

Disseminating Research with Web CV Hyperlinks¹

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Some academic web CVs, including homepages and publication lists, link to open access (OA) papers, resources, abstracts in publishers' websites, or academic discussions, helping to disseminate research. To assess how common such practices are and whether they vary by discipline, gender and country, we conducted a large scale email survey of astronomy and astrophysics, public health, environmental engineering, and philosophy across 15 European countries and analysed hyperlinks from academic web CVs. About 60% of the 2,154 survey responses reported having a web CV or similar and there were differences between disciplines, genders and countries. A follow-up outlink analysis of 2,700 web CVs found that a third had at least one outlink to an OA target, typically a public eprint archive or an individual self-archived file. This proportion was considerably higher in astronomy (48%) and philosophy (37%) than in environmental engineering (29%) and public health (21%). There were also differences in linking to publishers' websites, resources and discussions. Perhaps most importantly, however, the amount of linking to OA publications seems to be much lower than allowed by publishers and journals, suggesting that many opportunities for disseminating full-text research online are being missed, especially in disciplines without established repositories. Moreover, few academics seem to be exploiting their CVs to link to discussions, resources or article abstracts, which seems to be another missed opportunity for research publicity.

Introduction

Although scholars are often publically funded, the public and other researchers may have to pay to access their results and may find it difficult to discover basic information about publications, related resources, and relevant discussions. This may undermine the value of research by reducing its audience (Harnad, 2006) and can lead to the accidental duplication of research (<http://cordis.europa.eu/tvp/src/quicksc.htm>, European Commission). Open Access (OA) has thus been recognised as a key issue in the major Horizon 2020 funding programme (European Commission, 2012ab). Publishing in OA journals (gold OA) and self-archiving (green OA) are two different strategies to give free access to research. About 17% of Scopus indexed articles in 2011 were gold OA (12% full immediate OA and 5% delayed OA and hybrid OA) and gold OA journals grew 1% per year over the previous decade (Laakso & Björk, 2012). Moreover, most journals (about 90%) and many publishers (about 62%) seem to let authors deposit article preprints or postprints online through personal homepages or institutional repositories (see, Harnad et al., 2008; SHERPA/RoMEO, 2013). Nevertheless, only 20%-24% of articles are being self-archived by authors (Björk et al., 2010; Gargouri et al., 2012b) and a large-scale survey across the EU found that most authors were unlikely to voluntarily self-archive (Creaser et al., 2010), so there is a large gap between the amount of self-archiving that it permitted and the amount that occurs.

In response, the European Commission has initiated an OA pilot to mandate research funded by the EU to be freely available (European Commission, 2012c), this covers only a

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fraction of EU research. It is possible that future, stronger OA mandates may increase OA deposit rates, however (see Sale, 2006; Gargouri et al., 2012a).

This article focuses on one method of disseminating or publicising research: hyperlinks from web CVs. We took a large sample of European academics from four disciplines and assessed the extent of OA-linking CVs and the nature of the use of online CVs to publicise research. This does not reveal the full extent of OA use by scholars because articles may be published in OA journals or deposited in institutional or subject archives without CV hyperlinks, especially in astronomy and astrophysics. For example, an author may believe that peers will naturally search Google Scholar or a relevant subject repository and so web CV hyperlinks are superfluous. Nevertheless, links from CVs may at least give an additional access point, for example for those browsing the CVs of known experts. Perhaps because of this, multiple access points to OA research may increase citation impact (Xia, Myers & Wilhoite, 2011). This article also investigates other ways of using web CVs to publicise research. Scholarly web CVs can direct readers to abstracts of articles and books in publishers' websites or research discussions and presentations in blogs, online videos and other social media tools (Shema, Bar-Ilan & Thelwall, 2012; Sugimoto & Thelwall, 2013). However, the extent to which individual academics use web CVs to help disseminate their research is unknown and this is a serious omission, given the apparently widespread use of online CVs by academics.

Background

CVs in scientometric research

Academic CVs can complement bibliometric databases and surveys because they may include multiple publication types (e.g., books, technical reports, preprints) and information about grants, awards, jobs, teaching and qualifications that may help science policy and research evaluation studies (Cañibano & Bozeman, 2009). Dietz, Chompalov, Bozeman, Lane and Park (2000) conducted an early scientometric study on academic careers and the productivity of scientists and engineers based on coding CVs from *U.S. Department of Energy (DOE)* and *National Science Foundation (NSF)* funded projects, finding a relationship between age, subject areas, and early publication productivity and overall publication output. CVs have since been used for investigations of researcher mobility (e.g., Woolley & Turpin 2009; Cañibano, Otamendi & Solís, 2011), career impact (e.g., Gaughan, 2009; Cox et al., 2011), maps of scientific fields (Lepori & Probst, 2009), gender differences (Leahey, 2006) and grant peer-review (e.g., Cañibano, Otamendi, & Andújar, 2009). Other studies have used CVs with traditional bibliometric data for research evaluations (e.g., Lee & Bozeman, 2005; Sabatier, Carrere & Mangematin, 2006; Sandström, 2009).

