ECP-2007-DILI-537003

PEER

PEER USAGE STUDY
Descriptive statistics for the period March to August 2011

Deliverable number/name	*D5.2*
Dissemination level	*Public*
Delivery date	*18 June 2012*
Status	*Final*
Author(s)	*CIBER Research Ltd*

e*Content*plus

This project is funded under the *e*Content*plus* programme[1],
a multiannual Community programme to make digital content in Europe more accessible, usable and exploitable

[1] OJ L 79, 24.3.2005, p. 1.

PEER USAGE STUDY

Descriptive statistics for the period March to August 2011

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FINAL REPORT

15 June 2012

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EXECUTIVE SUMMARY

This study compares numbers of full text downloads of preprints from PEER repositories with downloads of the equivalent version of record at the publisher's web site over a six-month period, March to August 2011.

The key points to emerge are

- Overall, full text downloads are currently growing in a linear cumulative fashion for both PEER repositories and publishers. Publisher downloads are growing at a faster rate than repository downloads and it seems unlikely that the gap will close in the medium to short term. As a consequence, PEER's share of the combined PEER-publisher download market is likely to decline gradually. It is unlikely that PEER has had a large or significant impact on publisher downloads at the global level (p.15).
- The relative popularity of PEER, as measured by full text downloads as a proportion of publisher downloads reveals considerable variation between publishers, for reasons that are not yet clear. Over the 6-month period, PEER usage stood at 11.5 per cent of publisher usage, but the figures for individual publishers ranged between 2.0 and 24.0 per cent (p.17).
- PEER content in the social sciences, humanities and physical sciences is significantly more popular than content in medicine and the life sciences (p.17).
- An analysis of cumulated full text downloads by age of article (months since first online publication) shows that articles continue to accumulate over a long period and that an 18-month window represents only a small proportion of lifetime use in all four subjects studied (p.18).
- PEER is at an early stage in its development to inject critical mass into the project, a substantial backfill of content was entered during 2011. This makes it difficult to interpret the findings in relation to embargo periods, but there are indications that currency may not be such a critical issue for PEER users compared with visitors to publisher sites (p.19). More work is needed on a more stable set of data.
- An analysis of publisher:repository downloads shows that users tend to strongly prefer the publisher site for more recent content. This may have something to do with user expectations or the way sites are designed, since we are comparing articles on a like-for-like basis (p.8).

- In broad terms, article-level usage correlates positively and significantly across the publisher-repository divide. Articles that are popular on the one, tend also to be popular on the other but the correlation coefficients are modest, especially in the life sciences and in medicine and so there is strong possibility that different kinds of information behavior are taking place on the different platforms (p.28).
- During the six months March through August 2011, almost every single article (99.0 per cent) of those was downloaded at least once from the relevant publisher website. So was a very large majority, 73.6 per cent, from a PEER repository. The scholarly literature is under heavy scrutiny (p.29).

INTRODUCTION

This report explores the use of PEER preprints over the six months of March to August 2011 and relates this activity to the use of the version of record on the publishers' web sites. Nine publishers are featured in this study: BMJ Group, Elsevier, Institute of Physics Publishing, Nature, Oxford University Press, Portland Press, Sage, Springer and Wiley-Blackwell. For various technical and logistic reasons, data from EDP Sciences and from Taylor & Francis is unavailable for this report.

The report outlines the research design for this first phase of the PEER usage study and presents a range of statistical descriptions and tests. The early body of the report compares the emerging evidence so far with the research aims and objectives of the project. A detailed statistical appendix then follows, showing the richness of the data that has been compiled as well as pointing to some of the limitations of that data. This is particularly important at this early stage where numbers and time windows are fairly restricted. The report also looks forward to the second phase of the study where a randomised controlled trial (RCT) will supplement the basic descriptive data presented here, and provide tighter experimental control.

AIMS AND OBJECTIVES

The research aims and objectives for the usage strand of the PEER programme follow.

This report addresses the following questions:

What is the `commercial' impact (if any) of Green open access?

Does PEER impact on the use of Stage III articles on publisher platforms?

If so, what are the relative effects of:

- publisher deposit (PEER `publisher deposit' model)
- voluntary self-archiving (PEER `author deposit' model)

What are the effects of embargo periods, if any?

Is there any relationship between length of embargo and use of PEER preprints articles in different subject areas?

What are the key drivers of repository usage?

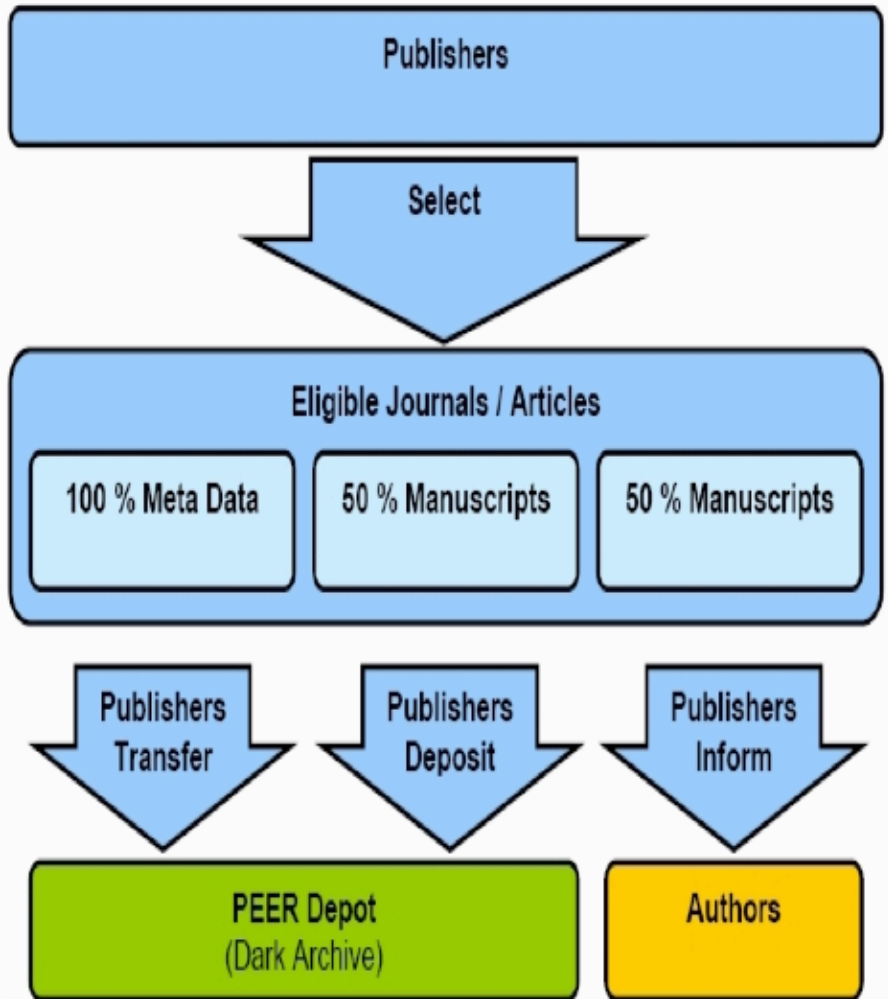
To what extent, if at all, do journal origin, impact factor, date of official publication and other factors impact upon repository usage and information-seeking behaviour?

RESEARCH DESIGN

The PEER production process

Figure 1 outlines the production processes by which materials are transferred from participating publishers to the PEER Depot and from there made available through a number of open access repositories. A detailed description can be found in Wallace (2011).

Figure 1: PEER production processes

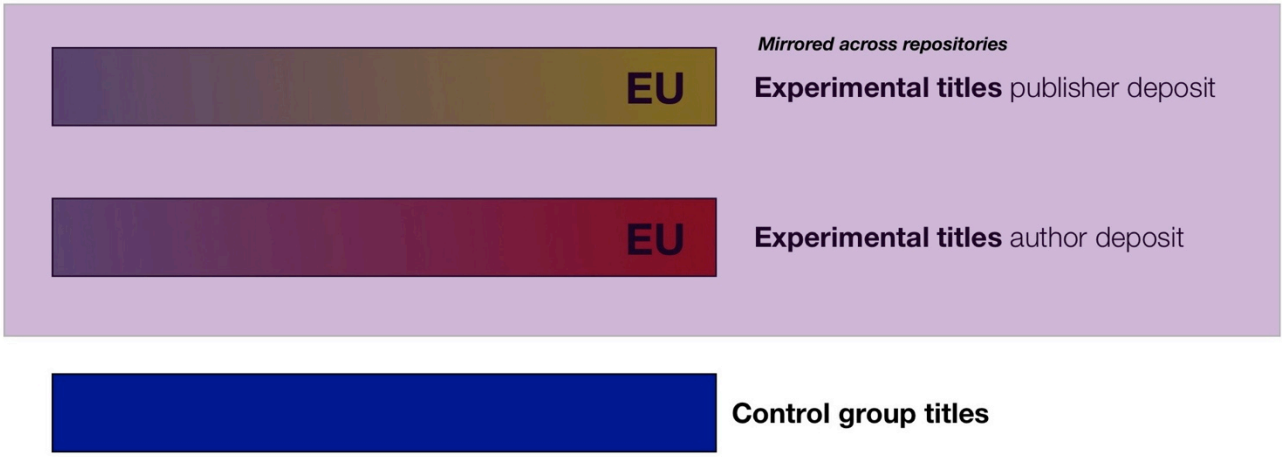


The most important point for someone coming to PEER usage findings for the first time is that the experiment deals with a subset of the global literature: only articles, not other document types such as letters, errata or editorial matter, with at least one EU-27 author are ingested into the PEER Depot. The production model has two content supply streams: preprints (Stage II) materials that are deposited automatically by the publishers (100 per cent of EU-27 content in selected journals) and those which are voluntarily deposited by the author following a prompt to participate in the PEER experiment.

The nature of the sample

This production process generates two sets of experimental content (Figure 2) which crudely map onto the status quo (voluntary author deposit) and onto a hypothetical future scenario based on comprehensive deposit facilitated by publishers themselves.

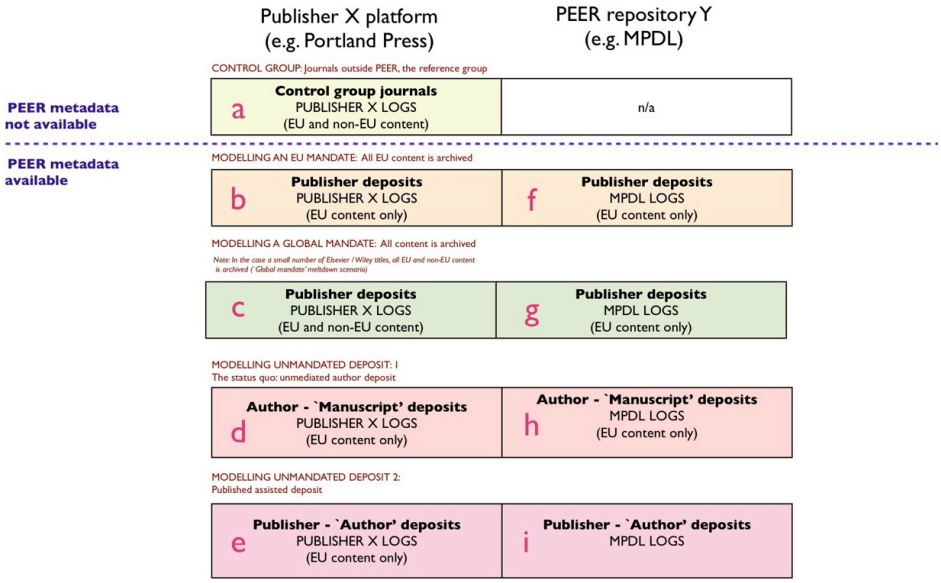
Figure 2: Broad overview of the Phase I research design



In the original design for the PEER usage study, we had a third group of control articles, comprising preprint materials from a carefully matched set of titles that were not ingested into the PEER Depot as in Figure 1 and were thus independent of the PEER experiment. This control group has not been used in this report for reasons that will be discussed in a few moments in relation to the second phase of the study.

A more detailed overview of the structure of the PEER data sets that CIBER has worked with is given below.

Figure 3: Detailed overview of the Phase I research design



PEER descriptive statistics

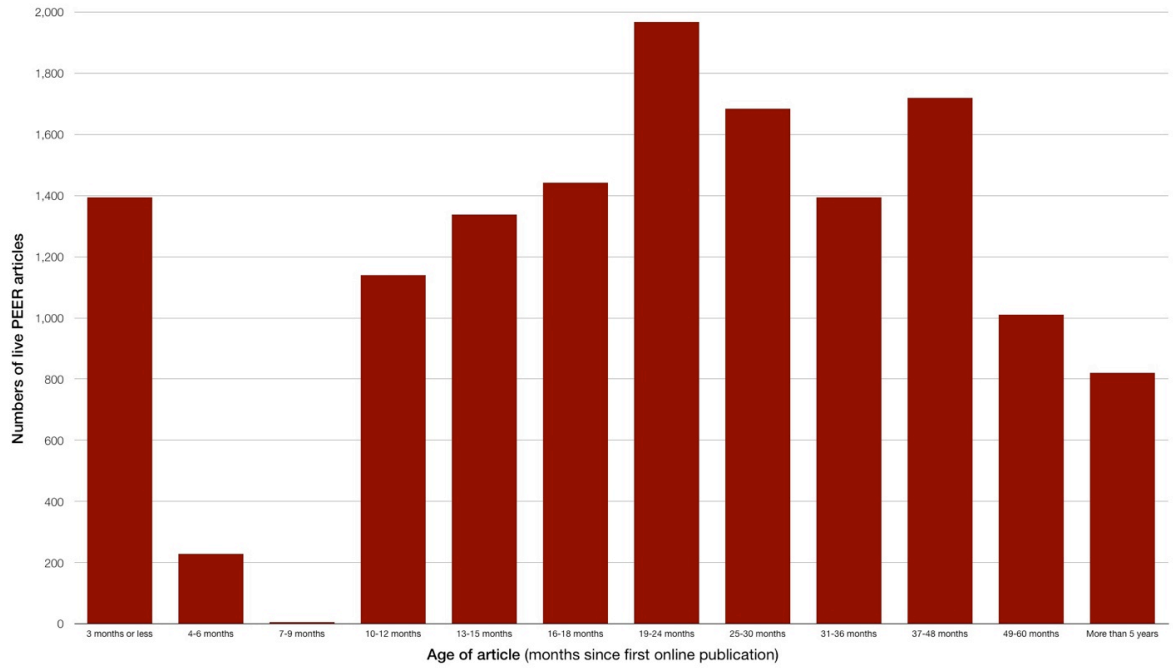
As a mini `experiment within an experiment' two titles[1] were selected to model the extreme case were all Stage II preprint content to be available (a `global mandate') through institutional or other repositories, regardless of the geographic origin of the authors. This is represented above as subsets *c* and *g*.

