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Citation-Capture Rates by Economic Journals: Do they Differ from Other Disciplines and Does it Matter?

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Abstract

In this paper we compare the rate of citation-capture across the social sciences and sciences, with particular attention paid to economics and its border disciplines generally located in Schools of Business. We also explore citation time-flow differences between a number of leading journals in economics and a representative science category, and between higher and lower ranked economics journals. Our findings suggest that short-term citation counting, either directly or indirectly, for purposes of generating impact factors and the like, introduces a bias in favour of the sciences over the social sciences. This is in addition to the well-known differences in the absolute number of cites between these discipline categories over the short and long term. Our findings call into question the usefulness of citation analysis in national research assessment exercises that concentrate on recent research contributions. Furthermore, within economics, we found short-term impact factors to be systematically biased in favour of lower ranked journals.

Keywords

research measurement
research assessment exercises
time pattern of citations

JEL Codes
A14, C81, I23, J24

1. Introduction

It is well known that citation practices differ between disciplines, and that papers in some disciplines attract, on average, substantially more citations than others (for example, see Evidence 2007, Levitt and Thelwall 2008 and THE 2011). It is for this reason that many in the social sciences are wary of the increasing tendency to use bibliometric measures based directly or indirectly on citation counts to judge research activity since, on average, social science papers are cited less frequently than those in the sciences. The same arguments apply to within-discipline categories. These concerns have been heightened by the emergence of national research assessment exercises (NRAEs), based, in part, on the direct and/or indirect use of bibliometrics, to measure research performance across institutions and to allocate funds accordingly (OECD 2010, Abramo, Cicero and D'Angelo 2011, Sgroi and Oswald 2013).

A key feature of all NRAEs is the time limitation placed on measurable research output: generally ranging from five to seven years (assume six years hereafter). Therefore, the average published article has approximately three years in which to collect citations (the basic building block of most bibliometric measures). In this paper we delve more deeply into inter-disciplinary citation-based measurement debate by focusing on the rate at which citations are captured over a given period of time.

In practice, research output measurements for purposes of NRAEs or other time-limited assessments such as tenure, early to mid-career promotions, and research grant renewals tend to rely on journal ranking schemes as proxies for the expected quantity of cites to individual papers rather than actual cites to such work. This practice is usually justified by reference to the short time period for citation generation to the average paper within the decision-making framework. However, the use of journal proxies to represent the expected number of citations to an individual paper only masks the importance of the citation timing issue.

Virtually all journal ranking schemes are based directly or indirectly on time-limited citation counts (Sgroi and Oswald 2013). The most popular of such measures is based on citations in a given year to papers published in the preceding two years – the two year impact factor (2YRIF).[1] Well known alternatives such as the five year impact factor (5YRIF) and immediacy index (II) are obviously based on time-limited citation counting.[2]

Viewed more generally, the timing of citation production or speed of citation generation is arguably an important indicator of the uptake of new ideas and the contribution of a paper

[1] For a critical analysis of this RAM, see Vanclay (2012).

[2] See Chang, McAleer and Oxley (2011) for an extensive discussion of these research assessment measures (RAMs).

to 'knowledge', or the 'use' of a paper.[3] In this case, one might argue that although two papers generate the same number of cites over the longer-term, the 'early' producer of cites is an indicator of a greater contribution to society's knowledge base. It is not just a matter of when the contribution to knowledge is available, but also its potential impact on future knowledge development. This argument hinges on the degree to which a citation is a valid proxy for knowledge impact.

The concept of citation-timing as used in this paper is more complex than that previously used in the literature. To date, citation-timing studies have been based on the absolute number of citations to a paper or a journal over various time periods. Our approach is to delve more deeply into the 'timing' issue: we focus is on the rate of citation-capture by a paper or a journal over a given period of time, not on the absolute number of cites to a paper or journal over an equivalent time period. For example, two journals may attract an equal number of cites over the long term, but one may attract a higher proportion of cites in the early years after publication than the other. Does this time pattern have implications on measured research performance using standard research assessment measures such as the 2YRIF or other well-known RAMs? It is this question we address in this paper.

More formally, the critical question to be explored is as follows: after adjusting for differences in the absolute number of citations per time period, does the introduction of a short to medium term citation time constraint mitigate or exacerbate the differences in science and social science research output measures relative to those based on long-term citing practices? To address this question we have adopted two restrictions to constrain the exercise to manageable proportions.