Although several projects have collected and standardised CVs, such as Europass (<http://europass.cedefop.europa.eu>, see also EURO-CV, 2008), academics may not have an online CV, may infrequently update it or may only embed partial information about their academic activities. This issue may diminish, however since there has been a call for mandating online academic CVs with links to full-text publications (preprints/postprints) at the institutional level to be used by promotion committees and research funders (Hitchcock et al., 2003) and the same online standardised CVs have been proposed as a rich and cheap data source for the UK Research Assessment Exercise (RAE) (Harnad, Carr, Brody & Oppenheim, 2003; Swan et al., 2005). A significant drawback for the practical use of online CVs in scientometrics, however, is that manually locating them may be difficult and time-consuming and automatic capturing online

CVs by crawlers may not be possible without extensive manual data cleaning. Nevertheless, one advantage of online CVs is that they can potentially be used for webometric studies and in particular for link analyses of their contents.

OA and self-archiving

Many organisations have launched their own OA repositories (see <http://maps.repository66.org>) and the European Commission has initiated OpenAIRE (<http://www.openaire.eu>) to promote OA repositories in Europe. In partial support, a small Danish survey found that respondents used OA journal archives or subject repositories at least monthly (Houghton, Swan & Brown, 2011). To give evidence for the value of OA repositories, many studies have assessed the citation advantage of OA publications against non-OA counterparts (e.g., Harter, 1996; Lawrence, 2001; Antelman, 2004; Harnad & Brody, 2004; Kurtz, 2004; Norris, Oppenheim, & Rowland, 2008). The findings suggest that OA publications tend to attract more citations than non-OA publications, although a debate still exists. The citation benefit of OA research was greater for highly cited papers and found to be independent of other correlates of citation impact such as article age, journal impact factor, and number of co-authors. A recent study with a large sample of OA articles from 2002-2006 that were self-archived voluntarily or mandatorily (e.g., required by the employing institution) revealed that there was no citation advantage difference between non-mandated and mandated OA articles (Gargouri et al., 2010).

Most authors appear to be willing to self-archive their published research if their institutions or funders ask them to (see below: Swan & Brown 2005). Moreover, a study found that self-archiving was allowed by 90% of 10,000 journals tested (Harnad et al., 2008; see also Coleman, 2007) and of the 1,256 publishers in the SHERPA/RoMEO database, 62% (771) allow postprint self-archiving of the refereed final draft of articles and 8% allow only pre-refereeing archiving (preprints) (SHERPA/RoMEO, 2013). Nevertheless, a survey of 684 faculty members from 17 American doctorate-granting universities about self-archiving in institutional repositories showed that only 40% knew about such a platform (Kim, 2010). Within the same research population there were several negative (e.g., age, copyright concerns, time and effort) and positive (e.g., academic reward, altruism, self-archiving culture, and technical skills) factors that could influence self-archiving (Kim, 2011).

More recent investigations indicate a small but continuing proportional growth in OA publications. An investigation of over 1,800 peer reviewed journals in 2008 indicated that about 8.5% of articles were freely available online at the publishers' sites (gold OA) and an additional 12% could be found online by search engines (green OA), making the overall OA percentage about 20% (Björk et al., 2010). A more recent study estimated that the proportion of gold OA journals (including delayed and hybrid OA) had increased from about 13.7% in 2008 to about 17% in 2011 (Laakso & Björk, 2012). Gargouri et al. (2012b) estimated the percentage growth for both green and gold OA across 14 subject areas based on a sample of 1,300 journal articles per year and per subject articles published during 2005-2010. The overall OA percentage was about 24% (21.4% green OA and 2.4% Gold OA) and so universal mandatory self-archiving could "almost immediately triple the baseline Green OA self-archiving rate" (Gargouri et al., 2012b, p. 292).

Academics have also been asked about self-archiving. Just under half of 1,296 authors across different subject areas and countries reported self-archiving at least one publication during the last three years through personal CVs or homepages (27%), departmental websites (20%) or subject-specific repositories (12%) (Swan & Brown, 2005). A majority would self-archive their

published research if employers or funders requested or mandated it (81% and 14% willingly and reluctantly, respectively) and only 5% would not accept OA mandates even if their employers or funders asked them to (Swan & Brown 2005). Similarly, almost half (42%) of the 811 respondents to a survey of EU project coordinators in an OA pilot found it easy to self-archive peer-reviewed articles (European Commission, 2012c). Nevertheless, self-reporting methods, such as surveys, may tend to give optimistic information. Moreover, a recent large-scale survey of 3,139 scholars across Europe showed that only 6% associated the OA model with self-archiving (Creaser et al., 2010, p. 152).

Web outlink analyses

Most webometric link analyses have used inlinks (links pointing to the website or web page analysed) and assessed the similarity between link metrics and offline scholarly-related metrics, such as journal Impact Factors (Vaughan & Hysen, 2002) or university rankings (Thelwall, & Harries, 2004). There have also been many investigations into interlinking between universities or departments and motivations for creating links and web citations (Bar-Ilan, 2005; Wilkinson, Harries, Thelwall, & Price, 2003). Outlinks (links from a website or web page investigated) have been rarely investigated, perhaps because of the early webometric focus on impact studies and hence inlinks (Ingwersen, 1998). Nevertheless, outlinks can also be useful to investigate how people attempt to share resources irrespective of any impact these attempts may have had.

Ajiferuke and Wolfram (2004) found a significant difference between the mean ranks of outlinks from web pages from five selected domains (.edu, .com, .gov, .net, .org). Vaughan and Wu (2004) found significant positive correlations between both inlinks and outlinks and business measures (e.g., gross revenue, profit, R&D expenditure) for commercial websites. García-Santiago and Moya Anegón (2009) argued that web co-outlink analysis can help to explore relationships and to map triple helix structures (university–industry–government). Holmberg (2009) similarly concluded that co-outlinking can reveal shared interests and cooperation between organisations.

