hanley, N.	19	Barrett, S.	56	Bovenberg, A.L.	31	Amacher, G.S.	26	Munda, G.	30
35	Färe, R.	38	Munda, G.	139	Huang, J.	19	Knetsch, J.L.	56	Portney, P.R.	30	Clark, C.W.	26	Ward, N.	30
36	Morey, E.	38	Pagiola, S.	137	Krueger, A.B.	19	McConnell, K.E.	56	Loomis, J.B.	29	Wu, J.	26	Winter, M.	30

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Rank	AJAE		EE		EDE		ERE		JEEM		LE		LUP	
	Authors	Σ of citations	Authors	Σ of citations	Autos	Σ of citations	Authors	Σ of citations	Authors	Σ of citations	Authors	Σ of citations	Authors	Σ of citations
37	Rozelle, S.	38	Ehrlich, P.	133	Nordhaus, W.	19	Arrow, K.J.	55	Sandler, T.	29	Brown, T.C.	25	Xu, J.	30
38	Sexton, R.J.	38	Polasky, S.	133	Wang, H.	19	Schulze, W.D.	55	Barrett, S.	28	Grosskopf, S.	25	Fry, G.	29
39	Wooldridge, J.M.	38	Pimentel, D.	129	Heal, G.M.	18	Turner, R.K.	54	Fredriksson, P.G.	28	Johnston, R.J.	25	Antrop, M.	28
40	Brorsen, B.W.	37	Tol, R.S.J.	127	Munro, G.	18	Cameron, T.A.	53	Jaffe, A.B.	28	Alberini, A.	24	Liu, J.	28
41	Evenson, R.E.	37	Hannon, B.	125	Solow, R.M.	18	Viscusi, W.K.	53	Kahneman, D.	28	Barbier, E.B.	24	Toulmin, C.	28
42	Gardner, B.L.	37	Funtowicz, S.	123	Amacher, G.S.	17	Brown, T.C.	52	McConnell, K.E.	28	Cropper, M.	24	De Soto, H.	27
43	Pardey, P.G.	37	Greene, W.H.	122	Barrett, S.	17	Willis, K.G.	52	Murdoch, J.C.	28	Färe, R.	24	Erb, K.-H.	27
44	Sadoulet, E.	37	Louviere, J.J.	121	Clark, C.W.	17	Ulph, A.M.	51	Bockstael, N.E.	27	Champ, P.A.	23	Hecht, S.B.	27
45	Swait, J.	37	Stavins, R.N.	116	Färe, R.	17	Hoel, M.	50	Grossman, G.M.	27	Freeman III, A.M.	23	Leach, M.	27
46	Anderson, K.	36	Wiedmann, T.	116	Heltberg, R.	17	Oates, W.E.	50	Louviere, J.	27	Khanna, M.	23	O'Riordan, T.	27
47	Diewert, W.E.	36	Limburg, K.	113	Sedjo, R.A.	17	Tversky, A.	50	Solow, A.	27	Ostrom, E.	23	Barbier, E.B.	26
48	Kahneman, D.	36	Nordhaus, W.D.	111	Taylor, J.E.	17	Barbier, E.B.	49	Hoel, M.	26	Parsons, G.R.	23	Haines-Young, R.	26
49	Good, D.L.	35	Wheeler, D.	110	Taylor, M.S.	17	Thaler, R.H.	49	Greenstone, M.	25	Wilen, J.E.	23	Murdoch, J.	26
50	Hertel, T.W.	34	Gowdy, J.M.	109	Weitzman, M.L.	17	Mitchell, R.C.	48	Hausman, J.A.	25	Arrow, K.	22	Needle, C.L.	26
51	Key, N.	34	Grossman, G.M.	109					Innes, R.	25	Grafton, R.Q.	22	Wolsink, M.	26
52	Yen, S.T.	34							Levinson, A.	25	Heckman, J.	22		
53									Phaneuf, D.J.	25	Howarth, R.B.	22		
54									Shavell, S.	25	Rosenberger, R.S.	22		
55									Tol, R.S.J.	25				
56									Wu, J.	25				

Table A4: Ranks of the top-50 most cited sources in the 7 selected ecological economics journals

	AJAE		EE		EDE		ERE		JEEM		LE		LUP	
Rank	Sources	Σ of citations	Sources	Σ of citations	Sources	Σ of citations	Sources	Σ of citations	Sources	Σ of citations	Sources	Σ of citations	Sources	Σ of citations
1	American Journal of Agricultural Economics	1853	Ecological Economics	6277	Journal of Environmental Economics and Management	215	Journal of Environmental Economics and Management	1095	Journal of Environmental Economics and Management	1155	Land Economics	723	Land Use Policy	604
2	American Economic Review	430	Journal of Environmental Economics and Management	1271	Ecological Economics	195	Environmental and Resources Economics	813	American Economic Review	342	Journal of Environmental Economics and Management	396	Landscape and Urban Planning	332
3	Econometrica	428	Environmental and Resource Economics	822	World Development	188	American Economic Review	475	Journal of Political Economy	246	American Journal of Agricultural Economics	343	Agriculture, Ecosystems and Environment	241
4	Journal of Political Economy	334	Land Economics	750	Environment and Development Economics	169	Ecological Economics	378	Environmental and Resource Economics	224	Ecological Economics	166	Ecological Economics	229
5	Journal of Environmental Economics and Management	279	Science	721	American Journal of Agricultural Economics	134	Land Economics	342	Journal of Public Economics	216	American Economic Review	155	Journal of Rural Studies	199
6	Review of Economics and Statistics	239	American Economic Review	670	Land Economics	133	American Journal of Agricultural Economics	321	American Journal of Agricultural Economics	212	Journal of Political Economy	135	World Development	175
7	Journal of Econometrics	238	Energy Policy	644	Environmental and Resource Economics	130	Journal of Public Economics	287	Land Economics	195	Environmental and Resource Economics	118	Science	160
8	Journal of Agricultural and Resource Economics	205	American Journal of Agricultural Economics	556	American Economic Review	122	Quarterly Journal of Economics	229	Econometrica	165	Econometrica	114	Journal of Environmental Management	148
9	Land Economics	197	World Development	504	Econometrica	83	Journal of Political Economy	223	Review of Economics and Statistics	127	Journal of Urban Economics	114	Land Economics	147
10	Review of Agricultural Economics	151	Nature	438	Journal of Political Economy	83	Econometrica	218	Quarterly Journal of Economics	126	Review of Economic and Statistics	112	Environment and Planning	130
11	Review of Economic Studies	148	Review of Economics and Statistics	333	Science	71	Review of Economic Studies	202	Review of Economic Studies	106	Journal of Econometrics	60	American Journal of Agricultural Economics	124
12	Quarterly Journal of Economics	134	Journal of Environmental Mangement	326	Journal of Development Economics	61	Resource and Energy Economics	143	Ecological Economics	87	World Development	60	Urban Studies	122