First, the paper focuses on the impact of short-term, citation-timing constraints on outcomes in a NRAE-like environment. Secondly, the detailed analysis is restricted to one discipline only, namely, economics. We have chosen economics as our representative social science discipline for the following reasons: based on 2012 Journal Citation Report (JCR) data, it leads all other social science categories with respect the number of journals, articles and citations; and it is the authors' home discipline, thus providing us with some knowledge of the disciplines citation practices.

Our approach is as follows: we compare the rate of citation-capture across the social sciences and sciences, with particular attention paid to economics and its border disciplines generally located in Schools of Business. We also explore citation time-flow differences between a number of leading journals in economics and a representative science category, and between higher and lower ranked economics journals. For reasons outlined above,

[3] Glanzel and Schoepflin (1995) model the use of scientific literature with a stochastic model involving aging and reception processes.

particular attention is paid to differences in rate of citation-capture at the three and six year mark. The paper concludes with a discussion of the policy implications of our findings.

2. Literature Review

The literature on citation-timing within an NRAE environment is very limited. We found only three papers that directly address the subject of this study. Two papers examine the relevance of citation measures in evaluating economic research in the context of New Zealand's research assessment exercise – the Performance-Based Research Fund (PBRF). In Tressler and Anderson (2012), the authors found that performance measures based directly on citation counts were of questionable value in measuring research output at both the departmental and individual researcher level due to the slow rate at which citations are accumulated over an average three year period.

In another paper, Anderson and Tressler (2013) found similar results for assessments based on the 'h' and 'g' index. However, both studies are based on research activity in a small nation state, and neither paper compares citation practices in economics with those in other disciplines. On the other hand, Abramo, Cicero and D'Angelo (2011) found that for Italy, citation flows to papers in the sciences, with the exception of mathematics, were sufficiently robust after two or three years to be a reliable indicator of long-run performance, and hence usable in Italy's NRAE (The Quinquennial Research Evaluation). However, the social sciences were ignored in this study, and the analysis focussed on the absolute number of cites to papers across many science disciplines, not the rate of citation capture that is the focus of our study.[4]

Several other studies have explored the role of citation-timing in contributing to various outcomes (Oromaner 1983, Glanzel and Schoepflin 1995, Adams 2005, Levitt and Thelwall 2008). In general, all of these studies were based on a very limited dataset and all failed to adjust for differences in total cites per year over the study period. That is, these studies did not estimate the rate of citation-capture in each year of the study period; instead they measured absolute citation differences per year over time. In most cases, these studies were based on small samples sizes. For example, Oromaner (1983) explored citation timing issues in four economics journals only over a one year span; Glanzel and Schoepflin (1995) studied citation practices of seven journals, in diverse fields, published over a three year period; Levitt and Thelwall (2008) studied six subject area (including economics) limiting their sample to 1970 publications that, over a 35 year period, generated over 1,000 and 500 cites to science and social science journals, respectively. They also constructed a second sample based on 1986 publications in 13 subject areas; the resulting analysis was restricted to the five most cited papers in each category over the 1986-2006 period. The Adams (2005) paper

[4] Abramo, Cicero and D'Angelo (2011) did discuss the rate of citation-capture for first cites only to papers in several science discipline categories.

utilizes a much more extensive database covering six subject areas in the physical and life sciences; however, the analysis is restricted to U.K. authored or co-authored work. In all these studies, the primary purpose was to explore the reliability of total short-term cites, generally up to six years (in Adams' case, 12- 24 months) as a proxy for total or long-term citations.

3. Data Sources

All data used in this study is from the Thomson Reuters/ Web of Science (WoS) and Journal Citation Reports (JCR). Although competing databases are available, namely Scopus and Google Scholar, the WoS/JCR database is still the de-facto gold standard in academic circles, especially in economics research (Chang, McAleer and Oxley 2011, Hoepner, Kant, Scholtens and Yu 2012). For purposes of this paper, the WoS/JCR databases provides relatively easy access to the information required for the development of multiyear, discipline and journal- specific citation patterns. Furthermore, the overview statistics listed in this paper, such as journal impact factors and article influence scores,[5] are based on the JCR's 2012 annual report (Web of Knowledge 2012a) – the latest available at the time of writing.