The data presented in this first report relate to subsets *b*, *c*, *f* and *g* only since there were so few occurrences of voluntary submission within the time window. Looking at the PEER metadata more generally, levels of author submission so far have been too low to warrant any further statistically-based research.

In framing how to structure the samples that would form the basis of the Phase I experiment, a further consideration needed to be thought through: that of timing. The pipe that feeds the PEER Depot comprises material of different ages (from the date of first online publication) and with different embargo periods. So what flows in is a mixed set in terms of age and embargo status. This is not a problem in itself except that efforts to establish critical mass have meant that substantial backfill activity has had to take place, leading to a sample whose temporal characteristics are really not representative of the state that would eventually be obtained were PEER to continue for an extended period and settle down into a natural rhythm (Figure 4).

Figure 4: Age profile of live PEER materials

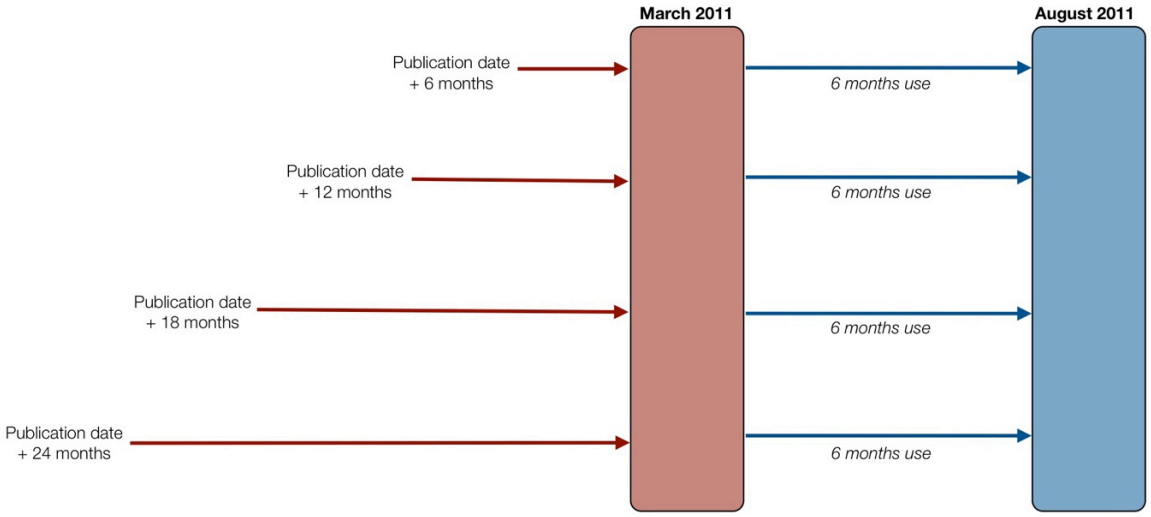
Numbers of articles, March 2011 to August 2011



The sample is particularly weak in relation to articles aged 3-10 months. For this report, we consider all PEER material that was ingested and exposed to the outside world by 1 March 2011 and track its use over the following six-months. This means we have a standard usage window and a mixture of publication ages and embargo expiries, as indicated in Figure 5.

[1] *Biochimica et Biophysica Acta: Molecular Basis of Disease* and *Marine Environmental Research*.

Figure 5: Polysynchronous research design



Substantial backfill is not a normal situation in journal publishing, and this means that a great deal of caution needs to be applied: the findings may not be generalisable outside of this specific context.

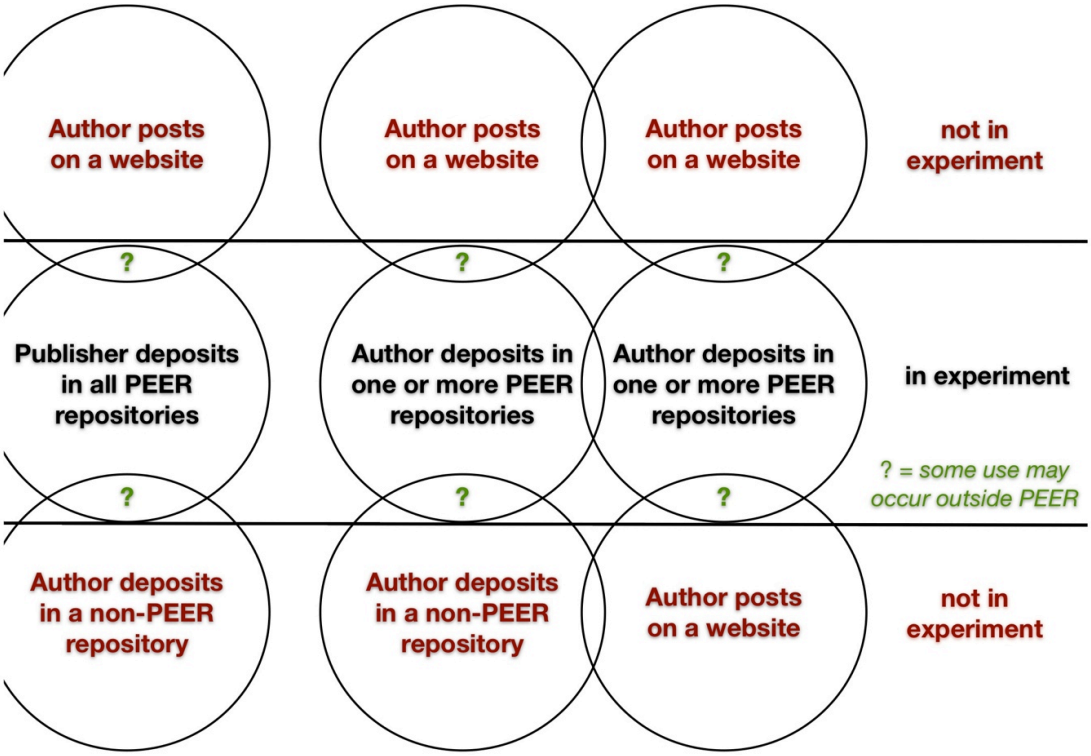
A note on experimental control

It is important in any communication regarding PEER usage findings to be clear about the specific aims (and limitations) of the experimental design. The specific aim is to model the impacts, if any, of the large-scale deposit of EU-27 authored materials. It is *not* an experiment with wider ambitions to model the impact of Green open access more generally. The question is whether PEER itself made a difference?

The overall environment within which PEER is operating is extraordinarily complex and there are now many routes to discovering and accessing scholarly content. Some authors are almost certainly posting PEER-equivalent materials on their personal or departmental web sites, or depositing them in other non-PEER repositories, and this creates an uncertain background of noise which we have to accept as an experimental limitation, because it is simply not practical to develop robots to track all non-PEER open access incidences. Davis and others attempted this in their 2008 paper but on a very much smaller sample of articles (1,379) and it was clear that the practical issues invoked (crucially around manually identifying false positives) meant that this was not a scalable option for PEER.

The PEER experiment took place in real time in the real world and is thus subject to considerable external noise. Figure 6 shows some the most obvious known unknowns that surround the PEER set up.

Figure 6: The PEER experiment in the wider environment



Other shifts in the scholarly discovery landscape are also likely to have impinged on the PEER experiment: decisions about Google and Google Scholar indexing, for example, and the rise of powerful third party gateway services like PubMed and arXiv are certain to affect usage of materials on the publishers' platforms and to do so differentially over time. Even the way that log data events are recorded over time may change and add further uncertainty. The key message is that longitudinal trends have to be treated with a caution since noise affects both sides of the equation (publisher and repository use) and in ways that are almost impossible to completely pin down.

Experimental control is obviously of major importance to the credibility of what PEER communicates to the outside world and we are tackling this issue in a subsequent report using a randomised controlled trial (RCT) following the example of Davis and others (2008) and Snijder (2010). This has many tactical advantages, the most important being that (a) we compare like with like, control is imposed from within the journal sets being considered, not from other journals with different characteristics, (b) control can be exercised within a very limited time span, even one month, rather than making comparisons across several years (a point that will be discussed later in this report), and (c) we have a full set of PEER metadata for both control and experimental articles. For these reasons, we have not used the list of control journals for this report. The difficulties of using them should become clear as we look at the first set of findings.

In summary, Figure 7 sets out the key assumptions, constraints and limitations of this study. We believe these are typical of the challenges facing scholarly communications researchers but that they will be helpful in guiding the reader of this report to a properly balanced conclusion on what can and what cannot be achieved in action research.

Figure 7: Experimental assumptions and limitations

Key assumptions

Full text downloads are a meaningful proxy for understanding the usage of scholarly materials.

A 6-month timeframe is a reasonable compromise for a usage study of this nature. It is long enough to allow a substantial amount of data to accumulate, but not so long that the external environment may changed out of all recognition by the end.

Key limitations

Delays in the implementation of PEER mean that the experimental sample is not fully representative of a steady state of PEER ingestion and release. It is limited in respect of newer materials (3-10 months post embargo) and materials with embargo periods greater than 18 months.

This study took place in the real world, in real time and against a background of noise and turbulence in the external environment. These factors are not easily measured and may play out differentially on the various actors involved, there is simply no way of telling.

PEER has unique characteristics that mean that it is not advisable to extrapolate from the findings presented here to make claims about green open access more generally. Generalisations should only be made based on the evaluation and triangulation of a critical mass of studies with similar objectives.

FINDINGS

Commercial impact of Green open access

In this first section of the findings we address the question 'Does PEER impact on the use of the versions of record available from the publishers' platforms?'

And, if so, what are the relative effects of:

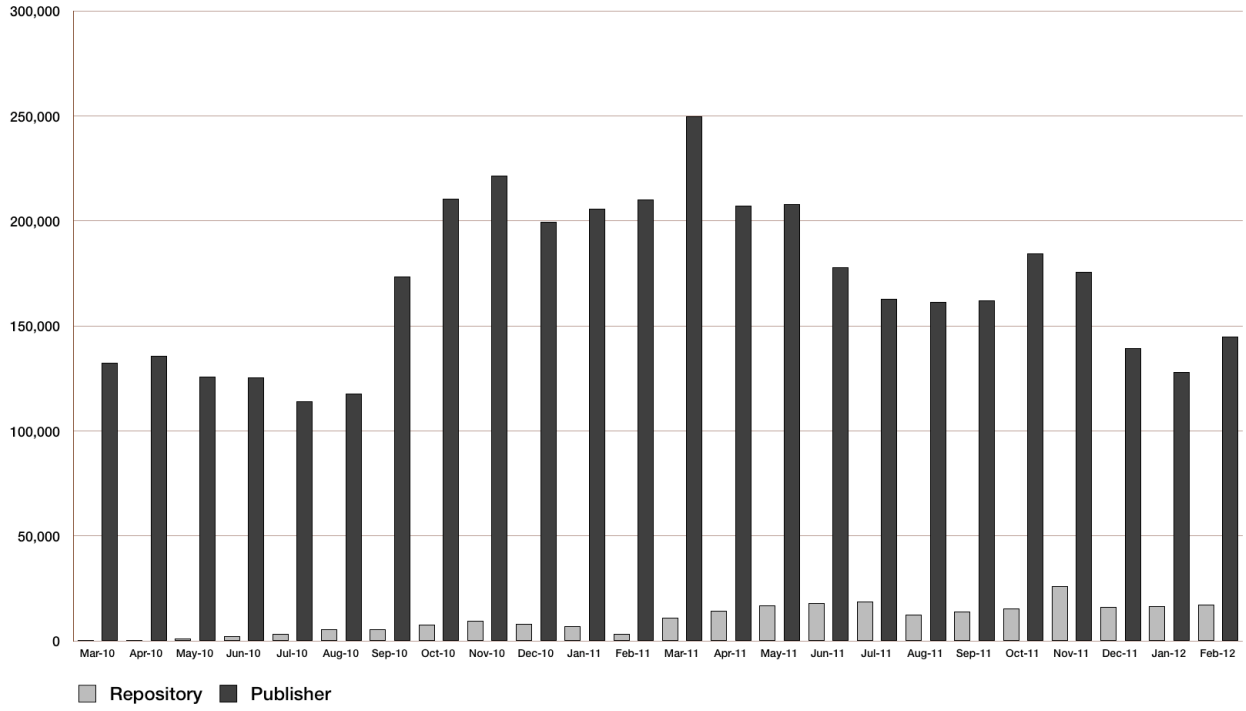
- publisher deposit (PEER `publisher deposit' model)
- voluntary self-archiving (PEER `author deposit' model)

Since there were very few incidences of voluntary self-archiving in the data set under consideration here (less than 0.2 per cent of deposits), we will focus on any evidence of the impact of PEER deposit on usage at the publishers' web sites. We are unable to say anything about voluntary self-archiving except that it barely registered, for whatever reasons.

In Figure 8, we show aggregate use across all four subject areas and nine publishers over a 24-month period to get a sense of the bigger picture.