13	Agricultural Economics	124	Journal of Political Economy	326	Review of Economics and Statistics	49	Economic Journal	140	Marine Resource Economics	85	Journal of Public Economics	58	Agricultural Systems	100

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	AJAE		EE		EDE		ERE		JEEM		LE		LUP	
Rank	Sources	Σ of citations	Sources	Σ of citations	Sources	Σ of citations	Sources	Σ of citations	Sources	Σ of citations	Sources	Σ of citations	Sources	Σ of citations
14	Economic Journal	110	Journal of Industrial Ecology	307	Economic Journal	48	Journal of Risk and Uncertainty	128	Economic Journal	78	Water Resources Research	49	Landscape Ecology	92
15	European Review of Agricultural Economics	91	Quarterly Journal of Economics	294	Water Resources Research	43	Journal of Economic Perspectives	103	Journal of Economic Literature	74	Journal of Law and Economics	48	Global Environment Change	78
16	European Economic Review	90	Econometrica	288	Journal of Public Economics	42	European Economic Review	94	Journal of Economic Perspectives	73	Journal of Real Estate Finance and Economics	48	Journal of Environmental Planning and Management	74
17	Journal of Development Economics	90	Conservation Biology	287	Resource and Energy Economics	41	Economics Letters	92	Journal of Economic Theory	70	Marine Resource Economics	46	Environmental Management	73
18	Environmental and Resource Economics	89	Economic Journal	246	Economic Development and Cultural Change	40	Energy Policy	87	Resource and Energy Economics	69	Journal of Economic Perspectives	45	Journal of Environmental Economics and Management	73
19	Journal of Business and Economic Statistics	88	Journal of Economic Perspectives	243	Review of Economic Studies	39	Science	85	Journal of Econometrics	64	Forest Science	44	Conservation Biology	67
20	Economics Letters	84	Proceedings of the National Academy of Sciences USA	238	Agricultural Economics	38	Journal of Economic Literature	84	Science	63	Science	42	Journal of the American Planning Association	65
21	Journal of Economic Literature	83	Energy Economics	236	Quarterly Journal of Economics	38	Journal of Environmental Management	81	Journal of Urban Economics	61	Journal of Agricultural and Resource Economics	40	Society and Natural Resources	65
22	RAND Journal of Economics	83	Environment and Development Economics	225	Journal of Economic Perspectives	36	Water Resources Research	81	Journal of Risk and Uncertainty	55	Economic Journal	39	Journal of Agricultural Economics	63
23	International Economic Review	80	Agriculture, Ecosystems and Environment	223	Nature	36	Environment and Development Economics	80	RAND Journal of Economics	55	Quarterly Journal of Economics	38	Development and Change	62
24	Canadian Journal of Agricultural Economics	77	Biological Conservation	202	Journal of Economic Literature	34	Journal of Econometrics	80	Canadian Journal of Economics	54	Journal of Regional Science	36	Forest Policy and Economics	62
25	Journal of Economic Theory	77	Journal of Public Economics	202	Energy Policy	33	Review of Economics and Statistics	78	Journal of Economic Dynamics and Control	47	Review of Economic Studies	34	Geoforum	62
26	Agribusiness - An International Journal	74	Ecological Applications	199	Journal of Econometrics	30	Energy Journal	74	Journal of Law and Economics	47	Agricultural Economics	33	Sociologia Ruralis	62

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	AJAE		EE		EDE		ERE		JEEM		LE		LUP	
Rank	Sources	Σ of citations	Sources	Σ of citations	Sources	Σ of citations	Sources	Σ of citations	Sources	Σ of citations	Sources	Σ of citations	Sources	Σ of citations
27	Journal of Applied Econometrics	74	BioScience	196	Agriculture, Ecosystems and Environment	29	Journal of Economic Behavior and Organization	72	International Economic Review	46	Environment and Development Economics	32	Annals of the Association of American Geographers	61
28	Journal of Agricultural Economics	72	Resource and Energy Economics	194	Journal of Environmental Management	29	Journal of Economic Theory	69	European Economic Review	45	Journal of Economic Literature	32	Environment and Behavior	60
29	Journal of Finance	71	Ecological Modelling	183	Marine Resource Economics	28	Journal of Economic Dynamics and Control	66	Economics Letters	44	Agricultural and Resource Economics Review	30	Soil and Tillage Research	59
30	Applied Economics	70	European Journal of Operation Research	183	Oxford Economic Papers	28	Oxford Economic Papers	62	Journal of Economic Behavior and Organization	39	Economics Letters	30	Agricultural Economics	58
31	Journal of Economic Perspectives	69	Water Resource Research	181	Journal of Development Studies	25	Energy Economics	61	Natural Resource Modeling	33	Journal of Agricultural Economics	30	American Economic Review	58
32	Journal of Agricultural and Applied Economics	67	Journal of Economic Literature	179	Climatic Change	24	Nature	61	Journal of Regulatory Economics	32	Conservation Biology	27	Energy Policy	58
33	Journal of Futures Markets	66	Economic Systems Research	166	Conservation Biology	24	Transportation Research	60	Oxford Economic Papers	32	Journal of Agricultural and Applied Economics	27	Proceedings of National Academy of Sciences USA	55
34	World Development	64	Land Use Policy	163	Agricultural Systems	23	Scandinavian Journal of Economics	58	Economic Inquiry	28	Journal of Environmental Management	27	Nature	53