We use two data sets. The first is a discipline-based dataset that consists of those categories listed in 2012 that were also listed in JCR annual reports from 2003 to 2012. More specifically, the JCR 2012 report lists 171 science and 55 social science categories; of these we generated 10 year citation patterns for 165 and 52 categories, respectively. The small discrepancies are due to additions and deletions of a limited number of discipline categories over the years.

Our second dataset holds data on all 2012 listed JCR economics journals for which a 10 year citation pattern could be constructed. In this case there is a dramatic difference between the number of items currently listed as economics journals and those reported in earlier time periods. For example, in 2003 only 169 journals were listed under the economics category; this number increased slowly over the 2004 to 2008 period (169 to 209), but then rose dramatically thereafter (247 in 2009; 305 in 2010 and finally to its current number of 333). Of the 333 currently listed economics journals, we were able to collect 10 year citations for 173.[6] Nevertheless, our 10 year citation dataset covers 9 of the top 10 economics journals in the 2012 JCR list with respect to 2 Year Impact Factor (2YRIF) and Article Influence Scores (AIS) and all top ten 5 Year Impact Factor (5YRIF) journals.

[5] For a discussion of the various JCR journal statistics, see Chang, McAleer and Oxley (2011) and Web of Knowledge (2012b).

[6] This outcome is due to the fact that many of the recent additions to the JCR/Economics category are regional journals that tend, on average, to attract relatively few cites.

4. General Characteristics of Citation Patterns by Subject Area and Discipline

In order to place citation practices in economics in a broader context, we shall begin by briefly reviewing discipline level 2012 JCR overview statistics. From Table 1 it is apparent that in 2012, the average number of cites to articles published in the preceding two and five years were substantially greater in the sciences than the social sciences. For example, 1.51 and 2.41 cites were received by science papers and 0.98 and 1.38 by social science papers over the applicable two and five year publication span.

As an aside, note that we have constructed three subsets of the science categories since aggregation masks a number of important differences within the set. More specifically, we generated three groupings that are arbitrary in nature but reflect the way in which many lay people view the science world: the groupings are denoted as the Life Sciences, Natural Sciences and Applied Sciences[7]. Within the sciences it is clear that life science journals, especially in biology and the medical area, are the most heavily cited within 5 years of publication. For economics, the 2YRIF and 5YRIFs are slightly lower than for the Business School Group[8] and even further behind the corresponding values for the social sciences overall. It should also be noted that for all science and social science papers included in the WoS database, the number of life-time cites are 32.2 and 27.5, respectively.

Table 1. 2012 JCR Statistics
Various Categories, Average Scores

JCR Category 2012	Total Number of Cites	2YRIF	5YRIF	Immed. Cites per Article	Half Life of Cites to Journals	Number of Journals	Total No. of Articles	Average No. of Cites per Article
Economics	450167	0.795	1.193	0.258	>10.0	333	16402	27.4
Business School Group	1256973	0.905	1.280	0.236	N/A	893	39010	32.2
Social Sciences: All	5264639	0.980	1.382	0.311	N/A	4145	191259	27.5
Life Sciences	32501220	1.863	2.919	0.624	N/A	6433	826182	39.3
Physics, Chemistry & Geology	14426109	1.625	2.760	0.664	N/A	1752	451326	32.0
Applied Sciences	9183066	1.062	1.795	0.328	N/A	2988	429979	21.4
Sciences: All	61386967	1.507	2.410	0.505	N/A	12851	1904902	32.2

Source: ISI Web of Knowledge, *Journal Citation Report*, 2012.

Within the sciences, Life Sciences once again are the most heavily cited (39.3), with the Natural Sciences papers displaying overall science-like numbers (32.0). On the other hand, papers in the Applied Sciences receive far fewer life-time cites; in fact, fewer cites than for

7 The various JCR discipline categories that have been arbitrarily aggregated to form three science-based groups (Life Sciences, Natural Sciences and Applied Sciences) are presented in Appendix 1. The three sub-groups incorporate 90 percent of the complete 2012 JCR/Science list.