Figure 8: Aggregate use of all PEER content on publisher and repository platforms

Numbers of full text downloads for publisher web sites and PEER repositories, March 2010 to February 2012



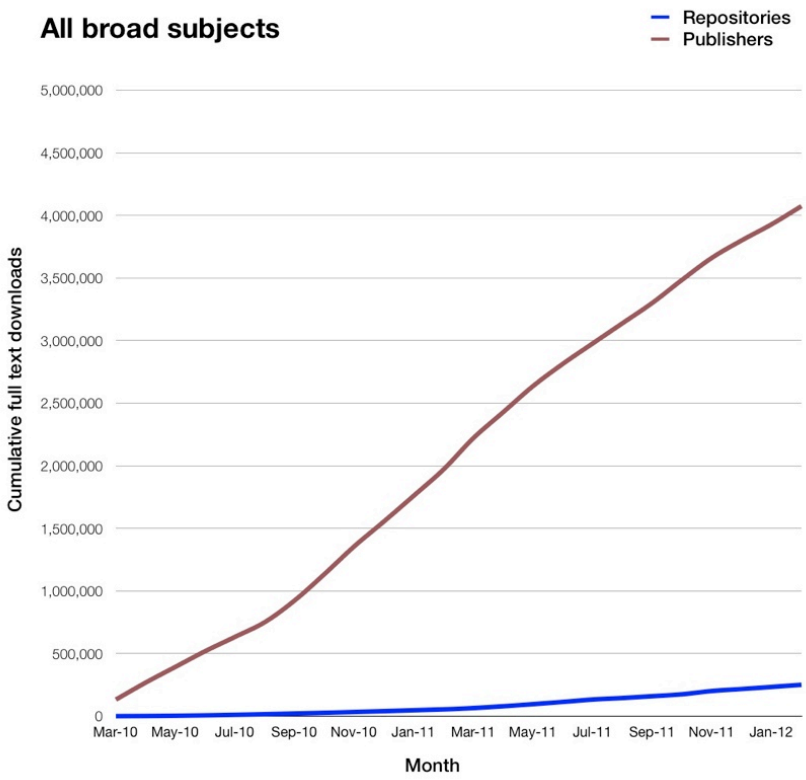
Several important points arise from this high-level overview. Use is clearly seasonal, following the patterns of the scholarly calendar. As we move across the chart from left to right, we see a gradual and reasonably steady increase in PEER downloads from a base of negligible content (March 2010). If we compare publisher downloads on a monthly like-for-like basis (say comparing June 2010 with June 2011) we find a very inconsistent picture emerging with publisher downloads generally up in 2011 on the 2010 figures up until August, and from then on down.

Equivalent charts for the individual subject areas (life sciences, medicine, physical sciences, and social sciences and humanities) can be found in the annex as Figures 24 to 31 and they make any clear interpretation even more difficult to establish. We know from previous studies that usage data is highly volatile and so a much longer time period is really needed to see what is really going on.

It may be instructive to look another view of this same data: this time cumulating publisher and PEER repository downloads over the full period (Figure 9).

Figure 9: Cumulated full text downloads in all subjects

Numbers for publisher web sites and PEER repositories, March 2010 to February 2012

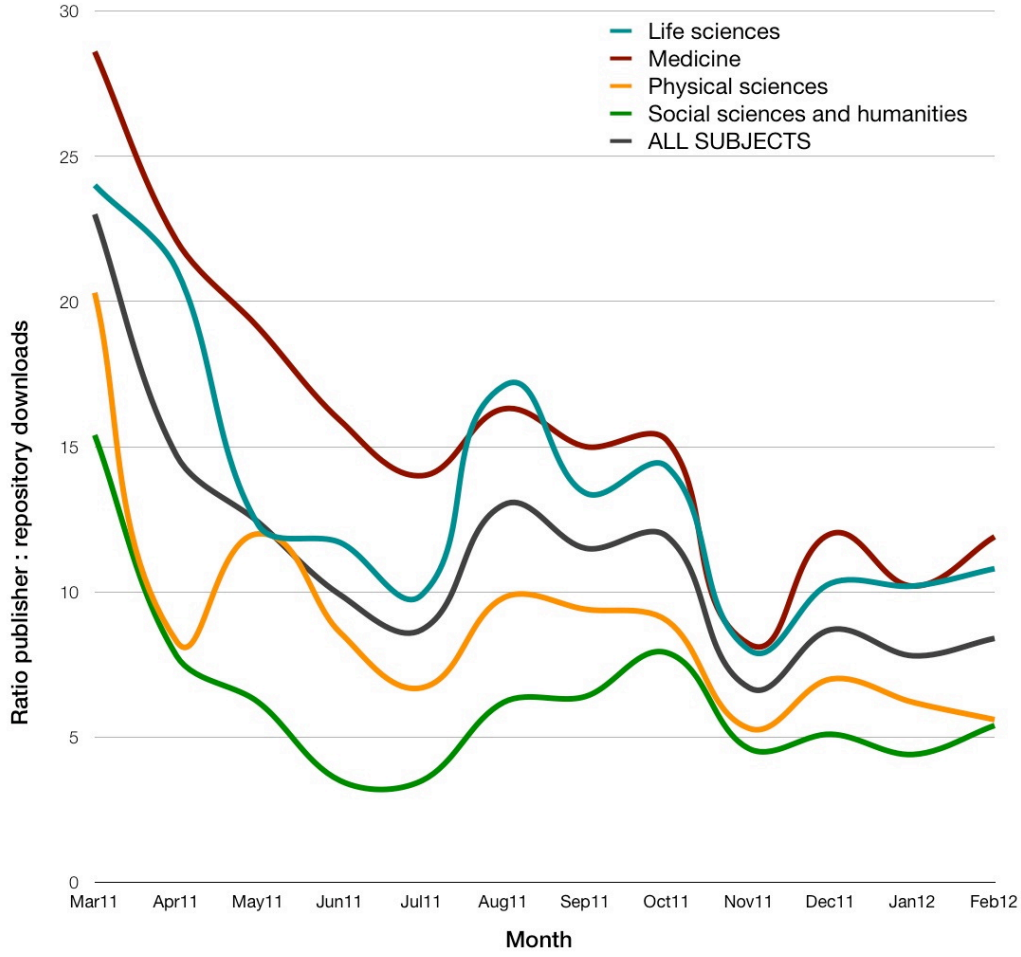


Publisher traffic is growing cumulatively in a strongly linear fashion (linear R^2=0.99) and at a faster rate than PEER traffic (also strongly linear, R^2=0.94). As a result, it must be concluded, on the basis of current trends at least, that PEER's share of the combined publisher-PEER download market is likely to decline, at least in the short to medium term. It should be borne in mind however that earlier part of the graph represents very low PEER critical mass since progress to populate the repositories with content was slower than anticipated.

The next chart plots the ratio of publisher to PEER repository full text downloads over the most recent twelve-month set of figures available. The higher the ratio, the greater the `preference' of users to access full text from the publishers' web site rather than a PEER repository and of course, vice versa.

Figure 10: Relative performance of PEER repositories

Ratios of publisher to repository downloads, March 2011 to February 2012 (database level)



Users in the social sciences and humanities and the physical sciences are considerably more `PEER-friendly' on the basis of this metric than those in the life sciences and medicine, perhaps because of the greater value attached to the final version of record in these disciplines.

The key question, which this six-month report is unable to settle, is whether these PEER downloads are in addition to the publishers' offerings and growing the overall market for scholarly information, or whether they are substitutes? The combined weight of evidence here is more suggestive of an additive rather than a competitive effect but these issues will be teased out in greater detail in the report on the randomised control trial (RCT) that follows this one.

CIBER holds the underlying data for this experiment in a large spreadsheet-like package, where the rows correspond to articles and the columns to values associated with those articles (e.g. numbers of repository downloads in March 2011). As might be expected, a large number of cells contain zero downloads either on the publisher or repository columns, or both. Since it is impossible to divide by zero, we have something of an issue defining repository-publisher ratios: depending on the level of aggregation and how the data are collapsed into bigger categories (article-level, journal-level, database-level) we get different values. Figure 10 above shows download ratios aggregated at the database level and the trends appear to be converging at a level of repository use approximately one eighth of that going to the publishers. It is too early to be clear whether PEER usage really is converging this way, especially given the highly seasonable nature of scholarly consumption.

It seems more appropriate when focusing on individual publishers to aggregate the ratios at the journal level, and this is what we see in Table 1.

There is considerable variation between publishers in the range 2.0% (CI95 1.8% to 2.3%) for Publisher E to 24.0% (CI95 23.5% to 24.6%) for Publisher G. A more detailed analysis and further research is needed to work out what is going on. We may be looking at an artifact of the backfill here, with age of articles being a confounding factor.

Table 1: Publisher and repository downloads by month (journal-level analysis)

PEER full text downloads as a percentage of publisher downloads, March 2010 to August 2011 (n=14,292 articles)

	Articles	Mean	95% confidence intervals	
			low	high
Publisher A	781	7.8	7.7	7.9
Publisher B	4,809	11.9	11.7	12.0
Publisher C	981	3.9	3.8	4.0
Publisher D	630	4.6	4.5	4.8
Publisher E	110	2.0	1.8	2.3
Publisher F	1,292	11.3	10.6	12.1
Publisher G	1,469	24.0	23.5	24.6
Publisher H	2,690	6.5	6.3	6.7
Publisher I	1,529	17.9	14.0	21.9
All publishers	**14,291**	**11.5**	**11.1**	**12.0**

Cutting the same data by subject in Table 2, we can see that subject content is a major source of variation, with social science and humanities materials proving to be relatively more popular for PEER users than materials in the sciences. Again, this prompts the need for further investigation.

Table 2: Repository downloads as a percentage of publisher downloads by subject (subject level analysis)

Numbers of articles and repository downloads expressed as a percentage of publisher downloads with 95% confidence intervals

	Articles	Mean	95% confidence intervals	
			low	high
Life sciences	4,486	9.3	9.0	9.5
Medicine	4,383	10.0	8.6	11.3
Physical sciences	3,422	12.2	11.9	12.5
Social sciences and humanities	2,001	19.0	18.6	19.5
All subjects	**14,292**	**11.5**	**11.1**	**12.0**

Effects of embargo periods

In this section we address the question 'Is there any relationship between length of embargo and the use of PEER preprints in different subject areas?'

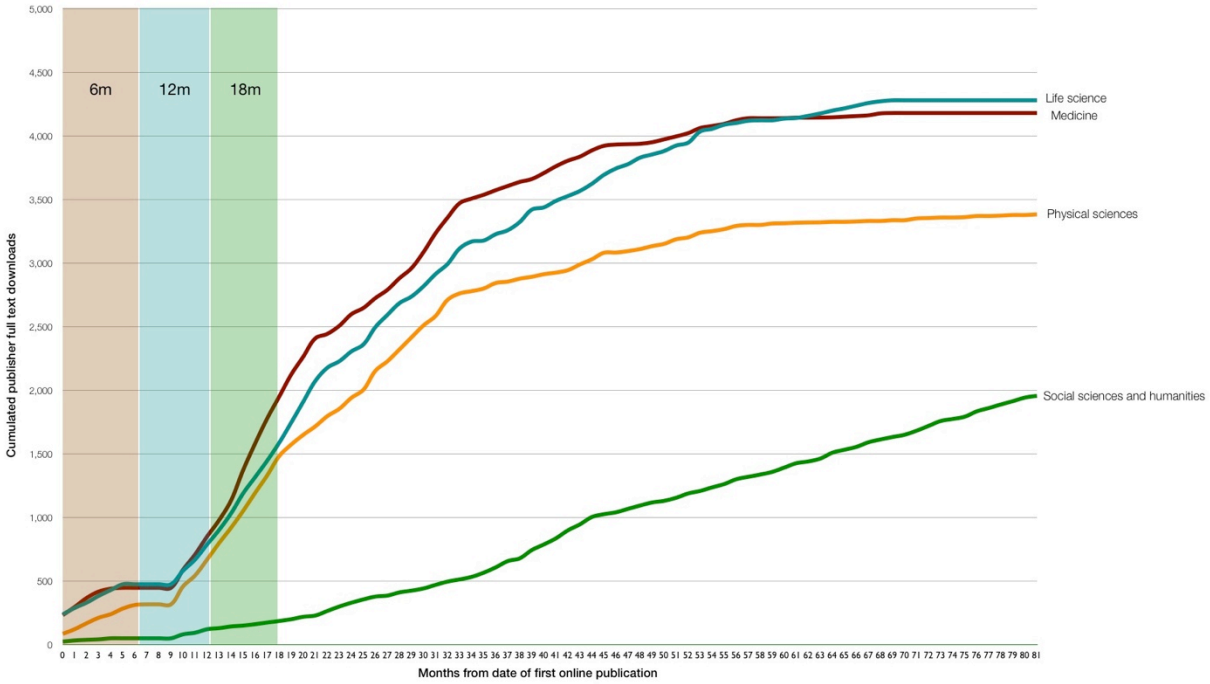
Quantifying any possible effects of the length of embargo periods on repository usage is an issue of concern to the whole community because it speaks to the fundamental question as to whether repositories co-exist or compete with publishers' offerings? (Beckett and Inger 2007).

Probably the best way to approach this question is to look at the age profile of downloads *from the publishers' sites* to get a sense of the point at which interest begins to wane, without the confounding factor of embargo periods to confuse the picture. In Figure 11 we analyse publisher downloads of PEER experimental articles over the period March to August 2011. We see cumulated numbers of downloads to the various publisher platforms on the vertical axis during

the period. The four broad subjects are picked out as different coloured lines and it is immediately obvious that they reveal different patterns of use. The horizontal axis represents the age of the articles downloaded (in months since first online publication) and the evident kinks round about month 8 show the effects of materials being released from their embargo periods. The results are broken down by subject.

Figure 11: Cumulated publisher downloads by age of article and broad subject

Numbers of full text downloads over the period March to August 2011



It is clear that publisher downloads accumulate over a long period and that usage within the first 18 months represents a small proportion of lifetime use.

The way that PEER is set up is that there is a mixture of articles with varying lengths of embargo, from zero to 36 months. So far, there are very few articles with long embargoes (24- or 36-months) that have had time to mature and go live in PEER, so these are excluded from Table 9 below. Similarly, 3- and 5-month embargoes are sparsely represented. Combined with the backfill issue, this makes it difficult to make reliable claims about the impact of embargo periods on PEER use. There is really no substitute for PEER reaching a steady state of ingestion in order to really test this.

In the case of embargo=0 months, there is no disadvantage to PEER users over visitors to the publisher's website, so it seems reasonable to index subsequent downloads against this benchmark. The data in Table 3 suggests that as far as PEER users are concerned, currency is possibly not of the utmost importance. Downloads for articles immediately available are not noticeably different from those where the user has to wait 6 or 12 months before accessing the material. If currency were a critical factor, one would expect the levels of use at 6- and 12-months to be considerably lower. This may well be a case of conditioning: repository users may not expect to find the same level of currency as they do on the publishers' platform. As always, information

behaviour may also be conditioned by the features available on the websites: there may not be much volition, people are taken where they are taken by the machine.

Table 3: Repository and publisher downloads by embargo period

Full text downloads and downloads indexed against no embargo

	Repository downloads		Publisher downloads	
	Downloads	Index	Downloads	Index
No embargo	25,332	100	149,040	100
6 months	23,384	93	476,978	320
12 months	26,432	104	363,350	244
18 months	8,364	33	66,263	45

The publisher data in Table 3 shows a different story, and content retains very significant value over the first 12 months before decline begins to set in.