Two previous investigations of self-archiving practices have used web CVs and outlinks. Covey (2009) manually coded 771 publication lists from Carnegie Mellon University and found that that 45% of the faculty with publication lists self-archived at least one journal article. About 41% and 59% of the OA articles were the authors' own self-archived manuscripts and publishers' PDF versions, respectively, and there were clear disciplinary differences. Perhaps surprisingly, the departments of philosophy (61%) and psychology (62%) had the highest percentages of links to OA articles (Covey, 2009). On a larger scale, Más-Bleda, Thelwall, Kousha and Aguillo (in press) studied outlinks created by European highly cited scientists from 892 online homepages or personal websites to a range of pre-selected web sources and file types. Almost half (46%) had at least one outlink to the selected websites, which were OA repositories, scholarly databases, social sites and publishers' websites. This investigation used 22 OA repositories, 38 journal publishers' websites and 4 book databases but no document sharing sites, online reference managers or social media tools. It focused on highly cited and productive researchers, mostly in the hard sciences and biomedical fields. These people are particularly important for science, but findings about their CVs are unlikely to also apply to typical researchers.

Research questions

This study assesses the extent to which scholars have OA-linking web CVs, personal home pages or publication lists (collectively described as web CVs for convenience from now on). For

practical reasons, the scope of the study is limited to four subjects, chosen to cover science, engineering, social science and the humanities: *astronomy & astrophysics, public environmental & occupational health, environmental engineering, and philosophy* (including history and philosophy of science). Similarly, the scope is limited to 15 European countries, *Bulgaria, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Israel, Italy, the Netherlands, Poland, Slovenia, Spain, and the United Kingdom*. The following research questions drive the investigation.

1. What proportion of EU researchers has a web CV (including publication lists and homepages) and does this vary by gender and status?
2. What proportion of EU researchers has a web CV linking to OA publications?
3. What proportion of EU researchers has a web CV linking to: publishers' websites; blogs and social network sites; multimedia resources?
4. Are the answers to the above questions influenced by country and academic subject?

Methods and procedures

For the first research question a large sample of academics in the chosen countries and subjects was needed. There is no definitive register of CVs or URLs for European researchers although there are some partial lists and some countries have comprehensive current research information systems. Hence we conducted a large-scale email survey, requesting URLs of web CVs and publication lists. This list was then supplemented with additional Google searches to be used for the second research question. A differences in proportions test with a Bonferroni correction (to reduce the risk of false positives from multiple tests) was used to check for differences between the percentage of people having CVs or the percentage of CVs having a type of hyperlink between countries, genders, statuses and disciplines. Country differences were only tested for between Eastern and Western Europe, unless stated, to avoid using too severe Bonferroni corrections for large numbers of comparisons.

Email survey

For the survey, we extracted a list of email addresses from published research papers indexed in the Thomson Reuters Web of Science (WoS) during 2005-2011 in the four chosen subjects. The email addresses were limited to the national domains of the 15 chosen EU countries as a practical step (e.g., uk, de). Due to the low WoS coverage of philosophy we exacted extra emails from publications indexed by Scopus and also included emails ending with non-national domains, such as com (e.g., gmail.com, yahoo.com, hotmail.com), org, and net, and verified the national locations of the authors from Scopus.

A questionnaire was devised to ask academics whether they had an online CV, personal webpage, publication list or other site for academic purposes and also requested department, gender and academic post information (<http://cybermetrics.wlv.ac.uk/survey-acumen.html>). In each discipline we took a random sample of authors proportional to the total number of email addresses extracted for each country. The survey response rate ranged from 11.4% in philosophy to 6.6% in environmental engineering.

The 2,154 survey respondents were 71.7% (1,545) male and 27.7% (596) female, with 13 (0.6%) giving no gender. For status, 21.4% (460) were full professors, 31.8% (686) were associate professors/readers/senior lecturers, 15.1% (325) were assistant professors/lecturers, 14.3% (308) were postdoctoral research fellows, 6.5% (141) were students (e.g., PhD or masters) and 10.9% (234) held other positions. In astronomy and astrophysics, environmental engineering

and philosophy 74%-80% of the respondents were male. However, about 45% of the public health respondents were female, probably reflecting greater female participation in this field.

Web CV sample

To increase the sample size for web CVs from the email survey for the outlink analysis component (research question 2) we collected extra URLs through nation-specific Google searches (e.g., CV OR resume OR "curriculum vitae" OR "publication list" Astrophysics site:hu), randomly selecting and manually checking web CVs and publication lists from the results (Table 1 – see also the extended version, Appendix A, Table 4). This sample is likely to be biased. For example, it excludes researchers without a web presence or with a web presence that is difficult to find with Google and disproportionately includes authors that respond to email surveys.

Table 1. Sources of Web CV URLs (including homepages and publication lists).