8 The Business School Group is also our own construct. See Table 2 for the JCR social science categories that are included this group.

the social sciences (21.4 versus 27.5). Although it was noted above that the 2YRIF and 5YRIF for economics are below the social science average, the number of life-time cites are virtually identical (27.4 versus 27.5, respectively). However, the corresponding value for the Business School Group is somewhat larger, and, in fact, slightly greater than the value exhibited by the Natural Science Group. In summary, based on 2012 citations to work published in the preceding two and five years, economics papers attract limited attention, but over their lifetime approach the social science average.

Before leaving Table 1, there is one more statistic that is of importance to this study: the Immediacy Index. This indicator represents the average number of cites per paper in the year of publication (2012 in this case). It is clear from the data that science papers start to generate cites more quickly than those in the social sciences. The corresponding value for economics is below the social science average, but in this case exceeds that of the Business School Group (0.26 versus 0.23). Before moving on, note that the 2012 WoS database is dominated by the sciences with respect to the number of journals, articles and life-time cites. The relevant science to social science ratios are: 3.1:1.0, 20.9:1.0, and 11.7:1.0, respectively.

For purposes of this study we have placed economics in the Business School Group; although this can be debated, especially in a North American context, we suggest that regardless of the institutional home of a university's economics department, the border disciplines of finance, marketing and strategy (save for law) are generally located in business schools. In Table 2 we present 2012 JCR data for disciplines frequently located in business schools. As expected, the Business/Finance category exhibits 2YRIF and 5YRIFs and life-time citation-rates that are roughly similar to those in economics. However, business and management papers are more heavily cited than any other Business School category, especially with respect to life-time cites where their performance exceeds that of the average article in the Life Sciences.

Table 2. JCR 2012 Data
by Category, Business School Journals

Name of Journal	Total Number of Cites	2YRIF	5YRIF	Immed. Cites Per Article	Half Life of Cites to Journals	Number of Journals	Total Number of Articles	Average Number of Cites/ Article
Business	242172	1.292	1.688	0.265	>10.0	116	5234	46.3
Business, Finance	106593	0.855	1.170	0.219	>10.0	89	3579	29.8
Communication	43924	0.750	0.983	0.179	8.4	72	2407	18.2
Economics	450167	0.795	1.193	0.258	>10.0	333	16402	27.4
Industrial Relations & Labor	16492	0.643	0.898	0.130	9.9	24	747	22.1
Information Sc & Library Sc	62790	0.743	1.298	0.297	7.3	85	3276	19.2
Management	334835	1.257	1.733	0.307	>10.0	174	7365	45.5
Average	179567.6	0.905	1.280	0.236	N/A	127.6	5572.9	32.2

Source: ISI Web of Knowledge, Journal Citation Report, 2012.

5. Ten Year Citation Capture Rates by Discipline and Subject Area

We now turn our attention to the stated objective of this paper: to study the rate of citation-capture to economics journals and to compare the findings to those of other disciplines. In Table 3 we show the percentage of citations received by journals in various classifications in each year of a ten year time frame. For example, for all papers published in JCR/Economics journals in 2003, 6.0 percent of all citations received over the 2003 to 2012 period (10 years) were collected in Year 3 (2005). The corresponding figures for Year 6 (2008) and Year 10 (2012) are 12.0 and 15.9 percent, respectively.

This table contains a number of important points. First, the rate of citation-capture in economics is very similar to that displayed by the Business School Group (including economics). It is, however, somewhat different from that of the social sciences: in years 1-5, cites are captured by economics papers more slowly than for their parent group. The reverse holds from year 6 through year 10. Note that the proportion of 10 year cites received in any one year reaches a maximum for economics in Year10 – in fact, it increases steadily over the 10 year time horizon[9]. Note that maximum citation rates for the Business School Group and the social sciences occur earlier: in Year 9 and Year 8, respectively. In summary, papers in economics tend to be relatively slow starters, but continue to accumulate citations at an increasing rate over a 10 year time horizon. Let us now contrast this result with those found in the sciences.

The maximum citation rate for the sciences occurs in Year 7 (12.2 percent of the total 10 year accumulation of cites). However, the peak rate for our three listed science groupings reveals substantial variation. Although the maximum citation-rates occur earlier for the Life Sciences (Year 6) and the Natural Sciences (Year 4), the rates vary little from years 3 through 10. This contrasts with economics, Business School Group and social sciences where the citation rates do not level off until Year 7. Note that the Applied Science Group displays citation rates that more closely resemble those of the social sciences than the sciences.