Looking at PEER downloads as a percentage of publisher downloads by subject (journal-level analysis) we find that PEER is highly popular for short embargo materials in the physical sciences and in the social sciences and humanities following by what appears to be a steady migration in favour of publisher content. In medicine, there is much less variation by embargo period and this really needs further investigation. As can be seen in the table, some of the cells represent low numbers of articles (n) and this is certainly an issue.

Table 4: Repository downloads as a percentage of publisher downloads by embargo period

Numbers of articles and repository downloads expressed as a percentage of publisher downloads with 95% confidence intervals

		Embargo period (months)			
		0	6	12	18
Life sciences		**11.8** (11.0-12.7)	**8.2** (7.7-8.7)	**8.5** (8.4-8.7)	**5.3** (4.5-6.1)
	n=	*1,085*	*823*	*2,556*	*22*
Medicine		**3.2** (3.2-3.2)	**11.4** (8.9-14.0)	**8.2** (8.0-8.4)	**11.7** (11.6-11.9)
	n=	*79*	*2,362*	*1,545*	*171*
Physical sciences		**35.0** (8.4-8.7)	**14.7** (8.0-8.4)	**6.7** (6.5-6.9)	**14.6** (14.4-14.8)
	n=	*152*	*348*	*565*	*1,518*
Social sciences and humanities		**24.0** (23.6-24.5)	**12.7** (11.9-13.5)	**13.2** (11.3-14.2)	**7.9** (7.6-8.2)
	n=	*1,232*	*204*	*316*	*2*

The evidence above data may have another implication which is related to the concept of information obsolescence. It is well understood from citation studies that the value of information content wanes with age, but at different rates in different disciplines. This has led to the development of concepts such as the half-life, or the median age (usually expressed in years), of citations to a particular set of articles, such as a journal or a field. Empirical data concerning the obsolescence of article usage is much more limited, the result of our ability only recently to map decreasing usage using full text downloads as a proxy measure.

Impact of the PEER intervention

The final question we address is that 'To what extent, if at all, do journal origin, impact factor, date of official publication and other factors impact upon repository usage and information-seeking behaviour?'

To answer this question we have carried out two sets of analysis. The first set looks at the usage before and after PEER intervention and presents ratio statistics. The second set of analysis looks at the the comparative take-up rates of publishers and repository.

An important question about the impact of the PEER is whether its usage is wholly complementary to what the publishers are offering – and so growing the market for scholarly information, or whether it is competitive? Or, more likely, a bit of both. Further clues as the nature and extent of these dynamics will emerge from the findings of the randomised control trial, but the descriptive evidence tends to suggests that PEER is complementary in net terms to the formal system.

In Table 5, we compare two 6-month periods: March-August 2010 and 2011. 2010 represents a very early point in the development of PEER content, before the Big Wave had kicked in and at a time when there was little use of PEER. Of course, a better benchmark would have been when repository use was zero, but we do not have access to a full set of publisher log data for 2009 and, in any case, that is going back a very long way in internet terms.

Table 5: Full text downloads: PEER repositories and publisher sites

Numbers of full text downloads, March -August 2010 (`before') and March - August 2011 (`after')

	Before		After	
	Repositories	Publishers	Repositories	Publishers
Life sciences	5,125	263,513	28,407	425,572
Medicine	3,686	201,213	23,019	431,659
Physical sciences	2,229	164,200	17,312	172,793
Social sciences and humanities	2,021	122,439	22,320	136,843
All broad subjects	**13,061**	**751,365**	**91,058**	**1,166,867**

The message from Table 5 is that after the Big Wave, publisher use increased in absolute terms all four subject areas, `despite' PEER.

A paired sample t-test (Table 6) confirms that publisher downloads increased overall in relative terms as well as in absolute numbers. Downloads per article increased in all four subjects, although in the physical sciences, that increase was not statistically significant.

Table 6: Before and after PEER intervention: paired sample t-tests

Mean full text downloads per article on the publisher's site, and test statistics, March -August 2010 (`before') and March -August 2011 (`after')

	Downloads per article		Paired sample statistics			Verdict on traffic to publisher site
	Before	After	t-statistic	Articles	p	*Verdict*
Life sciences	58.7	94.9	11.50	4,487	< 0.01	*Traffic up*
Medicine	45.9	98.5	22.66	4,383	< 0.01	*Traffic up*
Physical sciences	48.0	50.5	1.59	3,422	0.11	*Inconclusive*
Social sciences and humanities	61.2	68.4	4.74	2,000	<0.01	*Traffic up*
All subjects	**52.6**	**81.6**	**22.30**	**14,292**	**< 0.01**	***Traffic up***

PEER descriptive statistics

The following sub-sections offers further analysis using a variant of the ratio statistic introduced earlier. This time the ratio of publisher to repository downloads within the time window of March to August 2011.

This statistic needs to be treated with caution given the difficulties in interpreting longitudinal data in a complex and fast moving scholarly information environment. Since it is a ratio it is sensitive both to the numerator (changes in usage on the publisher platform) and, especially, the denominator: PEER downloads which for the period reported here are relatively small. For this reason, 95 per cent confidence intervals are provided around the mean.

Usage patterns at the article level are very highly skewed, with most articles being used once or only a few times, and a small number very frequently: they typically follow a log-normal distribution rather than the familiar bell curve. This is the case for both the PEER and publisher usage data examined in this report. In order to create a meaningful average, the download data were transformed into natural logs, and this gives a very reasonable approximation of a normal bell-shaped distribution and facilitates the legitimate use of the statistical test used here: a one-way Analysis of Variance (ANOVA).

By subject

This more formal analysis confirms the picture developed in Table 6, that users in the physical sciences and in the social sciences and humanities are the most `PEER friendly'. In fact, it shows that there is clear blue water, statistically, between these users and those in the life sciences and medicine. It is very unlikely indeed that what we are seeing here is just an artifact of a noisy system, these are strong clear signals. The higher the mean in this table, the greater the relative preference for the publisher version of record.

Table 7: Ratio statistics by broad subject

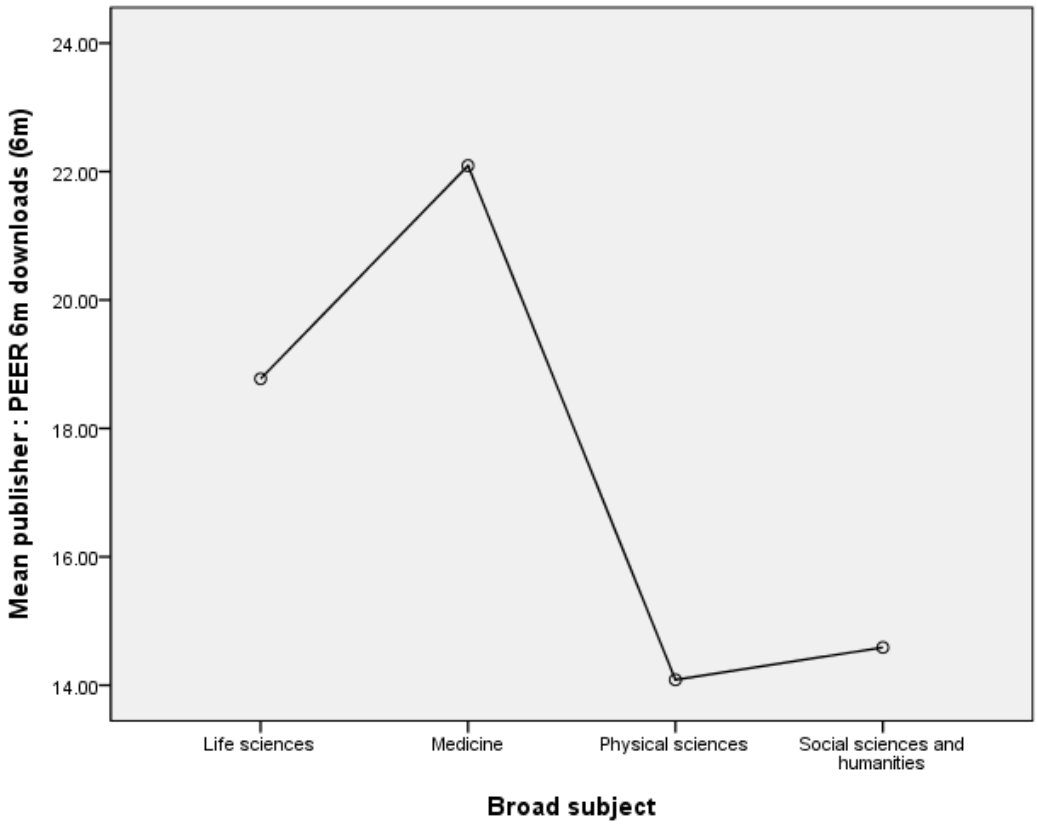
Ratios of publisher to repository full text downloads, March - August 2011, means and confidence intervals (journal level analysis)

				95% confidence intervals	
	Articles	Mean	SD	low	high
Life sciences	4,480	18.77	27.66	17.96	19.58
Medicine	4,362	22.09	20.62	21.48	22.70
Physical sciences	3,401	14.08	12.16	13.68	14.49
Social sciences and humanities	1,980	14.59	85.95	10.80	18.38
All subjects	**14,223**	**18.09**	**38.02**	**17.46**	**18.71**

ANOVA F=35.03, P<0.01

Figure 12: Ratio statistics by broad subject

Ratios of publisher to repository full text downloads, March - August 2011, means (journal level analysis)



By journal impact factor tertile

In the original design of the PEER experiment, journals were sampled using a variety of criteria, including journal impact factors grouped in tertiles. The data laid out below show that users are much more likely to download material from the top and middle tertiles from the publisher's website rather than from a PEER repository.

Table 8: Ratio statistics by journal impact tertile

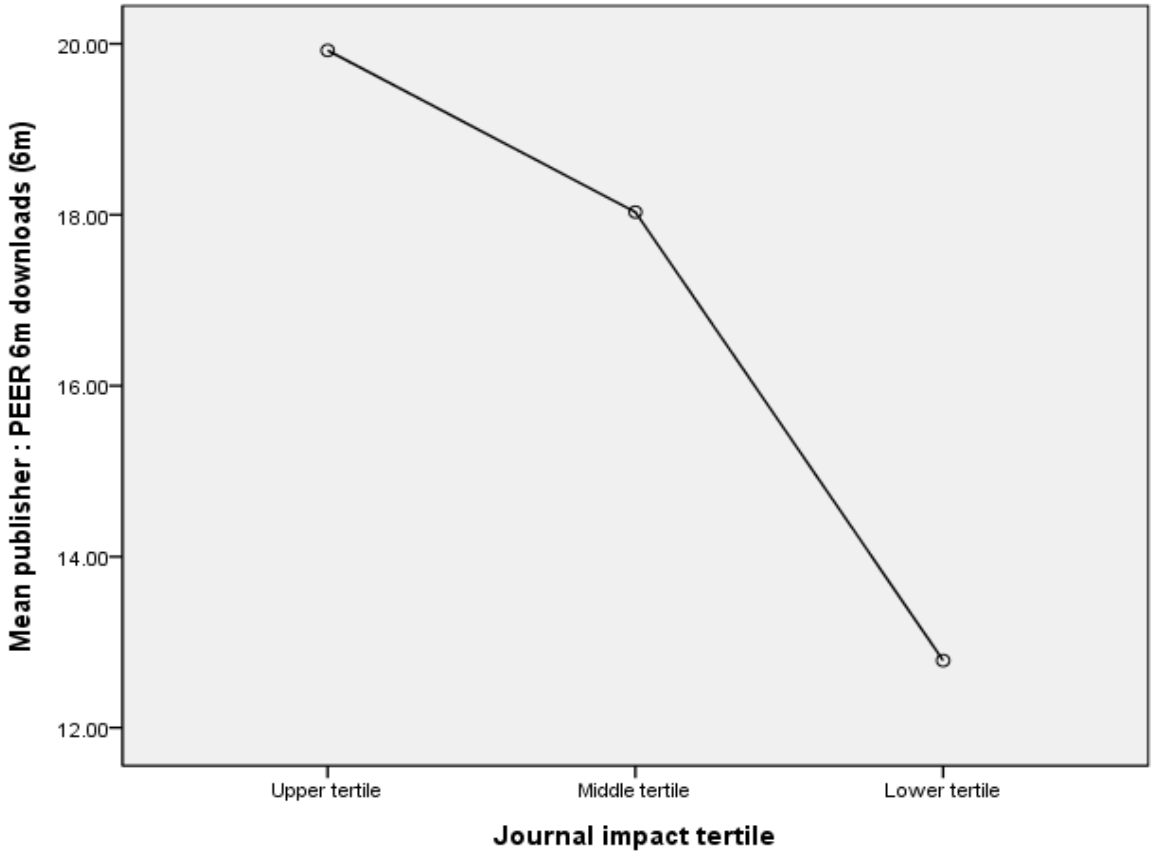
Ratios of publisher to repository full text downloads, March - August 2011, means and confidence intervals (journal level analysis)

				95% confidence intervals	
	Articles	Mean	SD	low	high
Upper tertile	7,529	19.92	25.08	19.36	20.49
Middle tertile	4,708	18.03	57.47	16.39	19.67
Lower tertile	1,421	12.79	9.24	12.31	13.27
All tertiles	**13,658**	**18.53**	**38.71**	**17.88**	**19.18**

ANOVA F=20.97, P<0.01

Figure 13: Ratio statistics by journal impact tertile

Ratios of publisher to repository full text downloads, March - August 2011, means (journal level analysis)



By publication year

Users also seem to `prefer' the publisher site for newer articles. This may be behavioural (the publisher site is still their first port of call, perhaps) or it may be something to do with how the sites are organised. This effect has nothing to do with embargo periods since all the articles are live concurrently on both PEER and the publisher platforms.