35	Journal of American Statistical Association	62	Energy	155	Economic and Political Weekly	22	Canadian Journal of Economics	55	Energy Journal	28	Journal of Risk and Uncertainty	27	Environmental and Resource Economics	51
36	Journal of International Economics	59	Environmental Management	150	International Economic Review	21	International Economic Review	52	International Tax and Public Finance	28	Natural Resource Modeling	27	Bioscience	45
37	Science	56	Journal of Econometrics	145	Proceedings of the National Academy of Sciences	21	Journal of Marketing Research	52	Journal of American Statistical Association	28	Environment and Planning	26	AMBIO	44
38	Food Policy	55	Review of Economic Studies	144	Journal of Risk and Uncertainty	20	Journal of Law and Economics	48	Journal of International Economics	28	Nature	25	Biological Conservation	44
39	Journal of Law and Economics	55	Environmental Science and Technology	140	European Economic Review	18	Journal of Regulatory Economics	48	Nature	28	Resource and Energy Economics	25	Land Degradation and Development	44

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Rank	AJAE		EE		EDE		ERE		JEEM		LE		LUP	
	Sources	Σ of citations	Sources	Σ of citations	Sources	Σ of citations	Sources	Σ of citations	Sources	Σ of citations	Sources	Σ of citations	Sources	Σ of citations
40	Ecological Economics	54	Journal of Cleaner Production	140	Australian Journal of Agricultural and Resource Economics	17	RAND Journal of Economics	48	Economic Theory	26	Journal of Development Economics	24	Environmental Science and Policy	43
41	Agricultural and Resources Economics Review	53	Agricultural Systems	134	Economics Letters	17	Marine Resource Economics	45	Water Resources Research	25	Applied Economics	23	Landscape Research	41
42	Journal of Productivity Analysis	52	Energy Journal	134	Journal of Economic Theory	17	Journal of International Economics	44	Energy Policy	24	International Economic Review	23	Area	40
43	Journal of Farm Economics	49	AMBIO	133	World Bank Economic Review	17	World Development	44	Environment and Development Economics	24	Regional Science and Urban Economics	23	Journal of Environmental Psychology	40
44	Economic Development and Cultural Change	48	Forest Ecology and Management	133	World Bank Research Observer	17	Management Science	42	Journal of Business and Economic Statistics	24	Urban Studies	23	Journal of Hydrology	39
45	Journal of Industrial Economics	48	Climatic Change	131	Energy Economics	16	Natural Resource Modeling	42	Scandinavian Journal of Economics	24	Contemporary Economic Policy	21	Ecological Modelling	38
46	Journal of Public Economics	48	Journal of Economic Behavior and Organization	130	Proceedings of the Royal Society of London	16	Economic Inquiry	41	Canadian Journal of Fisheries and Aquatic Science	23	Economic Development and Cultural Change	21	Journal of Political Economy	38
47	Marketing Science	43	Global Environmental Change	121	Canadian Journal of Economics	15	Journal of Applied Econometrics	36	World Development	23	European Review of Agricultural Economics	21	Forest Ecology and Management	37
48	Empirical Economics	42	Economics Letters	118	Journal of Economic Surveys	15	Public Choice	34	Journal of Applied Econometrics	21	Journal of Marketing Research	20	Food Policy	36
49	Australian Journal of Agricultural and Resource Economics	40	Environment and Planning	117	Marine Policy	15	Journal of Urban Economics	33	Journal of Marketing Research	21	European Economic Review	19	Journal of Applied Ecology	36
50	Marine Resource Economics	40	Agricultural Economics	114	Scandinavian Journal of Economics	15	Journal of Policy Analysis and Management	32	Southern Economic Journal	21	Management Science	19	Transaction of the Institute of British Geographers	36

Table A5: Top-25 most cited studies for each of the 7 journals in analysis

	AJAE		EE		EDE		ERE	
Rank	**Study**	**Σ of citations**	**Study**	**Σ of citations**	**Study**	**Σ of citations**	**Study**	**Σ of citations**
1	Greene, W.H., (1990) Econometric Analysis, , Macmillan New York	58	Costanza, R., d'Arge, R., De Groot, R., Farver, S., Grasso, M., Hannon, B., Limburg, K., van den Belt, M., The Values of the World's Ecosystem Services and Natural Capital (1997) Nature, 387, pp. 253-260	91	Greene, W.H., (1993) Econometric Analysis, , 2nd Edition, New York: Macmillan	16	Greene, W., (1990) Econometric Analysis, , MacMillan New York	36
2	Wooldridge, J.M., (2002) Econometric Analysis of Cross Section and Panel Data, , Cambridge and London: MIT	30	Ostrom, E., (1990) Governing the Commons: The Evolution of Institutions for Collective Action, , Cambridge University Press, Cambridge	78	Ostrom, E., (1990) Governing the Commons: The Evolution of Institutions for Collective Action, , Cambridge: Cambridge University Press	16	Louviere, J.J., Hensher, D.A., Swait, J.D., (2000) Stated Choice Methods: Analysis and Application, , Cambridge: Cambridge University Press	32
3	Deaton, A., Muellbauer, J., (1983) Economics and Consumer Behaviour, , Cambridge University Press, Cambridge	18	Greene, W.H., (1990) Econometric Analysis, , Macmillan New York	75	Grossman, G.M., Krueger, A.B., 'Economic growth and the environment' (1995) Quarterly Journal of Economics, 110, pp. 353-377	11	Train, K., (2003) Discrete Choice Methods with Simulation, , Cambridge University Press Cambridge, United Kingdom	25