In the last column of Table 3, we display the average number of 10 year cites per paper for each of the categories under review. As expected, the rate for the sciences (24.8) exceeds that of the social sciences (21.3) and economics (19.1). In order to control for this difference in an admittedly arbitrary fashion, let us focus on two groups: the Natural Science Group and the social sciences (all categories). We do so since each group displays almost identical 10-year citations per paper rates (21.7 and 21.3, respectively). Next, we sum the percentages in each of the first three years of citation collection to arrive at three year cumulative citation-rates. The differences are rather stark: for the social sciences only 13.0 percent of total ten year cites take place in the first three years of a paper's 10 year life; the corresponding figure for the Natural Sciences is 22.0 percent. For the Business School Group and economics the

9 Given that the citation rates continue to increase up to year 10, the true maximum rate may be attained in a subsequent year.

corresponding figures are less than half of the Natural Science rate: 10.1 and 9.9 percent, respectively.

From Table 4 we see that the rate of citation-capture in economics is very similar to that exhibited by the Business/Finance and Business School Group. Indeed, observe that cites to economics reach a peak in Year 10, and the other two categories reach a maximum in Year 9. Note that the two categories with an above-average number of cites per paper (both over a 10 year and life- time period), Business and Management, generate relatively few cites in the early years after publication.

Table 3. Percentage of Total 10YR ISI Cites to 2003 Publications Various Categories

JCR Category 2012	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Cites/ Paper
Economics	0.72	3.19	5.97	7.81	9.32	12.02	14.76	15.07	15.20	15.93	19.14
Business School Group	0.88	3.25	6.05	7.95	9.16	12.05	14.60	15.37	15.47	15.23	22.01
Social Sciences: All	1.12	4.34	7.54	9.47	10.23	11.90	13.77	14.00	13.69	13.93	21.29
Life Sciences	1.51	7.44	11.21	11.80	11.79	11.95	11.66	11.30	10.82	10.52	30.30
Physics, Chemistry & Geology	1.83	8.55	11.67	11.87	11.84	11.54	11.67	10.83	10.25	9.95	21.73
Applied Sciences	1.06	5.45	9.26	10.31	11.24	12.95	13.08	12.32	11.80	12.53	15.40
Sciences: All	1.41	6.85	10.57	11.28	11.63	12.20	12.22	11.64	11.13	11.08	24.79
Science & Social Science: All	1.34	6.25	9.85	10.85	11.29	12.13	12.59	12.20	11.75	11.76	24.54

Source: Derived by authors from ISI Web of Knowledge, Journal Citation Reports, 2003-2012.

Table 4. Percentage of Total 10YR ISI Cites to 2003 Publications in Business School Journals

Name of Journal Category	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Cites/ Paper
Business	0.45	2.23	4.68	6.73	8.87	12.34	15.63	16.57	16.25	16.26	27.50
Business Finance	0.83	3.31	6.07	8.17	8.96	12.29	14.10	15.26	15.53	15.48	17.44
Communication	0.91	3.54	6.79	8.95	9.95	12.12	14.78	14.83	15.04	13.10	14.05
Economics	0.72	3.19	5.97	7.81	9.32	12.02	14.76	15.07	15.20	15.93	19.14
Industrial Relations & Labor	1.16	4.01	7.32	8.01	8.63	11.53	14.32	15.63	15.17	14.22	14.31
Information Science & Library Science	1.64	4.58	7.43	9.28	10.06	12.79	13.87	13.87	13.29	13.19	15.02
Management	0.44	1.89	4.12	6.68	8.32	11.30	14.72	16.33	17.78	18.43	37.06
Average	0.88	3.25	6.05	7.95	9.16	12.05	14.60	15.37	15.47	15.23	22.01

Source: Derived by authors from ISI Web of Knowledge, Journal Citation Reports, 2003-2012.

6. Rate of Citation Patterns for Leading Journals in Economics and Neurosciences

In order to explore citation-timing issues in greater depth, we shall shift our attention from the discipline category to individual journals. To do so we have chosen to compare citation patterns in leading economics journals to those in neuroscience. Our selection of neuroscience is admittedly arbitrary; however, in our opinion it is representative of a major life science discipline. Of the 78 JCR life science categories in our Life Science Group, it ranks 3rd in the number of journals (252) and 2YRIF, 2nd in the number of lifetime cites, 12th in 5YRIF and 20th in Immediacy. We selected the top five journals in economics and neuroscience ranked by the 2012 JCR 5YRIF.