Table 9: Ratio statistics by publication year

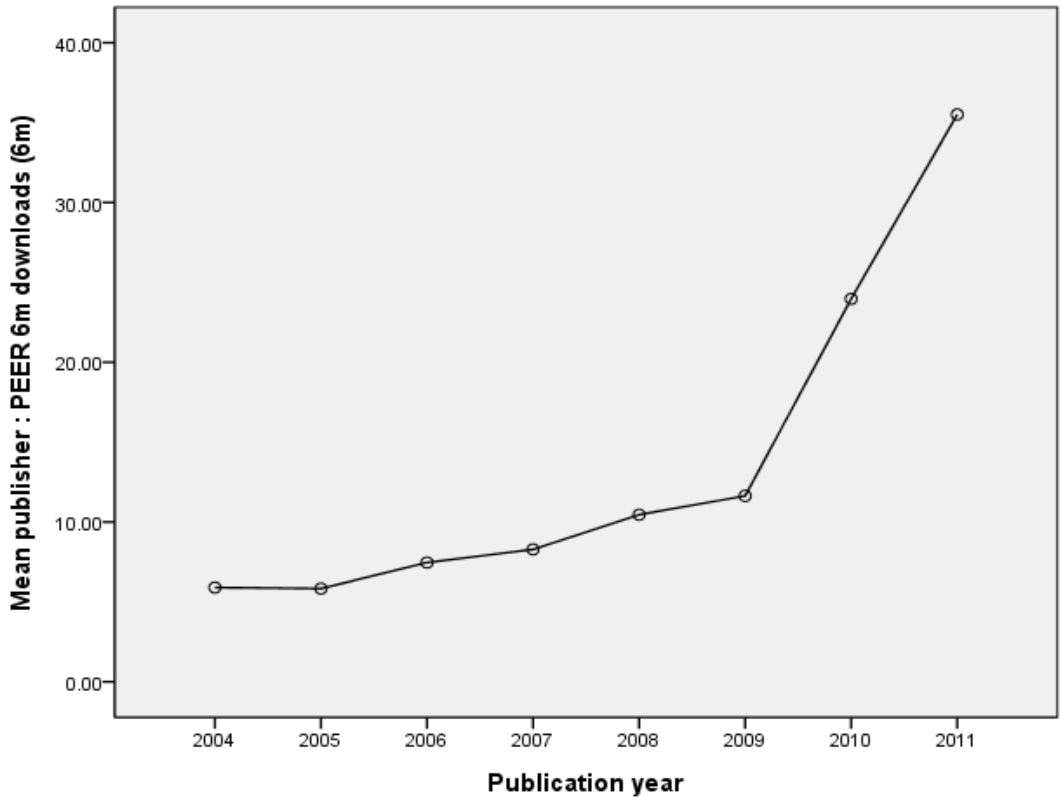
Ratios of publisher to repository full text downloads, March - August 2011, means and confidence intervals (journal level analysis)

				95% confidence interval	
	Articles	Mean	SD	low	high
2004	3	5.90	-	5.90	5.90
2005	395	5.83	6.18	5.22	6.44
2006	564	7.46	5.21	7.03	7.90
2007	1,160	8.28	4.26	8.04	8.53
2008	1,874	10.46	6.42	10.17	10.75
2009	3,445	11.64	6.22	11.43	11.84
2010	5,148	23.97	44.86	22.74	25.20
2011	1,634	35.51	73.29	31.95	39.07
All years	**14,223**	**18.09**	**38.02**	**17.46**	**18.71**

ANOVA F=121.63, P<0.01

Figure 14: Ratio statistics by publication year

Ratios of publisher to repository full text downloads, March - August 2011, means (journal level analysis)



By embargo period

It is not easy to interpret the data relating to embargo periods below and there are probably several things going on at the same time: it seems unlikely that users seem to prefer to download both very recent and quite old material from repositories. The data points at 24- and 36-months represent low numbers of articles, as does the 5-month figure, and this is a case where a much longer run of data is needed, and greater representation of longer embargo periods.

Table 10: Ratio statistics by embargo period

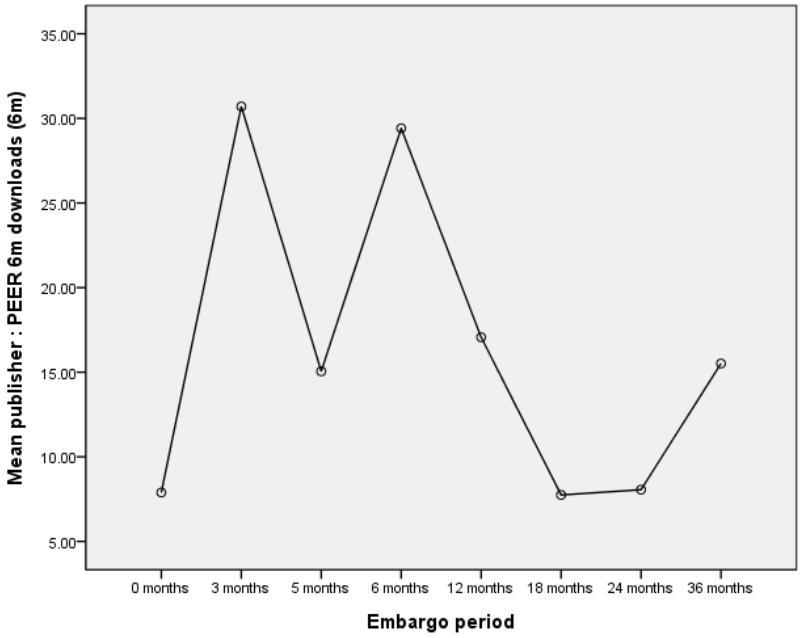
Ratios of publisher to repository full text downloads, March - August 2011, means and confidence intervals (journal level analysis)

				95% confidence interval	
	Articles	Mean	SD	low	high
0 months	2,548	7.89	5.35	7.68	8.10
3 months	770	30.70	13.90	29.72	31.69
5 months	226	15.06	5.12	14.38	15.73
6 months	3,678	29.42	70.14	27.15	31.68
12 months	4,980	17.07	15.21	16.64	17.49
18 months	1,709	7.75	2.98	7.61	7.89
24 months	156	8.06	4.71	7.31	8.80
36 months	156	15.52	4.19	14.85	16.18
All embargoes	**14,223**	**18.09**	**38.02**	**17.46**	**18.71**

ANOVA F=111.10, p< 0.01

Figure 15: Ratio statistics by embargo period

Ratios of publisher to repository full text downloads, March - August 2011, means (journal level analysis)



By age of article

The broad pattern regarding the age of an article, measured in months since first online publication, is that preprints are more likely to be downloaded from a PEER repository the older they are.

Table 11: Ratio statistics by months since first online publication

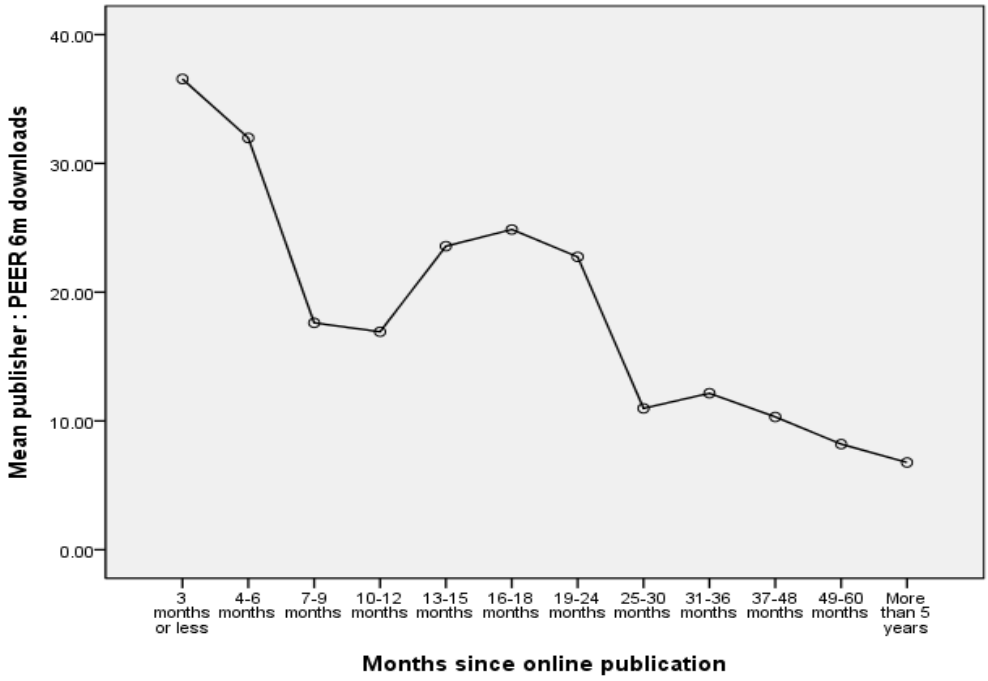
Ratios of publisher to repository full text downloads, March- August 2011, means (journal level analysis)

				95% confidence intervals	
	Articles	Mean	SD	low	high
3 months or less	1,361	36.56	78.31	32.39	40.72
4-6 months	241	31.98	41.23	26.74	37.21
7-9 months	32	17.62	16.50	11.66	23.57
10-12 months	1,135	16.92	13.61	16.13	17.72
13-15 months	1,335	23.57	35.60	21.66	25.48
16-18 months	1,454	24.87	43.72	22.62	27.11
19-24 months	1,972	22.74	54.08	20.36	25.13
25-30 months	1,689	10.98	5.88	10.70	11.26
31-36 months	1,401	12.15	7.08	11.78	12.52
37-48 months	1,731	10.31	6.25	10.02	10.61
49-60 months	1,020	8.20	4.60	7.92	8.48
More than 5 years	852	6.78	5.64	6.40	7.15
All ages	**14,223**	**18.09**	**38.02**	**17.46**	**18.71**

ANOVA F=73.77, p<0.01

Figure 16: Ratio statistics by months since first online publication

Ratios of publisher to repository full text downloads, March- August 2011, means (journal level analysis)



By language

Articles in French or German are more likely to be downloaded from a PEER repository than from the publishers' website. This is hardly noteworthy given the locations of the repositories and the sample sizes for non-English language materials are in any case very small.

Table 12: Ratio statistics by language of article

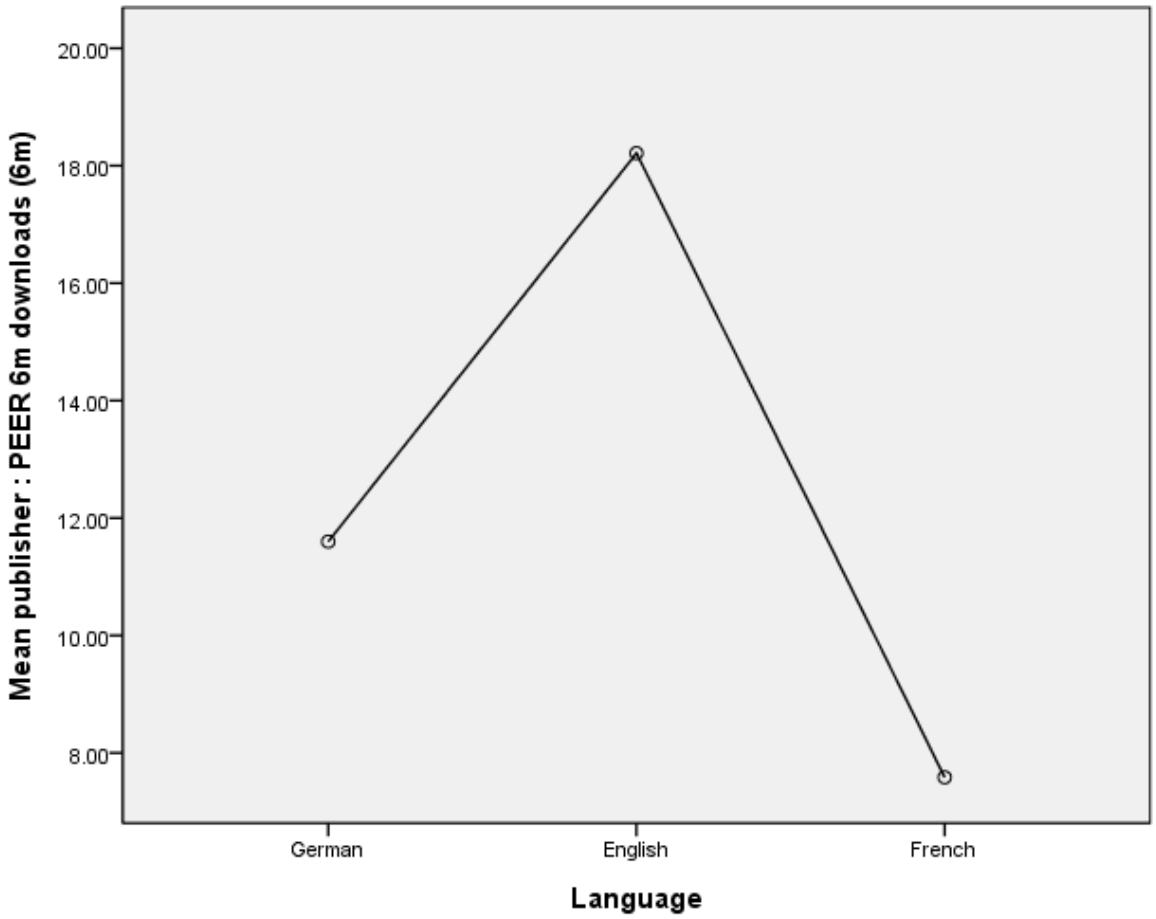
Ratios of publisher to repository full text downloads, March-August 2011, means (journal level analysis)

				95% confidence intervals	
	Articles	Mean	SD	low	high
German	69	11.60	0.00	11.60	11.60
English	14,028	18.21	38.26	17.58	18.85
French	126	7.58	3.17	7.03	8.14
All languages	**14,223**	**18.09**	**38.02**	**17.46**	**18.71**

ANOVA F=5.90, p<0.01

Figure 17: Ratio statistics by language of article

Ratios of publisher to repository full text downloads, March-August 2011, means (journal level analysis)



By lead author status

One of the dummy variables in the analysis is lead author status: whether the lead is based at an EU-27 institution or somewhere in the rest of the world. A plausible hypothesis was that PEER users might exercise a preference for a paper with an EU-27 lead, and this is strongly confirmed below.