4	Train, K., (2003) Discrete Choice Methods and Simulation, , Cambridge University Press, Cambridge	15	(1987) Our Common Future: The World Commission on Environment and Development, , Bruntland G.H. (Ed), Oxford University Press, Oxford	63	Clark, C., (1976) Mathematical Bioeconomics: The Optimal Management of Renewable Resources, , New York: John Wiley & Sons	11	Freeman III, A.M., (1992) The Measurement of Environmental and Resource Values: Theory and Methods, , 2nd ed. Resources for the Future, Washington	24
5	Deaton, A., Muellbauer, J., An Almost Ideal Demand System (1980) The American Economic Review, 70 (3), pp. 312-326	14	Wackernagel, M., Rees, W., (1996) Our Ecological Footprint: Reducing Human Impact on Earth, , New Society Publishers, Gabriola Island, BC	57	Baland, J.M., Platteau, J.P., (1996) Halting Degradation of Natural Resources: Is There a Role for Rural Communities?, , Oxford: Clarendon Press, for the Food and Agriculture Organisation	10	Swait, J., Louviere, J.J., 'The Role of the Scale Parameter in the Estimation and Comparison of Multinomial Logit Models' (1993) Journal of Marketing Research, 30, pp. 305-314	21
6	Goodwin, B., Mishra, A., Are Decoupled Farm Program Payments Really Decoupled? An Empirical Evaluation (2006) American Journal of Agricultural Economics, 88 (1), pp. 73-89	14	Daily, G., (1997) Nature's Services: Societal Dependence on Natural Ecosystems, , Island Press, Washington, DC	56	Singh, I., Squire, L., Strauss, J., (1986) Agricultural Household Models: Extensions, Applications, and Policy, , World Bank research publication, Baltimore: Johns Hopkins University Press	10	McFadden, D., Conditional logit analysis of qualititative choice behaviour (1974) Frontiers in Econometrics, , P. Zarembka (Ed.), New York: Academic Press	20
7	McFadden, D., Zarembka, P., Conditional logit analysis of qualitative choice behavior (1973) Frontiers in Econometrics, pp. 105-142. , Academic Press New York	14	Grossman, G., Krueger, A., Economic Growth and the Environment (1995) Quarterly Journal of Economics, 110, pp. 353-377	49	Pagiola, S., Arcenas, A., Platais, G., Can payments for environmental services help reduce poverty? An exploration of the issues and the evidence to date from Latin America (2005) World Development, 33 (2), pp. 237-253	8	Mitchell, R.C., Carson, R.T., (1989) Using Surveys to Value Public Goods: The Contingent Valuation Method, , Resources for the Future Washington D.C	19
8	Krinsky, I., Robb, A.L., On approximating the statistical properties of elasticities (1986) Review of Economics and Statistics, 68, pp. 715-719	13	Freeman III, A.M., (1993) The Measurement of Environmental and Resource Values, , Washington, D.C.: Resources for the Future	49	Wooldridge, J.M., (2002) Econometric Analysis of Cross Section and Panel Data, , Cambridge, MA: MIT Press	8	Cummings, R.G., Taylor, L.O., 'Unbiased Value Estimates for Environmental Goods: A Cheap Talk Design for the Contingent Valuation Method' (1999) American Economic Review, 89, pp. 649-665. , 3	17
9	McFadden, D., Train, K., Mixed MNL models for discrete response (2000) Journal of Applied Econometrics, 15 (5), pp. 447-470	13	Mitchell, R., Carson, R.T., (1989) Using Surveys to Value Public Goods: The Contingent Valuation Method, , Resources for the Future Washington, DC	47	Stern, D.I., The rise and fall of the environmental Kuznets curve (2004) World Development, 32 (8), pp. 1419-1439	8	Hanemann, W.M., 'Welfare Evaluations in Contingent Valuation Experiments with Discrete Responses' (1984) American Journal of Agricultural Economics, 66, pp. 332-341	17

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Rank	AJAE Study	AJAE Σ of citations	EE Study	EE Σ of citations	EDE Study	EDE Σ of citations	ERE Study	ERE Σ of citations
10	Clark, C.W., (1990) Mathematical Bioeconomics: The Optimal Management of Renewable Resources, , Wiley-Interscience	12	Georgescu-Roegen, N., (1971) The Entropy Law and the Economic Process, , Cambridge: Harvard University Press	46	Heckman, J.J., Sample selection bias as a specification error (1979) Econometrica, 47 (1), pp. 153-162	7	Krinsky, I., Robb, A., 'On Approximating the Statistical Properties of Elasticities' (1986) The Review of Economics and Statistics, 68, pp. 715-719	17
11	Davidson, R., MacKinnon, J.G., (1993) Estimation and Inference in Econometrics, , New York: Oxford University Press	12	(2005) Ecosystems and Human Well-Being: Synthesis, , Millennium Ecosystem Assessment (MA) Washington, DC: Island Press	45	Hotelling, H., The economics of exhaustible resources (1931) The Journal of Political Economy, 39, pp. 137-175	7	Weitzman, M.L., Prices vs. Quantities (1974) Review of Economic Studies, 41, pp. 477-491. , 4 October	17
12	Train, K., Recreation Demand Models with Taste Differences over People (1998) Land Economics, 74	12	Hardin, G., The tragedy of the commons (1968) Science, 162, pp. 1243-1248	42	Selden, T.M., Song, D., Environmental quality and development: Is there a Kuznets curve for air pollution? (1994) Journal of Environmental Economics and Environmental Management, 27, pp. 147-162	7	Baumol, W.J., Oates, W.E., (1988) The Theory of Environmental Policy, 2nd Edn., , Cambridge University Press	17