Discipline	Email invites	Total responses	Response rate	URLs from the survey	URLs from Google*	Total URLs
Astronomy	6,635	528 (24.5%)	7.96%	271	386	657
Pub. Health	7,277	534 (25.8%)	7.34%	213	407	620
Environ. Eng.	8,686	573 (26.6%)	6.60%	284	330	614
Philosophy	4,591	519 (24.1%)	11.41%	342	467	809
Total	27,189	2,154 (100%)	7.92%	1,110	1,590	2,700

*This extra sample of URLs from Google searches was used only for the outlink analysis

Web CV outlink analysis

The *SocSciBot* web crawler (socscibot.wlv.ac.uk) and *Webometric Analyst* (lexiurl.wlv.ac.uk) were used to automatically extract and analyse outlinks from the 2,700 academics' web CVs. We classified the targets of outlinks from web CVs into four broad categories and several sub-categories. This primarily reflects OA publishing but also includes other common targets: publishers' websites, social network sites, and scholarly-related multimedia. For a list of the URLs and file types used for this see <http://cybermetrics.wlv.ac.uk/paperdata/WebResearchDisseminationEUCVs.xlsx>.

OA publications

A web CV was counted as having an outlink to an OA publication if it had at least one link in any of the four types below (multiple links were ignored, even if of different types). Document file types are included in this class since a previous study showed that about 70% of OA documents in four science and four social science disciplines citing research papers were in non-HTML document format (PDF and DOC) (Kousha, 2009) and any non-HTML document format seems to be a good indicator of likely full text access.

- *Major OA repository*: 26 sites, including *ArXiv.org* in astronomy and astrophysics and *philpapers.org* in philosophy.
- *National and institutional OA repositories and digital libraries*: 765 sites from the 15 European countries in the study from <http://opendoar.org/>. Of these, 137 (18%) had

mandates in the Registry of Open Access Repositories Mandatory Archiving Policies (ROARMAP, <http://roarmap.eprints.org>).

- *Document sharing sites*: 7 sites, including *DropBox.com* and *SlideShare.net*.
- *Document file types*: word processed documents commonly used for preprints/postprints and other scholarly activities (e.g., file extensions doc, docx, rtf, dotx), presentations (e.g., ppt, pptx, key) and spreadsheet and statistical files (e.g., xls, xlsx, por, sav), which might be resources used in papers.

Publishers' websites (including DOI URLs)

A web CV was counted as having an outlink to a publisher's website if it had at least one link in any of the categories below. These are probably not OA outlinks and so are classified separately to record another way of publicising research. Presumably in some cases the publisher prohibits OA archiving (e.g., by about 30% of publishers, see SHERPA/RoMEO, 2013), but in other cases the researcher may choose not to self-archive, even if it is allowed by the publisher, or the article may be OA in a publisher's website. Similarly, some books might have full text or previews available, or visitors might buy them.

- *Major academic publishers (mostly for journals)*: 45 sites, such as *Science Direct*, *Springer*, and *Oxford Journals*. URLs were used for locations where abstracts of articles appear in the publishers' websites such as "journals.cambridge.org" instead of ".cambridge.org" to avoid counting irrelevant outlinks, when possible.
- *Major book publishers, online bookshops and book databases*: 30 sites (e.g., *Amazon.com*, *Google Books*, and *Cambridge*). Specific URLs were used for book sections of publishers' websites, when possible.
- *Digital Object Identifiers (DOIs)*: DOI-based hyperlinks in academic CVs typically redirect to major publishers' websites.

Blogs and social network sites

Blog posts, online reference managers and general or professional social network sites may also be used to publicise research (Li, Thelwall & Giustini, 2012; Shema, Bar-Ilan & Thelwall, 2012). Although most social network sites are not designed for research, a link to them in an academic CV might suggest that the academic considers them to be relevant to their research in some way, such as for networking.

- *Major blogs*: 50 in different languages based on the *Alexa.com* top global sites list and directories of blogs. This includes popular general blogging sites, such as *Blogspot.com*, and blog sites in science and philosophy such as *ScienceBlogs.com* and *Philosophyetc.net*.
- *Online reference managers*: 13 sites, including *Mendeley.com*, that allow academics to share bibliographic information.
- *Professional social network sites*: 5 sites, such as *LinkedIn.com* and *Academia.edu*, for academic or professional audiences.
- *General social network sites*: 20 sites, including *Facebook.com* and popular European social network sites, such as *vk.com*.

Multimedia

Online videos are used for research communication (Kousha, Thelwall & Abdoli, 2012; Sugimoto, & Thelwall, 2013), as are images (e.g., in visual arts and astronomy) and recorded speeches and lectures (e.g., audio files).

- *Video sharing sites*: 16 general sites, such as *YouTube*, and scholarly-related sites, such as *TedTalks.com*, *PhilosophyTalk.org* and *ScienceStage.com*.
- *Image sharing sites*: 14 general sites, such as *Flickr.com*, and scientific sites, such as *NASA Images*.
- *Video, audio and image file formats*: 20 multimedia file extensions for video (e.g., mp4), audio (e.g., mov) and images (e.g., jpeg).

Results

Web CVs: About 61% (1,309) of the survey respondents reported having an academic web CV (including homepages and publication lists). Most (53%) with CVs were full professors or associate professors/readers/senior lecturers. Perhaps surprisingly, philosophers reported having a Web CV the most often (Figure 1). A differences in proportions test between all pairs of disciplines found that all proportions were significantly different ($p < 0.001$ in all cases, with a Bonferroni correction for $n=6$ tests), except for astronomy & astrophysics (58.7%) and environmental engineering (60.3%).