Table 13: Ratio statistics by lead author status

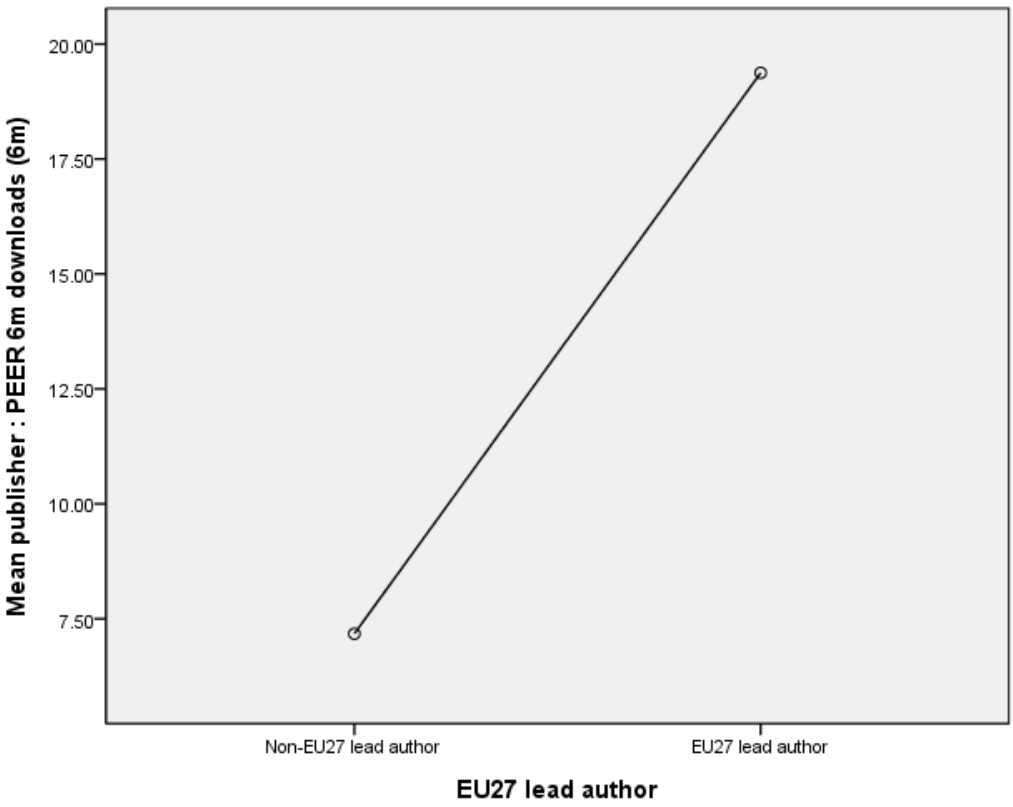
Ratios of publisher to repository full text downloads, March-August 2011, means (journal level analysis)

				95% confidence interval	
	Articles	Mean	SD	low	high
Non-EU27 lead author	1,501	17.17	6.04	18.68	20.07
EU27 lead author	12,722	19.37	39.95	17.46	18.71
All lead authors	**14,223**	**18.09**	**38.02**	**6.87**	**7.48**

ANOVA F=139.61, p<0.01

Figure 18: Ratio statistics by lead author status

Ratios of publisher to repository full text downloads, March-August 2011, means (journal level analysis)



Usage correlations

This section explores whether there is any correlation at the article level between use on the publishers' web sites or through PEER repositories? Evidence of a strong positive correlation would suggest that information behaviour is similar, irrespective of platform. In other words, articles that tend to be popular or unpopular on one platform are likely to be similarly popular or unpopular on the other. A lack of statistical association might suggest a prima facie case for different kinds of information behaviour being displayed on the different platforms.

The data presented here are partial correlations: the length of the embargo period, the journals' citation impact (SNIP) and the age of the article in months are controlled for to create a level playing field for comparison.

Table 14: Correlation between repository and publisher downloads

Partial correlation coefficients and significance, controlling for embargo period, journal impact and age of article

	Broad subject				
	Life sciences	Medicine	Physical sciences	Social sciences and humanities	**All subjects**
Correlation coefficient	0.115	0.220	0.570	0.308	**0.221**
Statistical significance	p < 0.01	p < 0.01	p < 0.01	p < 0.01	**p < 0.01**

In all four subjects, there is a positive and highly statistically significant correlation (this just means that the association is `real' and cannot be explained easily by chance). The correlation is moderate in the physical sciences and low in the other subjects. The hypothesis that users are displaying similar downloading behavior on both platforms is not therefore strong.

Comparison of publisher and repository take-up rates

By subject

This section introduces the notion of `repository take-up rates'. This refers to the percentage of experimental PEER articles that were downloaded at least once during the six months of March to August 2011. Practically all articles (99.0 per cent) were downloaded from the publisher platform over that period, compared with just under three quarters (73.6 per cent) from PEER repositories. PEER social sciences and humanities materials proved to be especially well used (83.0 per cent).

Table 15: Publisher take-up by broad subject

Articles used or not used, March - August 2011, row percentages

	Publisher take-up	
	Not used	Uesd
Life sciences	1.2	98.8
Medicine	1.6	98.4
Physical sciences	0.1	99.9
Social sciences and Humanities	0.9	99.2
All broad subjects	**1.0**	**99.0**

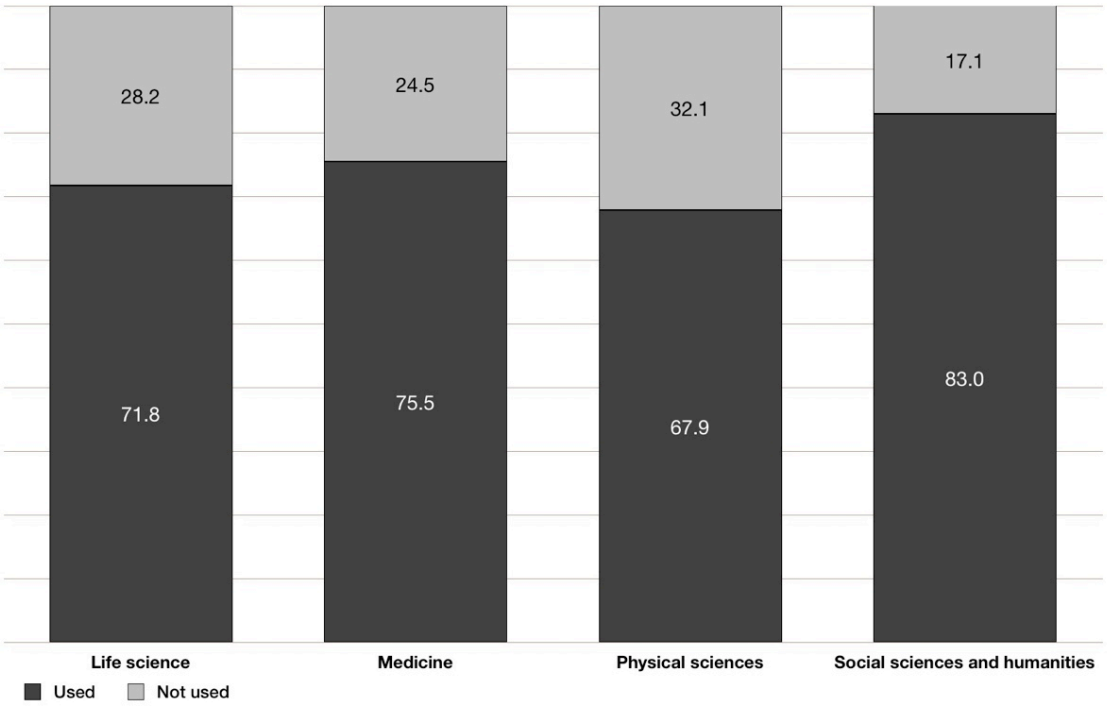
Table 16: Repository take-up by broad subject

Articles used or not used, March 2011 to August 2011, row percentages

	Repository take-up	
	Not used	Used
Life sciences	28.2	71.8
Medicine	24.5	75.5
Physical sciences	32.1	67.9
Social sciences and humanities	17.1	83.0
All broad subjects	**26.4**	**73.6**

Figure 19: Repository take-up by broad subject

Articles used or not used, March - August 2011, percentages within categories



By journal impact factor tertile

Slightly more articles in the lowest tertile category remained unaccessed over the period, but the overall pattern is that a majority of articles in PEER were used in a relatively short six-month period.

Table 17: Publisher take-up by journal impact tertile

Articles used or not used, March - August 2011, row percentages

	Publisher take-up	
	Not used	Not used
Upper tertile	1.0	99.0
Middle tertile	0.4	99.6
Lower tertile	1.9	98.1
All tertile	**0.9**	**99.1**

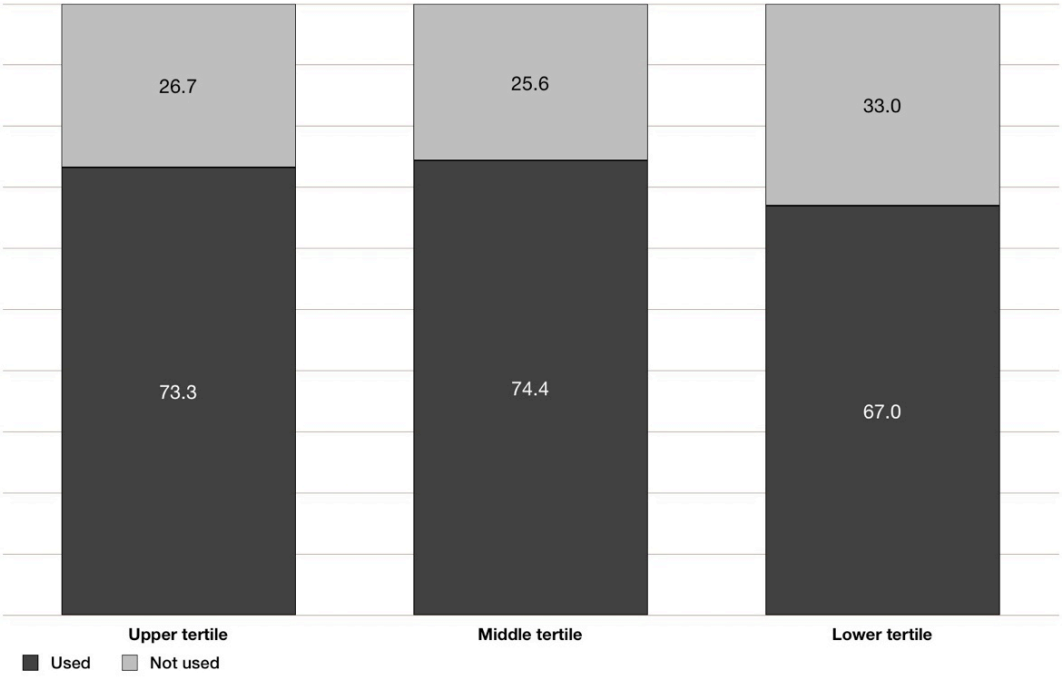
Table 18: Repository take-up by journal impact tertile

Articles used or not used, March 2011 to August 2011, row percentages

	Repository take-up	
	Not used	Not used
Upper tertile	26.7	73.3
Middle tertile	25.6	74.4
Lower tertile	33.0	67.0
All tertiles	**27.0**	**73.0**

Figure 20: Repository take-up by journal impact tertile

Articles used or not used, March -August 2011, percentages within categories



By publication year

The data in the following tables are really quite surprising: they suggest that PEER users are much more likely to download material that is several years old. This is almost certainly an experimental artifact, with a lot of new material being ingested into the repositories late in the six-month cycle, and an inevitable consequence of the Big Wave rather than a steady-state situation.

Table 19: Publisher take-up by publication year

Articles used or not used, March - August 2011, row percentages

	Publisher take-up	
	Not used	Not used
2004		100.0
2005	6.3	93.7
2006	2.1	97.9
2007	0.4	99.6
2008	0.6	99.4
2009	0.3	99.7
2010	0.5	99.5
2011	3.5	96.5
All publication years	**1.0**	**99.0**

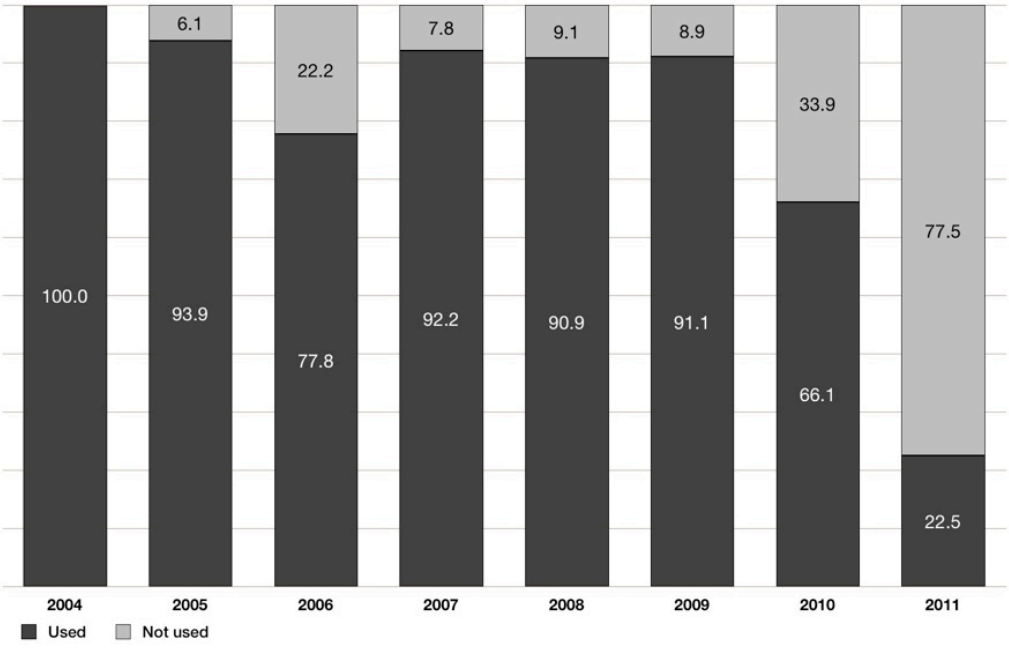
Table 20: Repository take-up by publication year

Articles used or not used, March - August 2011, row percentages

	Repository take-up	
	Not used	Not used
2004		100.0
2005	6.1	93.9
2006	22.2	77.8
2007	7.8	92.2
2008	9.1	90.9
2009	8.9	91.1
2010	33.9	66.1
2011	77.5	22.5
All publication years	**26.4**	**73.6**

Figure 21: Repository take-up by publication year

Articles used or not used, March - August 2011, percentages within categories



By embargo period

Similar strictures apply to the interpretation of take-up by embargo period (as we shall more fully later). There is no very clear or obvious pattern going on here except perhaps that shorter embargo periods (none and five months are associated with deeper exploration of the archive. But the same issues apply as previously, are we just seeing Big Wave effects?