13	Kahneman, D., Tversky, A., Prospect theory: an analysis of decision under risk (1979) Econometrica, 47 (2), pp. 263-291	11	De Groot, R.S., Wilson, M.A., Boumans, R.M.J., A typology for the classification, description and valuation of ecosystem functions, goods and services (2002) Ecological Economics, 41 (3), pp. 393-408	40	Solow, R.M., Intergenerational equity and exhaustible resources (1974) Review of Economic Studies (Symposium on the Economics of Exhaustible Resources), 14, pp. 29-45	7	Champ, P.A., Bishop, R.C., Brown, T.C., McCollum, D.W., Using Donation Mechanisms to Value Nonuse Benefits from Public Goods (1997) Journal of Environmental Economics and Management, 33, pp. 151-162	16
14	Mussa, M., Rosen, S., Monopoly and Product Quality (1978) Journal of Economic Theory, 18 (2), pp. 301-317	11	Arrow, K., Solow, R., Leamer, E., Portney, P., Radner, R., Schuman, H., Report of the NOAA Panel on Contingent Valuation (1993) Federal Register, 58, pp. 4601-4614	37	Wunder, S., Poverty alleviation and tropical forests: What scope for synergies? (2001) World Development, 29 (11), pp. 1817-1833"	7	Grossman, G.M., Krueger, A.B., 'Economic Growth and the Environment' (1995) Quarterly Journal of Economics, 110, pp. 353-377. , 2	15
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16	Barten, A.P., Bettendorf, L.J., Price Formation of Fish - An Application of an Inverse Demand System (1989) European Economic Review, 33, pp. 1509-1525	10	Stern, N., (2006) Stern review on the economics of climate change, , HM Treasury, London	36	Hartwick, J.M., 'Intergenerational equity and the investing of rents from exhaustible resources' (1977) American Economic Review, 67, pp. 972-974	6	Arrow, K.J., Solow, R., Portney, P.R., Leamer, E.E., Radner, R., Schuman, H., Report of the NOAA panel on contingent valuation (1993) Federal Register, 58, pp. 4601-4614. , 10	15
17	Fulton, M., Giannakas, K., Inserting GM Products into the Food Chain: The Market and Welfare Effects of Different Labeling and Regulatory Regimes (2004) American Journal of Agricultural Economics, 86 (1), pp. 42-60	10	Stern, D.I., The rise and fall of the environmental Kuznets curve (2004) World Development, 32 (8), pp. 1319-1339	35	Dasgupta, P.S., Heal, G.M., (1979) Economic Theory and Exhaustible Resources, Cambridge Economic Handbook, , Cambridge University Press	6	Carraro, C., Siniscalco, D., 'Strategies for the International Protection of the Environment' (1993) Journal of Public Economics, 52, pp. 309-328	14

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19	Maddala, G., (1983) Limited Dependent and Qualitative Variables in Econometrics, pp. 67-70. , Econometric Society Monograph No. 3. Cambridge: Cambridge University Press	10	Louviere, J.J., Hensher, D., Swait, J.D., Adamowicz, W.L., (2000) Stated Choice Methods: Analysis and Applications, , Cambridge: Cambridge University Press	34	Ostrom, E., Gardner, R., Walker, J., (1994) Rules, Games, and Common-Pool Resources, Ann Arbor, , MI: University of Michigan Press	6	Bateman, I.J., Carson, R.T., Day, B., Hanemann, W.M., Hett, T., Hanley, N., Jones-Lee, M., Swanson, J., (2002) Economic Valuation with Stated Preference Techniques: A Manual, , Cheltenham: Edward Elgar	14
19	Deaton, A., (1997) The Analysis of Household Surveys: A Microeconometric Approach to Development Policy, , Baltimore: The Johns Hopkins University Press	9	Selden, T.M., Song, D., Environmental Quality and Development: Is There a Kuznets Curve for Air Pollution Emissions? (1994) Journal of Environmental Economics and Management, 27 (2), pp. 147-162	34	Gordon, H.S., The Economic Theory of a Common Property Resource: The Fishery (1954) Journal of Political Economy, 62 (2), pp. 124-142	6	Clark, C.W., (1990) Mathematical Bioeconomics. The Optimal Management of Renewable Resources (2nd Edn), , Wiley	14
20	Jacoby, H., Shadow Wages and Peasant Family Labor Supply: An Econometric Application to the Peruvian Sierra (1993) Review of Economic Studies, 60, pp. 901-923	9	Clark, C.W., (1990) Mathematical Bioeconomics: The Optimal Management of Renewable Resources, , Wiley-Interscience	33	Arellano, M., Bond, S., 'Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations' (1991) Review of Economic Studies, 58, pp. 277-297	5	Barrett, S., Self-Enforcing International Environmental Agreements (1994) Oxford Economic Papers, 46, pp. 878-894	13
21	Louviere, J.J., Hensher, D., Swait, J.D., Adamowicz, W.L., (2000) Stated Choice Methods: Analysis and Applications, , Cambridge: Cambridge University Press	9	Miller, R.E., Blair, P.D., (1985) Input-output Analysis: Foundation and Extensions, , Prentice Hall Englewood Cliffs, NJ	33	Baland, J.-M., Platteau, J.-P., The ambiguous impact of inequality on local resource management (1999) World Development, 27, pp. 773-788	5	Dasgupta, P.S., Heal, G.M., (1979) Economic Theory and Exhaustible Resources, , Cambridge University Press Cambridge	13
22	Mishra, A., El-Osta, H., Morehart, M., Johnson, J., Hopkins, J., (2002) Income, Wealth, and the Economic Well-Being of Farm Households, 812. , Washington DC: U.S. Department of Agriculture, Economic Research Service, Agricultural Economic Report	9	Porter, M.E., Van Der Linde, C., Toward a new conception of the environment-competitiveness relationship (1995) J Econ Perspect, 9, pp. 97-118	31	Bluffstone, R., 'The effect of labor market performance on deforestation in developing countries under open access: An example from rural Nepal' (1995) Journal of Environmental Economics and Management, 29, pp. 42-63	5	Boxall, P.C., Adamowicz, W.L., 'Understanding Heterogeneous Preferences in Random Utility Models: A Latent Class Approach' (2002) Environmental and Resource Economics, 23, pp. 421-446. , 4	12