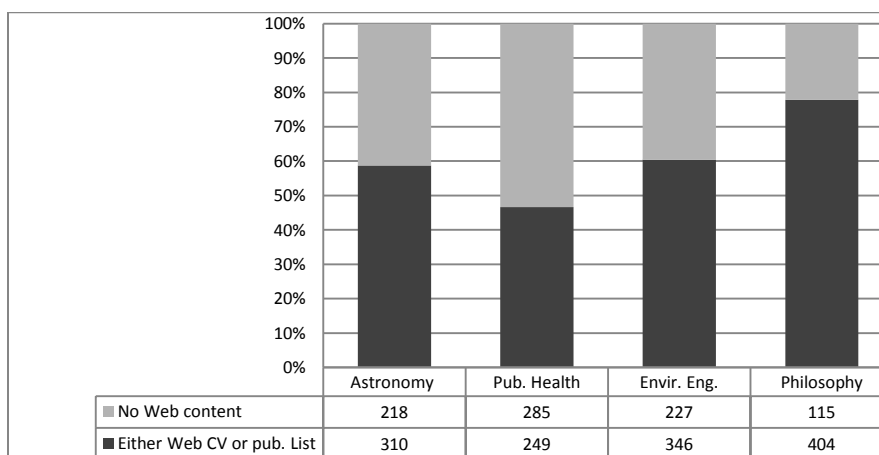


Figure 1. Email survey respondents ($n=2,154$) with web CVs by field.

A higher proportion of males (65%) reported having a Web CV than did females (49%) overall ($p < 0.001$) and in each of the four disciplines (not always statistically significant). Full professors were more likely to have a web CV than any other group in the survey (69%) but students (41%) and postdocs (51%) were the least likely (all differences significant $p < 0.001$). There were similar differences in all subject areas except that the proportion of full professors with web CVs was similar to that of associate professors in both philosophy and environmental engineering. Web CV proportions were almost the same in Western Europe (60.6%) and Eastern Europe (61.7%), although individual countries varied (e.g., UK 71% vs. Spain 45%).

Outlinks from Web CVs: A third (34% or 920 of 2,700) of the web CVs had at least one outlink to an OA publication (Figure 2). Astronomy and astrophysics (48%) and philosophy (37%) had the most OA outlinks, whereas environmental engineering (29%) and public health (21%) had

the least. All proportions were significantly different from each other ($p < 0.001$). The main differences are unsurprising because OA publishing has become the norm in astronomy and astrophysics and is common in philosophy, but not in public health and environmental engineering.

A much lower proportion of web CVs linked to the other three types of targets. In philosophy about 22% of the web CVs and in three other science disciplines about 16% had at least one outlink to a publisher's website. The philosophy percentage was significantly different from both public health and environmental engineering ($p < 0.05$). In philosophy the proportion of academics with at least one outlink to a social media site (about 24%) was nearly twice as much as in the three science fields and the difference was statistically significant ($p < 0.001$, but see the limitations below). This may reflect the importance of interactions and discussions in philosophy. Multimedia outlinks were significantly rarer in public health than in the other three fields ($p < 0.01$) and most common in environmental engineering (difference only statistically significant with public health, $p < 0.05$).

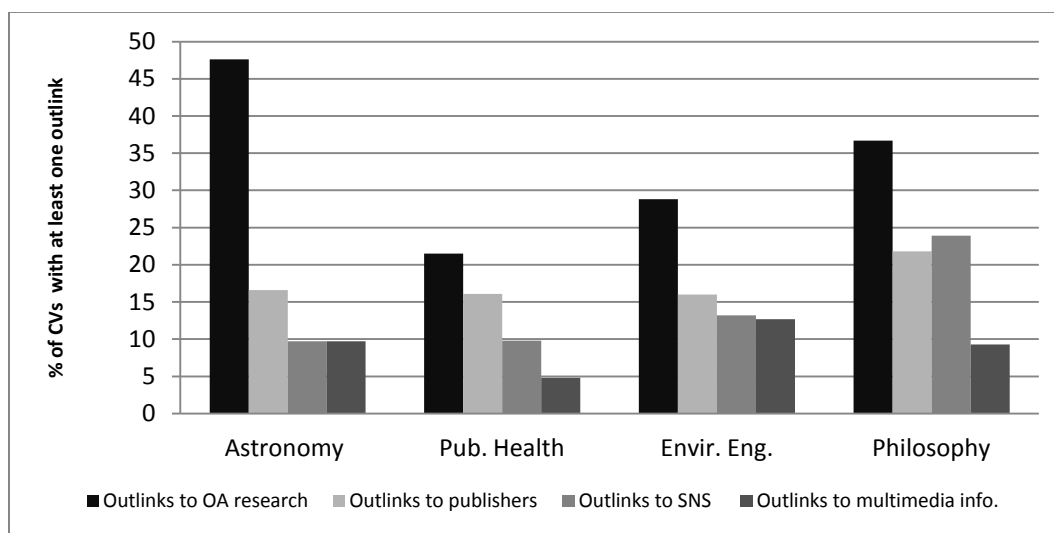


Figure 2. Common outlink targets of EU web CVs across subject areas.

More web CVs in Western EU countries had outlinks than those in Eastern countries in all categories (see also Appendix A, Table 5): OA research (39% vs. 24%), publishers (23% vs. 9%), SNS (18% vs. 9%) and multimedia files (10% vs. 7%) ($p < 0.01$ or lower in all cases).