Table 21: Publisher take-up by embargo period

Articles used or not used, March - August 2011, row percentages

	Publisher take-up	
	Not used	Used
0 months	3.7	96.3
3 months	0.1	99.9
5 months	0.4	99.6
6 months	1.1	98.9
12 months	0.2	99.8
18 months	0.1	99.9
24 months		100.0
36 months		100.0
All embargo periods	**1.0**	**99.0**

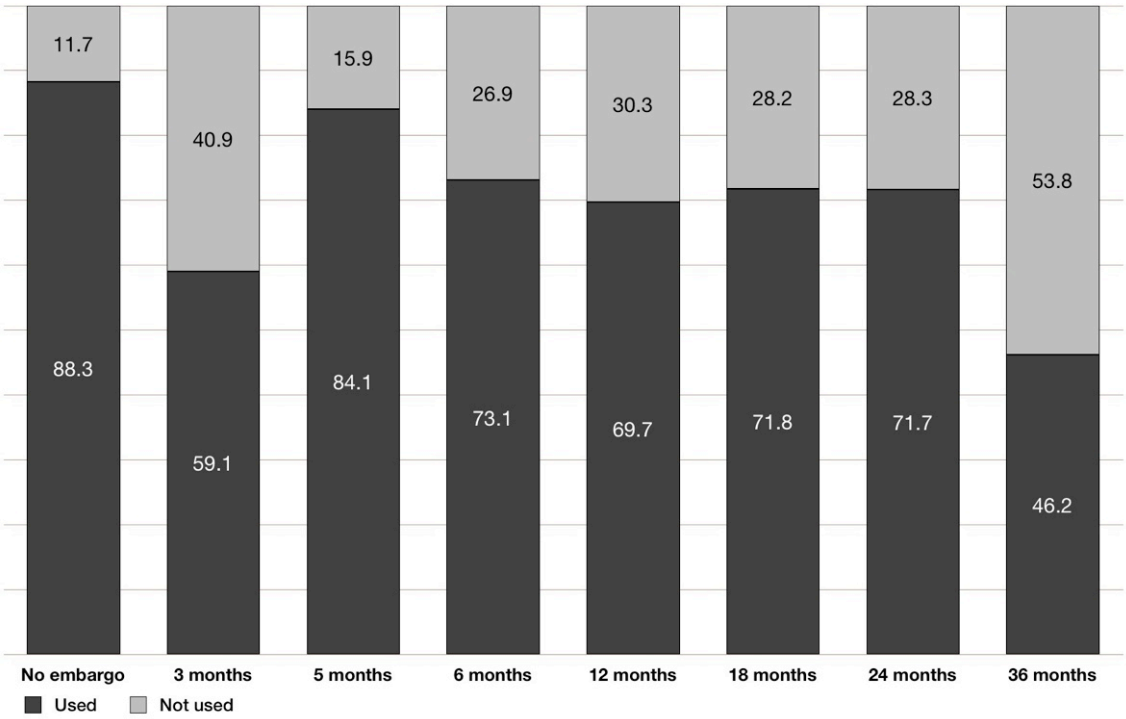
Table 22: Repository take-up by embargo period

Articles used or not used, March - August 2011, row percentages

	Repository take-up	
	Not used	Used
0 months	11.7	88.3
3 months	40.9	59.1
5 months	15.9	84.1
6 months	26.9	73.1
12 months	30.3	69.7
18 months	28.2	71.8
24 months	28.3	71.7
36 months	53.8	46.2
All embargo periods	**26.4**	**73.6**

Figure 22: Repository take-up by embargo period

Articles used or not used, March 2011 to August 2011, percentages within categories



By age of article

A more useful way to understand the time characteristics of repository take-up is by looking at the actual age of articles (in terms of months elapsed between online publication and download). Broadly, this seems to suggest that the PEER archive is more exhaustively trawled for older materials, which is surprising.

The devil is in the detail. There are only 32 articles in the 7-9 month band, and 249 in the 4-6 month band compared, say with 1,978 aged between 19 and 24 months. The sample is heavily weighted towards older articles because of the Big Wave effect, and not too much should be read into the data at this juncture. More time is needed for PEER to settle down.

Table 23: Publisher take-up by age of article (months since first online publication)

Articles used or not used, March - August 2011, row percentages

	Publisher take-up	
	Not used	Used
3 months or less	0.8	99.2
4-6 months	8.4	91.6
7-9 months	84.4	15.6
10-12 months		100.0
13-15 months	0.1	99.9
16-18 months	0.9	99.1
19-24 months	0.5	99.5
25-30 months	0.3	99.7
31-36 months	0.5	99.5

37-48 months	0.6	99.4
49-60 months	0.9	99.1
More than 5 years	3.6	96.4
All ages	**1.0**	**99.0**

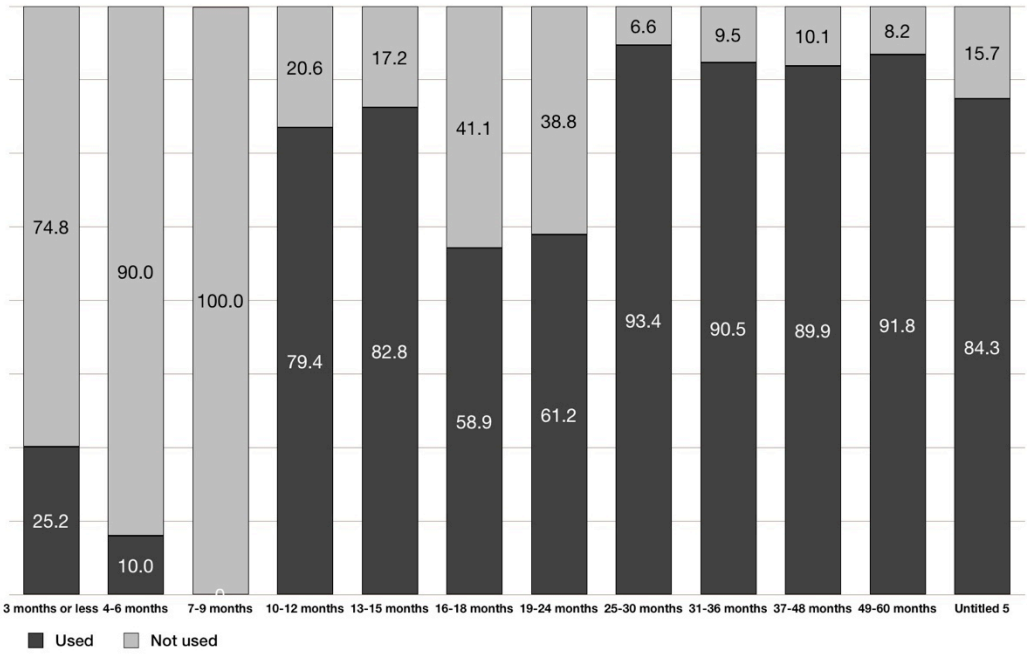
Table 24: Repository take-up by age of article (months since first online publication)

Articles used or not used, March - August 2011, row percentages

	Repository take-up	
	Not used	Used
3 months or less	74.8	25.2
4-6 months	90.0	10.0
7-9 months	100.0	
10-12 months	20.6	79.4
13-15 months	17.2	82.8
16-18 months	41.1	58.9
19-24 months	38.8	61.2
25-30 months	6.6	93.4
31-36 months	9.5	90.5
37-48 months	10.1	89.9
49-60 months	8.2	91.8
More than 5 years	15.7	84.3
All ages	**26.4**	**73.6**

Figure 23: Repository take-up by age of article (months since first online publication)

Articles used or not used, March - August 2011, percentages within categories



LIMITATIONS AND FURTHER RESEARCH

Action research in an environment as complex as the scholarly web is fraught with difficulties and caution must be applied to the findings of this study. We absolutely must not generalise from the findings here to green open access more generally since PEER has a number of characteristics that taken together make it unique. Automated publisher deposit of content into institutional repositories is far from the norm, and while there may be on-going initiatives for repositories to harvest and share green content, we know of no example which duplicates the huge volume of quality-indexed content across multiple platforms that has has been achieved in the case of PEER. For these reasons PEER stands alone.

The build up to this experiment was long and fraught with unexpected issues along the way (Wallace 2011). A major constraint facing the usage research was that the delays in implementation meant that PEER has still not reached a steady state of ingestion and release of materials. Considerable backfill activity took place, especially during the second half of 2011, and the result is that while PEER has achieved an admirable level of content, the temporal characteristics of that content is not representative of the real world. Substantial backfill is not a normal situation in journal publishing and because of the short duration of the project, the PEER sample is particularly weak in relation to articles aged 3-10 months at one end and at the other end, papers with embargo periods longer than 18 months. In an ideal world, the usage descriptions and randomised controlled trial would have been postponed for twelve months or even longer to allow PEER to attain a natural steady state of ingestion and release following embargo expiry.

Most of CIBER's previous work has involved very detailed scrutiny of a single publisher's log records. PEER was different since so many players were involved, with different log structures and varying levels of detail. In some cases, the log record was almost perfunctory, in others very rich and granular. It would be therefore be invaluable to follow through content from one or two publishers in greater detail, avoiding the lowest common denominator issue. In-depth analysis of the referral patterns to both repository and publisher sites is essential if we are to validate or reject CIBER's conjecture that digital visibility is the likely main driver of the uplift in publisher usage that is the main finding of the trial.

Central to understanding what is going on is a grounded empirical study of the routes that users actually take to discover and navigate their way to content across the scholarly web. The PEER usage studies leave some important questions hanging: to what extent are these findings influenced by search engine factors, social media referral, Google (Scholar) indexing policies, the availability of PEER content on other green platforms such as personal web pages, or system interface design? Are these factors of little effect or significance or could they actually be more important than the experiment itself? A radical conjecture could be that search engines have now become so dominant as to render the underlying question behind this research (do repository downloads impact on publisher usage) of little more than academic interest. We simply don't know.

As well as the `how', there are also important questions about `who' consumes green open access materials and `why'. More insights are needed into which groups benefit from green open access, especially those groups (e.g. citizen scientists, small and medium sized enterprises) who are largely outside of the licensed walled garden and who might otherwise not be able to access these materials at all. The size and demographics of these user populations would be fascinating and of considerable policy significance.

Davis and Fromerth (2007) propose the idea that repositories and publisher sites offer different user experiences and deliver different kinds of value with repositories typically supporting known item searches and publisher platforms supporting browsing and resource discovery. This is a crude dichotomy but an important one and PEER provides a huge test bed of data for understanding user behaviour more deeply.

The two CIBER usage studies so far paint a broad picture of the impact of repositories on publisher usage but the precise mechanisms are not yet fully explicated. We think there would be considerable benefit in taking an homogenous sample of PEER papers with reasonably high activity levels on all platforms and examining the full range of interaction between repositories and publisher sites as well understanding how search engines, social media platforms and other tools fit into the picture.

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ANNEX 1: PROFILE OF PEER CONTENT

Table 25: Number of PEER preprints by deposit mechanism

Numbers of preprints and column percentages

	n	*%*
Publisher deposit	14,265	99.8
Author deposit	27	0.2
All deposit mechanisms	**14,292**	**100.0**

Table 26: Number of PEER preprints by language

Numbers of preprints and column percentages

	n	*%*
English	14,097	98.6
French	126	0.9
German	69	0.5
All languages	**14,292**	**100.0**

Table 27: Number of PEER preprints by subject

Numbers of preprints and column percentages

	n	*%*
Life sciences	4,487	31.4
Medicine	4,843	33.9
Physical sciences	3,422	23.9
Social sciences and humanities	2,000	14.0
All subjects	**14,292**	**100.0**

Table 28: Number of PEER preprints by impact factor tertile

Numbers of preprints and column percentages

	n	*%*
High tertile	7,557	55.1
Middle tertile	4,729	34.5
Low tertile	1,432	10.4
All tertiles	**13,718**	**100.0**

Table 29: Number of PEER preprints by publication year

Numbers of preprints and column percentages

	n	*%*
2004	3	0.0
2005	395	2.8
2006	564	3.9
2007	1,160	8.1
2008	1,874	13.1
2009	3,445	24.1
2010	5,164	36.1
2011	1,687	11.8
All publication years	**14,292**	**100.0**

Table 30: Number of PEER preprints by embargo period

Numbers of preprints and column percentages

	n	*%*
0 months	2,584	18.1
3 months	770	5.4
5 months	226	1.6
6 months	3,737	26.1
12 months	4,938	34.6
18 months	1,713	12.0
24 months	159	1.1
36 months	156	1.1
All embargo periods	**14,292**	**100.0**

Table 31: Number of PEER preprints by lead author status

Numbers of preprints and column percentages

	n	*%*
EU27 lead author	12,791	89.5
Non-EU27 lead author	1,501	10.5
All lead authors	**14,292**	**100.0**

Table 32: Number of PEER preprints by publisher

Numbers of preprints and column percentages

	n	*%*
Publisher A	781	5.5
Publisher B	4,809	33.6
Publisher C	981	6.9
Publisher D	630	4.4
Publisher E	111	0.8
Publisher F	1,292	9.0
Publisher G	1,469	10.3
Publisher H	2,690	18.8
Publisher I	1,529	10.7
All publishers	**14,292**	**100.0**

ANNEX 2: TRENDS IN PEER USAGE BY SUBJECT

Trends in PEER usage in the life sciences

Figure 24: Monthly full text downloads in the life sciences

Numbers for publisher web sites and PEER repositories, March 2010 to February 2012