In Table 5 we display the basic 2012 JCR statistics for all ten journals. The neuroscience journals dominate with respect to the 2YRIF, 5YRIF and Immediacy indexes. For example, in 2012, the leading economics journal, the *Journal of Economic Literature,* attracted 6.7 cites per paper for articles published in 2010 and 2011; the corresponding number for the leading neuroscience journal, the Nature Reviews *Neuroscience*, is 31.7. Given our focus on citation-timing, attention is drawn to two issues: first, the disparity between the economics and neuroscience scores declines materially as one moves from the 2YRIF to 5YRIF scores – in other words, over time, the relative performance of economics journals improves. Second, the immediacy index scores demonstrate that papers in neuroscience start to attract cites much more quickly than those in economics.

Table 5. JCR 2012 Overview Data for 5YRIF Top 5 Journals in Economics and Neuroscience

Name of Journal	ISSN	Total Cites	2YRIF	5YRIF	Immediacy Index	Number of Articles	Cited Half-life	Article Influence: Score
Economics								
J Econ Lit	0022-0515	5012	6.667	10.16	1.083	24	>10.0	10.628
Q J Economics	0033-5533	15000	5.278	8.147	1.000	41	>10.0	12.205
J Finance	0022-1082	18729	4.333	6.185	0.867	60	>10.0	8.824
J Econ Perspect	0895-3309	6047	3.489	5.864	0.295	44	>10.0	6.703
Econometrica	0012-9682	21481	3.823	5.702	0.740	77	>10.0	9.622
Neuroscience								
Nat Rev Neurosci	1471-003X	26938	31.673	35.888	5.065	62	6.5	16.201
Annu Rev Neurosci	0147-006X	12638	20.614	31.028	3.115	26	>10.0	17.030
Trends Cogn Sci	1364-6613	15717	16.008	16.845	4.056	54	7.3	8.022
Nat Neurosci	1097-6256	42519	15.251	16.412	2.882	228	7.1	8.644
Neuron	0896-6273	69526	15.766	16.403	2.603	348	8	8.763

Source: ISI Web of Knowledge, Journal Citation Report, 2012.

In Table 6 we present the 10 year pattern of citation-rate capture for the selected economics and neuroscience journals. Before exploring differences in the time-stream of cites, note that the total number of cites per paper over the 2003-2012 period follow the expected pattern. Neuroscience journals dominate with only one journal displaying total cites per paper below that of the leading economics journal. Overall, the average number of cites per paper for the Top 5 neuroscience journals is more than twice that of the Top 5 economics journals: 147.4 versus 69.2. There are at least two ways of looking at the differences in the rate at which citations are captured by the Top5 neuroscience and economics journals. First, it is clear that the proportion of 10 year cites generated in a given year reaches a maximum for economics journals much later than for their neuroscience counterparts.

Note that for economics, two journals reach a maximum citation rate in Year 10, one in Year 8 and two in Year 7. For the Top 5 neuroscience journals, citation-rate maximums are reached in years 10, 4 and 3 for two, two and one journal, respectively. The weighted average across all Top 5 journals is such that a maximum citation rate is reached in Year 10 for economics and Year 7 for neuroscience. Second, recall that in the context of a six year research assessment exercise, year three represents the average life of a publication. In the case of the Top 5 neuroscience journals, over 20 percent of their total 10 year cites have been generated by the end of Year3; the corresponding figure for the Top 5 economics journals is less than half that rate (20.1 percent versus 9.7 percent). By Year 6 the cumulated citation rates have converged somewhat, but still display a wide discrepancy: 54.2 versus 39.3 percent, for neuroscience and economics, respectively.

7. Rate of Citation Patterns for Economics Journals at Different Quality Levels

To this point we have explored citation-timing rates at the category level and between top rated journals in our reference discipline, economics, and in a representative science discipline. We shall now turn our attention to economics journals and explore absolute and relative citation practices between groups of journals ranked from high to low per the 2012 JCR 5YRIF.[10] Using our 10 year citation database covering 173 economics journals, we derived citation rates for groups of ten journals to cover high, medium and lower ranked journals. The results are shown in Table 7. Note that the total number of cites per paper collected over the 2003-2012 period follow the expected pattern, although the magnitude of the difference between high and low ranked journals may be illuminating for some readers (62.1 for journals ranked 1 to 10 and 3.6 for journals ranked 151 to 160).