23	Nevo, A., Measuring market power in the ready-to-eat cereal industry (2001) Econometrica, 69 (2), pp. 307-342	9	Arrow, K., Bolin, B., Costanza, R., Dasgupta, P., Folke, C., Hollig, C., Jansson, B., Levin, S., Mäler, K.-G., Perrings, C., Pimentel, D., Economic Growth, Carrying Capacity and the Environment (1995) Science, 268 (28), pp. 520-521	29	Copeland, B.R., Taylor, S., Trade, growth and the environment (2004) Journal of Economic Literature, 92, pp. 7-71	5	Deshazo, J.R., Fermo, G., 'Designing Choice Sets for Stated Preference Methods: The Effects of Complexity on Choice Consistency' (2002) Journal of Environmental Economics and Management, 44, pp. 123-143	12
24	Rosen, S., Hedonic Prices and Implicit Markets: Product Differential in Perfect Competition (1974) Journal of Political Economy, 82 (1), pp. 34-55	9	Van den Bergh, J.C.J.M., Verbruggen, H., Spatial sustainability, trade and indicators: An evaluation of the ecological footprint (1999) Ecological Economics, 29, pp. 61-72	29	Dasgupta, S., Laplante, B., Wang, H., Wheeler, D., Confronting the environmental Kuznets curve (2002) Journal of Economic Perspectives, 16, pp. 147-168	5	Hahn, R.W., Market Power and Transferable Property Rights (1984) Quarterly Journal of Economics, 99, pp. 753-765	12

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Rank	AJAE Study	AJAE Σ of citations	EE Study	EE Σ of citations	EDE Study	EDE Σ of citations	ERE Study	ERE Σ of citations
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26	Singh, I., Squire, L., Strauss, J., (1986) Agricultural Household Models, , Baltimore: John Hopkins University Press	9			Hanemann, W.M., 'Welfare evaluations in contingent valuation experiments with discrete responses' (1984) American Journal of Agricultural Economics, 66, pp. 332-341	5	Jaffe, A.B., Peterson, S.R., Portney, P.R., Stavins, R.N., 'Environmental Regulation and the Competitiveness of U.S. Manufacturing: What Does the Evidence Tell Us?' (1995) Journal of Economic Literature, 33, pp. 132-163	12
27	Swait, J., Louviere, J., The Role of the Scale Parameter in the Estimation and Comparison of Multinomial Logit Models (1993) Journal of Marketing Research, 30, pp. 305-314. , (Aug.)	9			Hardin, G., 'The tragedy of the commons' (1968) Science, 162, pp. 1243-1248	5	Haab, T.C., McConnell, K.E., (2002) Valuing Environmental and Natural Resources - The Econometrics of Non-market Valuation, , Edward Elgar Publishing Limited United Kingdom	12
28	White, H., A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity (1980) Econometrica, 48 (4), pp. 817-838	9			Heltberg, R., Determinants of impact of local institutions for common resource management (2001) Environment and Development Economics, 6, pp. 183-208	5	Wooldridge, J.M., (2002) Econometric Analysis of Cross Section and Panel Data, , The MIT Press Cambridge, MA"	12
29					Jodha, N.S., Common property resources and rural poor in dry regions of India (1986) Economic and Political Weekly, 21, pp. 1169-1181	5		
30					Mendelsohn, R., Nordhaus, W., Shaw, D., 'The impact of global warming on agriculture: A Ricardian analysis' (1994) The American Economic Review, 84, pp. 753-771	5		
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35					Stokey, N.L., Are there limits to growth? (1998) International Economic Review, 39 (1), pp. 1-31	5		
36					White, H., A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity (1980) Econometrica, 48, pp. 817-838	5		
37					(1992) World Bank Development Report 1992: Development and the Environment, , World Bank , Washington, DC: World Bank	5		
38					(2005) Ecosystems and HumanWell-being: General Synthesis, , Millennium Ecosystem Assessment, Washington, DC: Island Press	5		
39					Dasgupta, P., (1993) An Inquiry into Well-Being and Destitution, , New York: Oxford University Press	5		
40					McFadden, D., Conditional logit analysis of qualitative choice behaviour (1974) Frontiers in Econometrics, pp. 105-142. , P. Zarembka (ed) New York: Academic Press	5		
41					Olson, M., (1965) The Logic of Collective Action: Public Goods and the Theory of Groups, , Cambridge, MA: Harvard University Press	5		
42					Pagiola, S., Bishop, J., Landell-Mills, N., (2002) Selling Forest Environmental Services: Market-Based Mechanisms for Conservation and Development, , London and Sterling, VA: Earthscan Publications	5		
43					Wade, R., (1988) Village Republics: Economic Conditions for Collective Action in South India, , Cambridge: Cambridge University Press"	5		

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Rank	**Study**	**Σ of citations**	**Study**	**Σ of citations**	**Study**	**Σ of citations**
1	Baumol, W.J., Oates, W.E., (1975) The Theory of Environmental Policy, , Englewoods Cliffs, NJ	17	Greene, W.H., (1990) Econometric Analysis, , Macmillan New York	36	de Soto, H., (2000) The Mystery of Capital: Why Capitalism Triumphs in the West and Fails Everywhere Else, , New York: Basic Books	17
2	Gordon, H.S., ""The Economic Theory of a Common Property Resource: The Fishery"" (1954) Journal of Political Economy, 62 (2), pp. 124-142	17	Rosen, S., ""Hedonic Prices and Implicit Markets: Product Differential in Perfect Competition"" (1974) Journal of Political Economy, 82 (1), pp. 34-55	18	Ostrom, E., (1990) Governing the Commons: The Evolution of Institutions for Collective Action, , Cambridge University Press, Cambridge	14