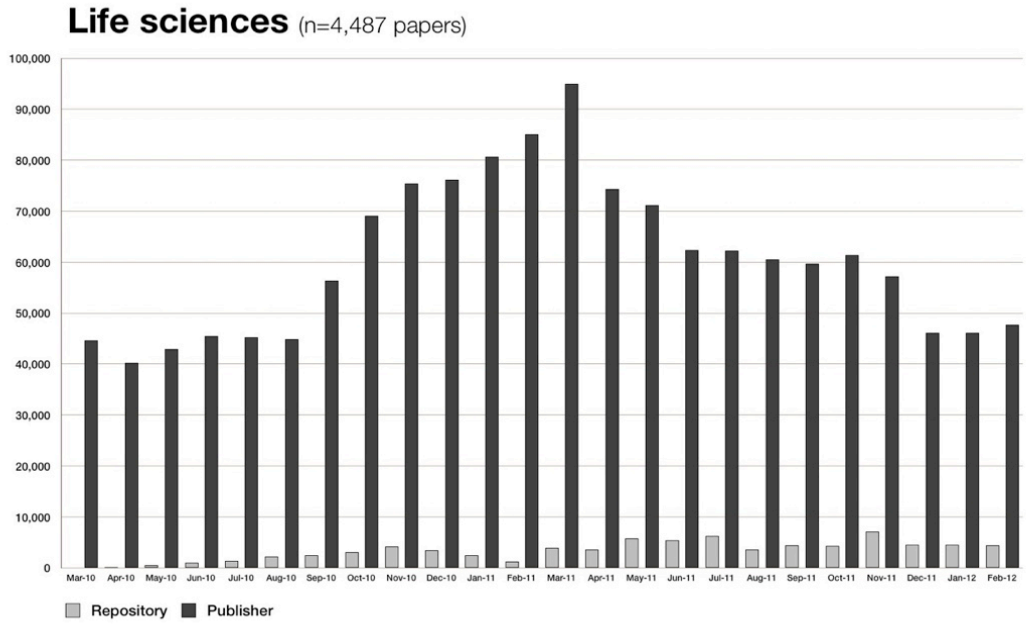
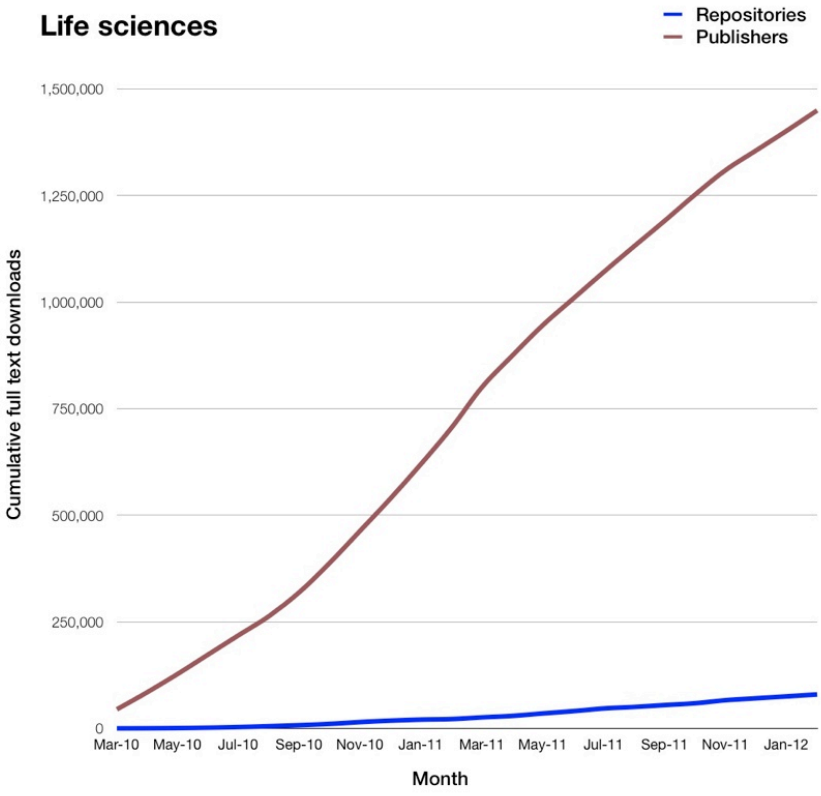


Figure 25: Cumulated full text downloads in the life sciences

Numbers for publisher web sites and PEER repositories, March 2010 to February 2012



Trends in PEER usage in medicine

Figure 26: Monthly full text downloads in medicine

Numbers for publisher web sites and PEER repositories, March 2010 to February 2012

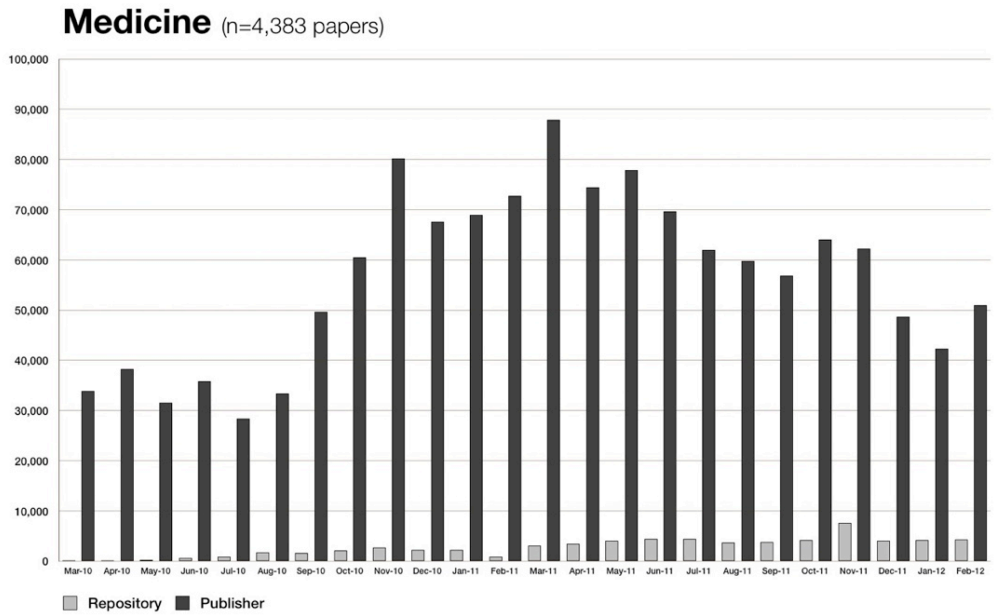
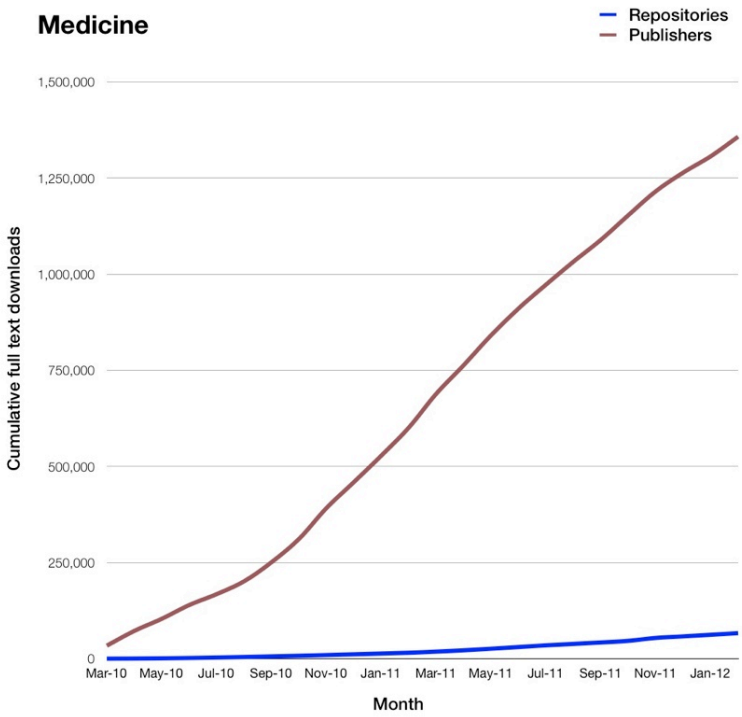


Figure 27: Cumulated full text downloads in medicine

Numbers for publisher web sites and PEER repositories, March 2010 to February 2012



Trends in PEER usage in the physical sciences

Figure 28: Monthly full text downloads in the physical sciences
Numbers for publisher web sites and PEER repositories, March 2010 to February 2012

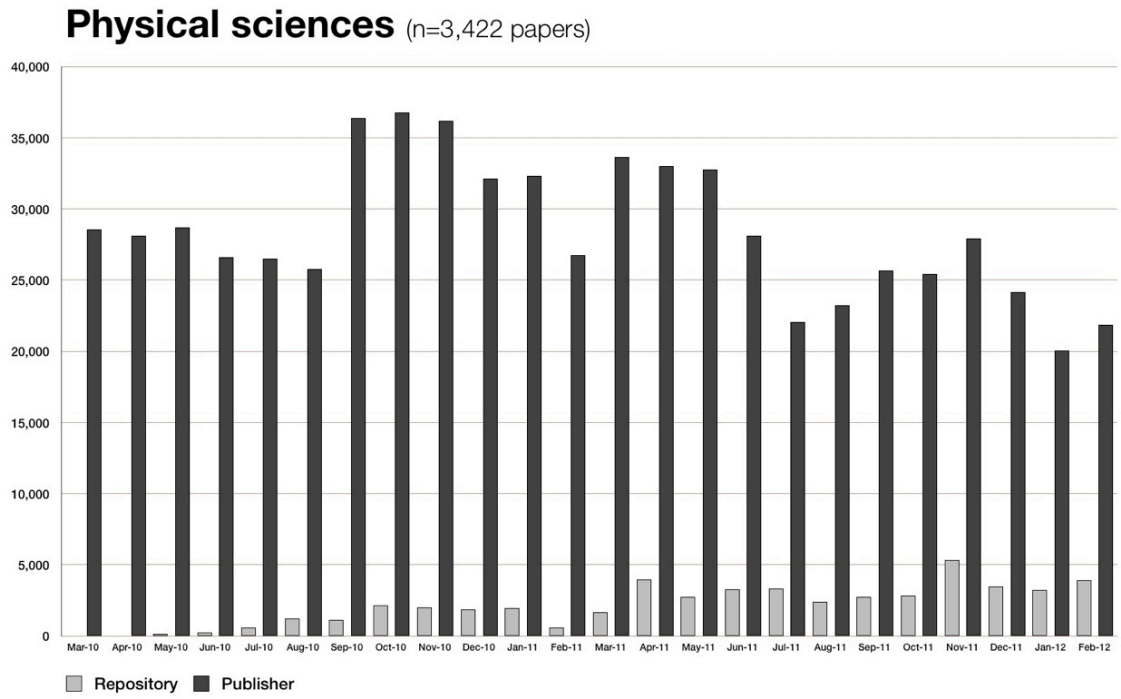
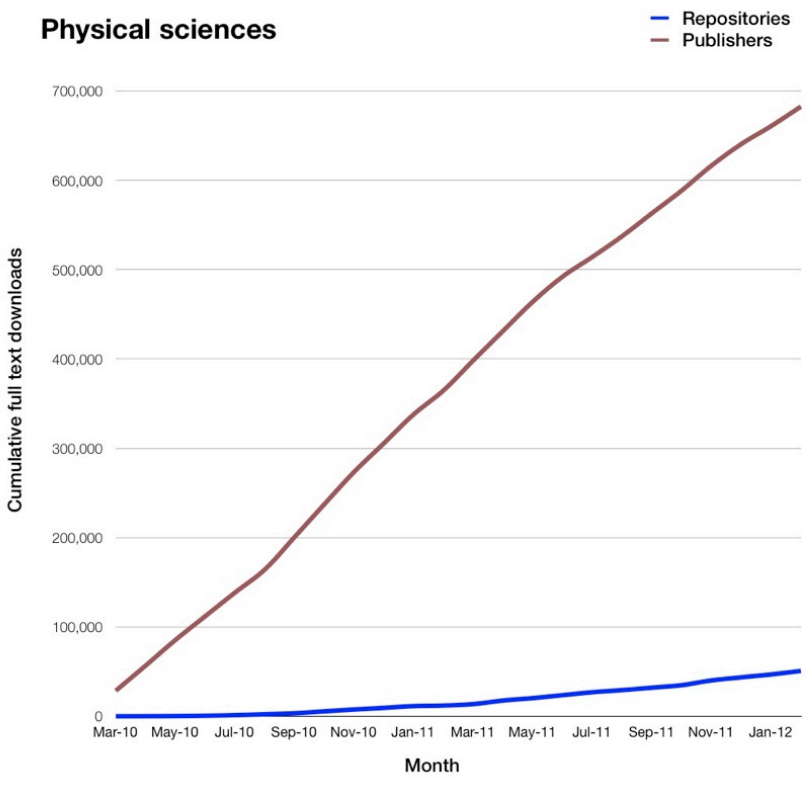


Figure 29: Cumulated full text downloads in the physical sciences
Numbers for publisher web sites and PEER repositories, March 2010 to February 2012



Trends in PEER usage in the social sciences and humanities

Figure 30: Monthly full text downloads in the social sciences and humanities

Numbers for publisher web sites and PEER repositories, March 2010 to February 2012

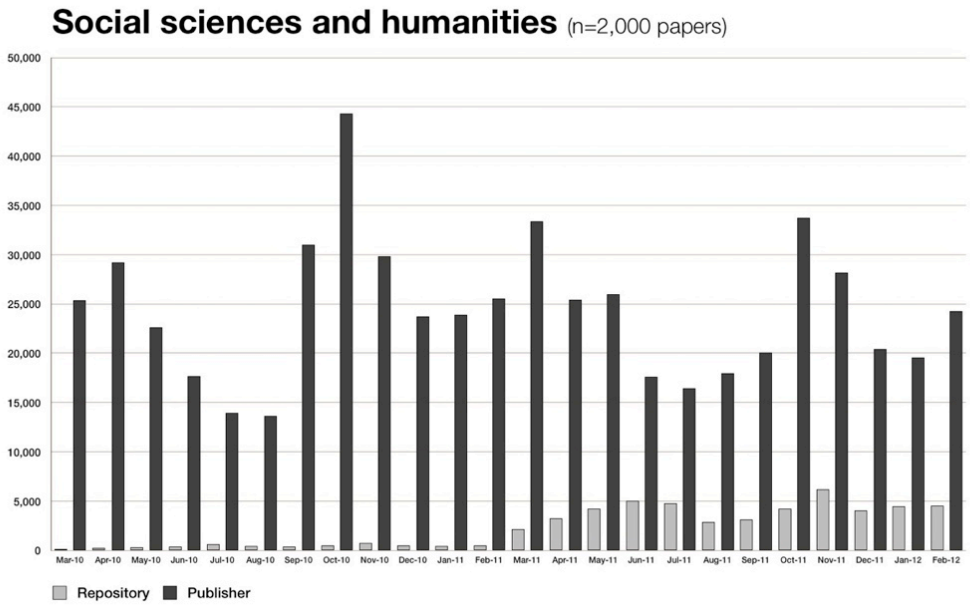


Figure 31: Cumulated full text downloads in the social sciences and humanities

Numbers for publisher web sites and PEER repositories, March 2010 to February 2012