[10] We used the 2012 JCR 5YRIF to rank the journals for which we have 10-year citations (173 out of 333 journals).

Table 6. Percentage of Total 10YR ISI Cites to 2003 Publications in Top 5 Journals in Economics and Neuroscience

Name of Journal	ISSN	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Cites per Article
Economics												
J Economic Literature	0022-0515	0.80	3.87	6.94	9.14	9.34	13.08	16.34	13.28	12.47	14.74	71.4
Quarterly J Economics	0033-5533	0.45	2.25	5.06	7.00	8.24	12.08	14.25	15.58	17.37	17.70	121.0
J Finance	0022-1082	0.82	3.11	5.80	9.96	8.95	12.67	14.75	14.95	14.85	14.13	55.2
J Economic Perspectives	0895-3309	0.57	3.71	6.43	9.85	9.38	11.42	15.90	14.90	13.23	14.61	56.8
Econometrica	0012-9682	0.75	2.64	5.39	6.79	9.07	11.12	14.46	16.25	15.65	17.88	63.3
Average:												
Top 5 Economic Journals		0.68	3.12	5.92	8.55	9.00	12.07	15.14	14.99	14.72	15.81	69.2
Neuroscience												
Nat Rev Neuroscience	1471-003X	1.19	6.82	10.47	11.23	11.38	11.28	11.65	12.07	11.69	12.22	236.5
Annual Rev Neuroscience	0147-006X	0.94	8.30	12.94	12.96	11.80	11.47	11.15	10.58	10.19	9.68	213.7
Trends Cogn Science	1364-6613	1.12	4.39	8.05	10.23	11.28	11.48	13.46	13.03	13.15	13.81	85.3
Nat Neuroscience	1097-6256	2.14	8.65	11.14	11.45	11.03	10.93	11.34	11.13	11.29	10.89	167.9
Neuron	0896-6273	2.42	9.83	11.89	11.68	11.43	10.88	10.82	10.70	10.20	10.15	135.6
Average:												
Top 5 Neuroscience Jls		1.56	7.60	10.90	11.51	11.38	11.21	11.68	11.50	11.31	11.35	147.4

Source: Derived by authors from ISI Web of Knowledge, Journal Citation Reports, 2003-2012.

Table 7. Percentage of Total 10YR ISI Cites to 2003 Publications in Various Groupings of JCR Listed Economics Journals

Journal Groups	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Cites per Article
Mean: Jrs Ranked 1-10	0.7	2.9	5.7	8.6	9.0	12.3	14.6	15.2	15.2	15.8	62.1
Mean: Jrs Ranked 51-60	0.7	3.4	7.4	9.5	10.6	12.5	13.8	14.8	13.7	13.6	15.5
Mean: Jrs Ranked 101-110	1.3	4.1	8.0	8.5	10.3	13.7	14.5	13.9	12.4	13.3	9.6
Mean: Jrs Ranked 151-160	0.9	6.0	9.5	9.3	10.4	12.7	15.0	14.3	11.6	10.3	3.6
Mean: All 173 Journals	0.7	3.2	6.0	7.8	9.3	12.0	14.8	15.1	15.2	15.9	19.1

Source: Derived by authors from ISI Web of Knowledge, Journal Citation Reports, 2003-2012.

Following prior practice, we first draw attention to the year in which the maximum rate of citations is attained for each group of journals. Group 1[11] journals (rank: 1-10) reach a maximum citation rate in Year 10; the corresponding figures for Group 2[12] (rank: 51-60), Group 3[13] (rank: 101-110) and Group 4[14] (rank: 151-160) are years 8, 7 and 7, respectively. In other words, higher ranked journals attract an increasing number of citations over a longer time period than lower ranked journals.