3	Train, K., (2003) Discrete Choice Methods and Simulation, , Cambridge University Press, Cambridge	16	Freeman III, A.M., (1993) The Measurement of Environmental and Resource Values, , Washington, D.C.: Resources for the Future	13	Greene, W.H., (1990) Econometric Analysis, , Macmillan New York	14
4	Copeland, B.R., Taylor, M.S., Trade and transboundary pollution (1995) Amer. Econ. Rev., 85, pp. 716-737	15	Maddala, G., (1983) Limited Dependent and Qualitative Variables in Econometrics, pp. 67-70. , Econometric Society Monograph No. 3. Cambridge: Cambridge University Press	11	Lin, G.S.L., Ho, S.P.S., China's land resources and land-use change: insights from the 1996 land survey (2003) Land Use Policy, 20, pp. 87-107	12
5	Clark, C.W., (1990) Mathematical Bioeconomics: The Optimal Management of Renewable Resources, , Wiley-Interscience	14	Train, K.E., (2003) Discrete Choice Methods with Simulation, , Cambridge, U.K, Cambridge University Press	11	Lambin, E.F., Turner II, B.L., Geist, H., Agbola, S., Angelsen, A., Bruce, J., Coomes, O., Xu, J., The causes of land-use and land-cover change-moving beyond the myths (2001) Global Environ. Change, 11, pp. 2-13	11
6	Greene, W.H., (1990) Econometric Analysis, , Macmillan New York	14	Anselin, L., (1988) Spatial Econometrics: Methods and Models, , Dordrecht, The Netherlands: Kluwer Academic Publishers, Inc	9	Lambin, E.F., Geist, H.J., Lepers, E., Dynamics of land-use and land-cover change in tropical regions (2003) Annual Review of Environment and Resources, 28, pp. 205-241	11
7	Krinsky, I., Robb, A.L., On approximating the statistical properties of elasticities (1986) Review of Economics and Statistics, 68, pp. 715-719	11	Arrow, K., Solow, R., Leamer, E., Portney, P., Radner, R., Schuman, H., ""Report of the NOAA Panel on Contingent Valuation"" (1993) Federal Register, 58, pp. 4601-4614	9	Hardin, G., The tragedy of the commons (1968) Science, 162, pp. 1243-1248	11
8	Sanchirico, J.N., Wilen, J.E., ""Bioeconomics of Spatial Exploitation in a Patchy Environment"" (1999) Journal of Environmental Economics and Management, 37, pp. 129-150	11	Krinsky, I., Robb, A.L., On approximating the statistical properties of elasticities (1986) Review of Economics and Statistics, 68, pp. 715-719	9	Boserup, E., (1965) The Conditions of Agricultural Growth. The Economics of Agrarian Change under Population Pressure, , George Allen & Unwin Limited, London	11
9	Smith, M.D., Wilen, J.E., Economic impacts of marine reserves: The importance of spatial behavior (2003) J Environ Econ Management, 46, pp. 183-206. , 2	11	Geoghegan, J., Wainger, L., Bockstael, N., Spatial landscape indices in a hedonic framework: an ecological economics analysis using G.I.S. (1997) Ecological Economics, 23, pp. 251-264	8	(2005) Ecosystems and Human Well-Being: Synthesis, , Millennium Ecosystem Assessment (MA) Washington, DC: Island Press	11
10	Copeland, B.R., Taylor, M.S., (2003) Trade and the Environment: Theory and Evidence, , Princeton University Press Princeton, NJ	10	Haab, T.C., McConnell, K.E., (2002) Valuing Environmental and Natural Resources the Econometrics of Non-market Valuation, , Edward Elgar Cheltenham	8	Yang, H., Li, L., Cultivated land and food supply in China (2000) Land Use Policy, 17, pp. 73-88	10
11	Montgomery, D., ""Markets in Licenses and Efficient Pollution Control Programs"" (1972) Journal of Economic Theory, 5 (3), pp. 395-418	10	Louviere, J.J., Hensher, D., Swait, J.D., Adamowicz, W.L., (2000) Stated Choice Methods: Analysis and Applications, , Cambridge: Cambridge University Press	8	Feder, G., Nisho, A., The Benefits of Land Registration and Titling: Economic and Social Perspectives (1999) Land Use Policy, 15 (1), pp. 25-43	10

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Rank	**Study**	**Σ of citations**	**Study**	**Σ of citations**	**Study**	**Σ of citations**
12	Porter, M.E., Van Der Linde, C., Toward a new conception of the environment-competitiveness relationship (1995) J Econ Perspect, 9, pp. 97-118	10	McFadden, D., Conditional logit analysis of qualitative choice behavior (1973) Frontiers in Econometrics, , P. Zarembka Ed, Academic Press, New York, NY	8	Yin, R.K., Case study research: Design and methods (2003) Applied Social Research Methods Series, 5. , Sage, XVI, Thousand Oaks, CA	9
13	Weitzman, M.L., Prices vs. quantities (1974) Review of Economic Studies, 41 (4), pp. 477-491	10	Wooldridge, J., (2002) Econometric Analysis of Cross Section and Panel Data, , Cambridge, Mass, MIT Press	8	Tiffen, M., Mortimore, M., Gichuki, F., (1994) More People, Less Erosion: Environmental Recovery in Kenya, , J. Wiley, Chichester, New York	9
14	Antweiler, W., Copeland, B.R., Taylor, M.S., ""Is Free Trade Good for the Environment?"" (2001) American Economic Review, 91 (4), pp. 877-908	9	Bin, O., Polansky, S., Effects of Flood Hazards on Property Values: Evidence before and after Hurricane Floyd (2004) Land Economics, 80 (4), pp. 490-500	7	Rosen, S., ""Hedonic Prices and Implicit Markets: Product Differential in Perfect Competition"" (1974) Journal of Political Economy, 82 (1), pp. 34-55	9
15	Barrett, S., Self-enforcing international environmental agreements (1994) Oxford Economic Papers, 46, pp. 878-894	9	Boxall, C.P., Adamowicz, W., Swait, J., Williams, M., Louviere, J., A comparison of stated preferences methods for environmental valuation (1996) Ecological Economics, 18, pp. 243-253	7	North, D., (1990) Institutions, Institutional Change and Economic Performance, , Cambridge University Press, Cambridge	9