Discussion

Major OA archives: In terms of links from web CVs, OA archives are particularly important in astronomy and astrophysics (ArXiv, SAO/NASA Astrophysics Data System (ADS)) but almost irrelevant in environmental engineering (Table 2). Nevertheless, given that ArXiv and ADS seem to be almost universally used in astronomy and astrophysics (see also Nicholas et al., 2012), it is perhaps surprising that under half of the academic CVs in astrophysics had at least one OA outlink.

Broadly confirming this, a manual check of a random sample of 100 astronomy and astrophysics CVs found that 56% had at least one OA link (e.g., ArXiv, ADS, PDF or Doc files), whereas 38% had no hyperlinks and 6% were not accessible. Of CVs without hyperlinks, 7% were in PDF format. Presumably many of the owners of HTML CVs without OA hyperlinks had

articles in subject specific repositories (see Björk, Laakso, Welling & Paetau, in press; Cullen & Chawner, 2011), but did not link to them from their CVs because they couldn't or considered depositing in ArXiv or ADS to be sufficient.

In public health the majority of outlinks were to the *US National Library of Medicine databases (NLM)* and *BiomedCentral.com* (an online publisher of free peer-reviewed scientific articles). In philosophy and history and philosophy of science the dominant targets of outlinks were *Philpapers.org*, *ArXiv*, and *PhilSci-Archive*.

National and institutional archives: National and institutional archives had comparable uptake to the major archives in all disciplines except astronomy and astrophysics. In contrast to the three other disciplines, environmental engineering had a higher proportion of online CVs linking to national or institutional eprints archives (7%) than to major OA repositories (1%), however, presumably because no major archive serves this community. There was a relatively small difference between CVs with at least one outlink to mandated (18%) and non-mandated (16%) OA repositories (excluding the major OA archives) (see also Appendix A, Table 5).

Publishers' websites and academic databases: Table 2 reports the proportion of CVs with at least one outlink to a journal or book publisher website. In philosophy about 20% and 7% of the CVs had at least one outlink to the websites of journal publishers (including DOI links) and book publishers (including online bookshops), respectively, whereas in the three science fields this proportion was lower for journal publishers' websites (about 16%) and much smaller for book publishers' websites (0.7%-1.4%). In philosophy *Springer* (9%), *Wiley* (4%) and *Amazon.com* (4%), in astronomy and astrophysics the *Institute of Physics* (4%), in public health *Oxford University Press* and *Wiley* (both 3%) and in environmental engineering *Elsevier* (4%) and *Springer* (3%) were the most linked-to publishers. DOI outlinks occurred in about 4% of CVs in philosophy, astronomy and public health but about 8.5% in environmental engineering.

Blogs and other social network sites: Blogs seem to be particularly important in philosophy (Table 4). These blogs were created for variety of scholarly reasons, including scientific meeting announcements, course lectures and alternative homepages. In contrast, the automatically extracted links to social network sites did not seem to have been created for scholarly reasons. A manual checked of 60 outlinks to Facebook found that all outlinks were from hyperlinked icons to university or department Facebook pages, rather than academics' pages.

Online video and image sites: Environmental engineering and philosophy had the most multimedia outlinks, targeting *YouTube* videos in particular. Although some outlinks were to science videos, typically of lectures, manual checking revealed that most were from hyperlinked YouTube icons to institutional channels. Nearly all of the links to image sharing sites were from hyperlinked Flickr icons (e.g., university Flickr pages) rather than individually created scientific links.

Table 2. Web CVs with at least one outlink by target website types.

Disciplines	Outlinks to OA websites			Outlinks to publishers or DOIs		Outlinks to social network sites				Outlinks to videos and images		Any outlink
	Major OA Repos.	National OA Repos.	Doc. sharing	Jrnl./DOI	Book Publisher	Major blogs	Online ref.	Prfs. SNS	Genl. SNS	Online video	Image sharing	
Astronomy	243 (37%)	17 (2.6%)	2 (0.3%)	105 (16%)	9 (1.4%)	15 (2.3%)	8 (1.2%)	18 (2.7%)	33 (5%)	20 (3%)	9 (1.4%)	312 (47.5%)
Pub. Health	23 (3.7%)	18 (2.9%)	0 (0%)	100 (16.1%)	6 (1%)	4 (0.6%)	4 (0.6%)	17 (2.7%)	50 (8.1%)	21 (3.4%)	1 (0.2%)	154 (24.8%)

Envir. Eng.	7 (1.1%)	43 (7%)	1 (0.2%)	97 (15.8%)	4 (0.7%)	12 (2%)	13 (2.1%)	39 (6.4%)	58 (9.4%)	43 (7%)	6 (1%)	182 (29.6%)
Philosophy	52 (6.4%)	50 (6.2%)	15 (1.9%)	159 (19.7%)	53 (6.6%)	44 (5.4%)	58 (7.2%)	39 (4.8%)	103 (12.7%)	39 (4.8%)	9 (1.1%)	326 (40.3%)
No. (%) from all CVs)	325 (12%)	128 (4.7%)	18 (0.7%)	461 (17.1%)	72 (2.7%)	75 (2.8%)	83 (3.1%)	113 (4.2%)	244 (9%)	123 (4.6%)	25 (0.9%)	974 (36.1%)

Outlinks by file type: Just over a quarter of the CVs had at least one outlink to a document file type (Table 3), although more in philosophy (34%) and less in public health (19%). Hence, it seems that at least in comparison to the limited set of fields examined, philosophy researchers are more willing to share preprints/postprints online, assuming that this is the nature of the linked-to files. Just under three-quarters (73%) of the links to document file types were to *PDF* files, 8% to *Microsoft Word* files, 2.5% to presentation files (e.g., *PowerPoint* slides) and about 0.5% to *Microsoft Excel* files.

Although about 14% of the outlinks targeted image files, manual checking of 70 found that only 16% were created for scholarly reasons, such as images of galaxies and nebulae or scanned images of conference papers or posters. In philosophy we found a few (15) interesting outlinks to mp3 audio files. All were digitised lectures, speeches and podcasts of philosophers discussing philosophical topics (e.g., <http://eis.bris.ac.uk/~plajb/research/index.html>).

Table 3. Outlinks from web CVs and publication lists by file type.

Disciplines	Document files	Presentation files	Stat. files	Video files	Image files	Audio files	Archive files	Any file type
Astronomy	169 (25.7%)	6 (0.9%)	1 (0.2%)	4 (0.6%)	39 (5.9%)	5 (0.8%)	0 (0.0%)	186 (28.3%)
Pub. Health	119 (19.2%)	2 (0.3%)	0 (0.0%)	1 (0.2%)	7 (1.1%)	1 (0.2%)	1 (0.2%)	123 (19.8%)
Envir. Eng.	149 (24.3%)	7 (1.1%)	3 (0.5%)	3 (0.5%)	39 (6.4%)	0 (0.0%)	6 (1.0%)	172 (28.0%)
Philosophy	274 (33.9%)	8 (1.0%)	0 (0.0%)	2 (0.2%)	34 (4.2%)	15 (1.9%)	1 (0.1%)	286 (35.4%)
No. (%) of all CVs	711 (26.3%)	23 (0.9%)	4 (0.1%)	10 (0.4%)	119 (4.4%)	21 (0.8%)	8 (0.3%)	767 (28.4%)

Limitations

The research findings are subject to a number of limitations. First, the survey had a low response rate and so the web CV analysis is based upon self-reported findings, probably biasing the results towards people with an online presence and hence the results are likely to be overestimates. In particular, academics may have not taken the time to find their web CV URLs.

The outlink analysis results were based upon heuristics, including assumptions that links from CVs or publication lists to document file types were always to freely-accessible full-text copies of an author's own research publications rather than to others' papers or teaching material. Similarly, links to known full-text OA archives were assumed to be to full-text copies of the CV owner's publications. In contrast, links to publishers' websites were assumed to be to bibliographic information about an article rather than a full text copy, but there will be gold OA and other exceptions such as sample articles in some fee-based journals. In terms of social media

tools, most links were shown to be irrelevant by manual checking and so these statistics should be disregarded.

Conclusions

Since the advent of the web, many initiatives have sought to make research freely available online and to establish a proper infrastructure for researchers to publicise their scientific findings. Nevertheless, whilst a small majority of researchers seem to have web CVs, most do not use them to direct visitors to full-text research, and most seem not to direct visitors to any other major type of scholarly resource. Perhaps unsurprisingly, the proportion of scientists with web CVs and the proportion that link to various types of scholarly sites or resources varies by country, gender and discipline, even within the EU.

In terms of OA research, since a small majority of academics responding to the EU survey had a web presence and about a third of the CVs checked seemed to have at least one link to an OA publication, it seems that, very approximately, a fifth of EU academics have a OA-linking web presence. This is perhaps surprisingly low since most academics seem to be willing to self-archive their research if required (Swan & Brown, 2005) and about 90% of journals and 62% of publishers let authors deposit preprints or postprints online (Harnad et al., 2008; SHERPA/RoMEO, 2013). Although some of the authors may have self-archived in OA repositories, especially in astronomy and astrophysics, this seems to be a clear missed opportunity to disseminate findings as fully as possible. This is alarming from the perspective of improving access to scientific information in the EU, particularly outside of astronomy and astrophysics.

The structure of CVs can also influence the extent of linking from CVs and perhaps also self-archiving at national or institutional levels, and this seems to be an easily fixable issue. For instance, about 60% (18) of the CVs collected from the survey from Estonian authors were hosted in the *Estonian Research Portal* (<https://www.etis.ee>) of the Estonian Ministry of Education and Research. Its CV template seems to be not flexible enough to allow self-archiving by linking to full-text publications online. Nevertheless, developing standardised CV templates with hyperlinking capabilities does not guarantee OA self-archiving in a cause-and-effect manner and vice versa. It is not clear if pre-defined CV templates in individual academic institutions across the EU are seriously curtailing the OA publishing and self-archiving of research, but it is important that all institutional and national bodies providing templates or hosting for academic CVs should ensure that they promote or at least enable linking to full-text copies of publications. This could occur in parallel with efforts to establish effective mechanisms for research institutions and funders to create or strengthen mandates for self-archiving (see Gargouri et al., 2012a).

The gender, disciplinary and geographic differences found can help to target groups most needing help to create effective web CVs. Within the EU, Eastern countries, disciplines without established repositories and women seem to be particularly important in this respect. The disciplinary variations may be due to a lack of awareness within some research communities about self-archiving or other factors such as the structure of CVs, copyright issues with journals, or different disciplinary communication needs. International variations may be due to differing levels of infrastructure support, that policy makers should consider remedying if they wish to ensure that their national research is effectively disseminated, maximising the value for money of research support.