16	Hotelling, H., The Economics of Exhaustible Resources (1931) Journal of Political Economy, 39 (2), pp. 137-175	9	DeShazo, J.R., Fermo, G., ""Designing Choice Sets for Stated Preference Methods: The Effects of Complexity on Choice Consistency"" (2002) Journal of Environmental Economics and Management, 44, pp. 123-143	7	Geoghegan, J., The value of open spaces in residential land use (2002) Land Use Policy, 19 (1), pp. 91-98	9
17	McFadden, D., Conditional logit analysis of qualitative choice behavior (1973) Frontiers in Econometrics, , P. Zarembka Ed, Academic Press, New York, NY	9	Hanemann, W.M., ""Welfare Evaluations in Contingent Valuation Experiments with Discrete Responses"" (1984) American Journal of Agricultural Economics, 66 (3), pp. 332-341	7	Ding, C., Land policy reform in China: assessment and prospects (2003) Land Use Policy, 20 (2), pp. 109-120	9
18	Arora, S., Gangopadhyay, S., Toward a theoretical model of voluntary overcompliance (1995) Journal of Economic Behavior & Organization, 28, pp. 289-309	8	Holmes, T.P., Adamowicz, V.L., Attribute based methods (2002) A Primer on Non-marketValuation, , K.J. Boyle and P.A. Champ (eds) Boston:Kluwer Academic Publishers, Chapter 6	7	Bromley, D.W., (1991) Environment and Economy: Property Rights and Public Policy, , Cambridge, MA: Basil Blackwell	9
19	Cameron, T.A., Combining contingent valuation and travel cost data for the valuation of nonmarket goods (1992) Land Economics, 68 (3), pp. 302-317	8	Mitchell, R., Carson, R.T., (1989) Using Surveys to Value Public Goods: The Contingent Valuation Method, , Resources for the Future Washington, DC	7	McGregor, D.F.M., Simon, D., Thompson, D.A. (Eds.), 2006. The Peri-Urban Interface, Approaches to Sustainable Natural and Human Resource Use. Earthscan, London.	8
19	Hahn, R.W., Market power and transferable property rights (1984) The Quarterly Journal of Economics, 99 (4), pp. 753-765	8	Train, K.E., Recreation demand models with taste differences over people (1998) Land Econ., 74 (2), pp. 230-239	7	Mather, A.S., The forest transition (1992) Area, 24 (4), pp. 367-379	8
20	Train, K.E., Recreation demand models with taste differences over people (1998) Land Econ., 74 (2), pp. 230-239	8	Bateman, I.J., Carson, R.T., Day, B., Hanemann, W.M., Hanley, N., Hett, T., Jones-Lee, M., Swanson, J., (2002) Economic Valuation with Stated Preference Techniques: A Manual, , Edward Elgar Cheltenham, UK	7	Foley, J.A., DeFries, R., Aner, G.P.M., Barford, C., Bonan, G., Carpenter, S.R., Chapin, F.S., Snyder, P.K., Global consequences of land use (2005) Science, 309, pp. 570-573	8

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Rank	**Study**	**Σ of citations**	**Study**	**Σ of citations**	**Study**	**Σ of citations**
21	Adamowicz, W.L.,Louviere, J., Williams, M., Combining revealed and stated preference methods for valuing environmental amenities (1994) J Environ Econ Manage, 26, pp. 271-292	7	Acharya, G., Barbier, E.B., Valuing groundwater recharge through agricultural production in the Hadejia-Nguru Wetlands in Northern Nigeria (2000) Agricultural Economics, 22, pp. 247-259	6	Verburg, P.H., Soepboer, W., Limpiada, R., Espaldon, M.V.O., Sharifa, M., Veldkamp, A., Land use change modelling at the regional scale: the CLUE-S model (2002) Environmental Management, 30 (3), pp. 391-405	7
22	Arrow, K., Solow, R., Leamer, E., Portney, P., Radner, R., Schuman, H., ""Report of the NOAA Panel on Contingent Valuation"" (1993) Federal Register, 58, pp. 4601-4614	7	Adamowicz, W.L.,Boxall, P., Williams, M., Louviere, J., ""Stated Preference Approaches for Measuring Passive Use Values: Choice Experiments and Contingent Valuation"" (1998) American Journal of Agricultural Economics, 80 (1), pp. 64-75	6	Renn, O., Participatory processes for designing environmental policies (2006) Land Use Policy, 23 (1), pp. 34-43	7
23	Barro, R.J., Sala-I-Martin, X., (1995) Economic Growth, , New York: McGraw-Hill	7	Ben-Akiva, M., Lehrman, S.R., (1985) Discrete Choice Analysis: Theory and Application to Travel Demand, , MIT Press, Cambridge, M.A	6	Platteau, J.-P., The evolutionary theory of land rights as applied to sub-Saharan Africa: a critical assessment (1996) Development and Change, 27 (1), pp. 29-86	7
24	Cameron, T.A., Quiggin, J., ""Estimation Using Contingent Valuation Data from a 'Dichotomous Choice with Follow-Up' Questionnaire"" (1994) Journal of Environmental Economics and Management, 27 (3), pp. 218-234	7	Champ, P., Bishop, R., Donation payment mechanisms and contingent valuation: an empirical survey of hypothetical bias (2001) Environmental and Resource Economics, 19 (4), pp. 383-402	6	Morris, C., Potter, C., Recruiting the new conservationists: farmers' adoption of agri-environmental schemes in the U.K. (1995) Journal of Rural Studies, 11-1, pp. 51-63	7
25	Carraro, C., Siniscalco, D., Strategies for the International Protection of the Environment (1993) Journal of Public Economics, 52 (3), pp. 309-328	7	Cooper, J.C., Osborn, C.T., The effect of rental rates on the extension of conservation reserve program contracts (1998) American Journal of Agricultural Economics, 80, pp. 184-194	6	Mather, A.S., Recent Asian forest transitions in relation to forest-transition theory (2007) International Forestry Review, 9 (1), pp. 491-502	7
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