Future research could analyse the variables assessed here in more detail. The proportion of web CVs linking to OA articles in different disciplines could be influenced by differences in the proportions of OA articles between subject areas (e.g., Gargouri et al., 2012b; Björk, Laakso, Welling & Paetau, in press). For instance, mathematics (45%) and earth sciences (33%) have higher proportions than arts (10%) and chemistry (13%) (see Björk et al., 2010, p.8; Gargouri et al., 2012b, p. 288). Future research might assess the relationship between these two variables. The proportion of OA articles could perhaps be estimated either through the share of OA publications in the Directory of Open Access Journals for gold OA or by using web crawlers, search engines or academic databases for OA copies of both gold or green articles (e.g., Hajjem, Harnad, Gingras, 2005; Matsubayashi et al., 2008; Björk et al., 2010). Future studies can also analyse the difference between web CV links to green OA or gold OA across fields, and perhaps also investigate the impact of institutional and other mandates on the results.

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Appendix A

Table 4. Web presence survey results by country and field.

Astronomy & Astrophysics				Public environmental & occupational health			Environmental engineering			Philosophy; History and philosophy of science			Total		
EU countries	Answered	CVs URLs from the survey (Survey +Google)	% survey response rate	Answered	CVs URLs from the survey (Survey +Google)	% survey response rate	Answered	CVs URLs from the survey (Survey +Google)	% survey response rate	Answered	CVs URLs from the survey (Survey +Google)	% survey response rate	Answered	CVs URLs from the survey (Survey +Google)	% survey response rate
UK	71	47(47)	66.2	79	49(49)	63.3	51	35(50)	68.63	140	110(110)	78.57	341	241(256)	70.67
Spain	71	32(53)	45.07	68	16(48)	23.5	80	36(44)	45	67	46(73)	68.66	286	130(218)	45.45
Slovakia	9	6(37)	66.67	6	3(24)	50	10	5(35)	50	11	6(44)	54.55	36	20(140)	55.56
Poland	24	18(59)	75	20	7(41)	35	41	15(40)	36.59	10	8(54)	80	95	48(194)	50.53
Netherlands	50	35(48)	70	64	41(55)	64.1	50	33(43)	66	40	30(57)	75	204	139(203)	68.14
Italy	75	37(49)	49.33	56	29(51)	50	85	58(58)	68.24	72	62(89)	86.11	288	188(247)	65.28
Israel	25	17(41)	68	22	13(30)	59.1	32	20(40)	62.5	21	16(40)	76.19	100	66(151)	66.00
Hungary	18	16(49)	88.89	7	6(40)	85.7	29	24(43)	79.31	5	4(41)	80	59	50(173)	84.75
Germany	63	37(52)	58.73	51	25(48)	51	30	17(46)	56.67	59	47(55)	79.66	203	126(201)	62.07
France	53	25(47)	47.17	34	5(58)	14.7	31	19(41)	61.29	45	34(47)	75.56	163	83(193)	50.92
Finland	22	9(24)	40.91	38	8(33)	21.1	32	13(42)	40.63	11	9(44)	81.82	103	39(143)	37.86
Estonia	4	4(25)	100	5	3(22)	60	18	12(22)	66.67	3	3(25)	100	30	22(94)	73.33
Denmark	17	13(41)	76.47	68	36(53)	51.5	48	39(43)	81.25	22	19(57)	86.36	155	107(194)	69.03
Czech	19	12(38)	63.16	11	6(36)	54.6	29	18(44)	62.07	11	9(42)	81.82	70	45(160)	64.29
Bulgaria	7	2(47)	28.57	5	2(32)	40	7	2(23)	28.57	2	1(31)	50	21	7(133)	33.33
TOTAL	528	310(657)	58.71	534	249(620)	46.6	573	346(614)	60.38	519	404(809)	77.84	2154	1,309(2,700)	60.77

Table 5. Web CVs with at least one outlink by field and country.

Countries	Astronomy	Pub. Health	Envir. Eng.	Philoso phy	OA mandates **	OA archives **
UK	73.3%	58.7%	71.7%	74.3%	58	209
Italy	51.0%	39.2%	62.3%	46.1%	30	72
Finland	66.7%	39.4%	42.9%	50.0%	28	14
Spain	54.7%	27.1%	41.9%	56.4%	14	98
Germany	69.2%	43.8%	45.3%	61.3%	13	165
France	63.8%	32.8%	48.7%	61.7%	12	71
Denmark	65.9%	45.3%	65.1%	56.1%	4	11
Poland	49.2%	31.7%	20.0%	55.6%	3	75
Netherlands	47.9%	65.5%	46.7%	59.6%	3	24
Hungary	28.6%	20.0%	35.8%	56.1%	3	13
Czech	36.8%	8.3%	38.6%	54.8%	0	8
Bulgaria	48.9%	18.8%	21.7%	17.5%	0	6
Estonia	36.0%	13.6%	59.1%	33.3%	0	5
Israel	73.2%	36.7%	57.8%	42.5%	0	2
Slovakia	54.1%	12.5%	11.4%	31.8%	0	0

*High and low percentages of outlinks are highlighted in bold and italic respectively.

EU countries are arranged based on number of OA mandates as recorded in Registry of Open Access Repositories Mandatory Archiving Policies (ROARMAP, <http://roarmap.eprints.org>), *number of OA repositories as recorded in Directory of Open Access Repositories (<http://www.opendoar.org>)