Another way of looking at this issue, and placing it explicitly in the context of a time-limited research assessment exercise, is to focus on the cumulative three and six year citation levels. At the critical three-year level (within a six-year research assessment framework) a summation of the first three years' citation rates shows that the cumulative percentage of total 10-year cites is inversely related to journal ranking. More specifically, Group 1 journals have, on average, acquired 9.3 percent of their 10 year total by the end of Year 3 versus 16.5 percent for Group 4 journals. The corresponding percentages for Groups 2 and 3 are 11.5 and 13.4, respectively. By

[11] Group 1 Journals are: Journal of Economic Literature; Quarterly Journal of Economics; Journal of Finance; Journal of Economic Perspectives; Econometrica; Brookings Papers on Economic Activity; Journal of Political Economy; Review of Financial Studies; Journal of Financial Economics; and Economic Geography.

[12] Group 2 Journals are: Journal of Economic Surveys; Work Employment and Society; Journal of Regional Science; Journal of Law Economics and Organization; International Economic Review; Resource and Energy Economics; Oxford Review of Economic Policy; International Journal of Forecasting; Oxford Bulletin of Economics and Statistics; and Journal of Economic Psychology.

[13] Group 3 Journals are: World Economy; Journal of Evolutionary Economics; Kyklos; Emerging Market Finance and Trade; Journal of Economic Dynamics and Control; Journal of Real Estate Finance; Journal of Regulatory Economics; Oxford Economic Papers; Review of World Economics; and Journal of Economic History.

[14] Group 4 Journals are: Scottish Journal of Political Economy; Politicka Ekonomie; Open Economics Review; Development Economics; Manchester School; Japan and the World Economy; Post-Communist Economics; Journal of Media Economics; Jahrbucher Fur Nationalokonomie Und Statistik; and Journal of Mathematical Economics.

year six the disparity is reduced, but the rank order remains the same: the proportion of 10 year cites is inversely related to journal ranking from Year 1 to Year 10 (where convergence occurs by definition).

8. Policy Implications and Conclusions

Our findings can be summarized as follows. First, not surprisingly, the average number of cites to science papers exceeds that of the social sciences and, more specifically, economics; this holds at the life-time and 10 year mark. Secondly, within a 10 year time frame, the rate of citation-capture in the early years after publication is generally much higher in the sciences than in economics and the social sciences. In fact, for economics, the citation rate increases every year over the first 10 years after publication whereas the average science paper reaches a peak in Year 7. Thirdly, in a comparison of Top 5 journals in economics and neuroscience, the disparity in summary statistics (such as the 2YRIF, 5YRIF, and life-time and 10 year cites per paper) exceed the corresponding figures for all economics journals and all science journals. In addition, the critical three year cumulative percentage of total 10 year cites reveals an even larger disparity between the Top 5 neuroscience and Top 5 economics journals (20.1 versus 9.7) than exists between all 173 economics journals and all science categories (18.8 versus 9.9).

Fourthly, citation-timing rates in economics closely resemble those in the Business School Group, although the average number of 10 year cites lags somewhat (22.0 versus 19.1). Fifth, a comparison of citation-timing within economics journals reveals that top tier journals are rather different from medium and lower tiered journals. Aside from the obvious fact that the former obtain more cites than the latter, top journals were found to increase their rate of citation-capture continuously over a 10-year period, whereas lower ranked journals reached maximums in years 7 and 8. More importantly in the context of a time-limited research evaluation exercise, the cumulative percentage of 10 year cites received at years three and six are inversely rated to journal quality.

On a more general level our findings have relevance to the following matters:

- The usefulness of citation analysis in national research assessment exercises (NRAEs) that concentrate on recent research contributions.
- A possible bias in favour of lower quality journals if citation analysis is used in NRAEs.
- A systematic bias in short-term indicators of journal quality such as 2YRIF and 5YRIF, and preference for 5YRIFs over 2YRIFs.
- The potential importance of assessing the 'real cost' of citation delays as indicators of lags in the uptake of new ideas in disciplines.
- The significant differences in rate of citation-capture patterns across disciplines.

In conclusion, it is clear that the use of short-term citation counting, either directly or indirectly for purposes of generating impact factors and the like, introduces a bias in favour of the sciences over the social sciences. This is in addition to the well-known differences in the absolute number of cites between these broad discipline categories over the short, medium and long term. However, we must acknowledge a number of possible limitations to our analysis. First, we utilized the WoS/JCR database as opposed to major competitors such as Scopus and Google Scholar (are our results search-scheme specific?). Second, we use publications in 2003 as the base year of our citation collection exercise (is 2003 a representative year?). Third, some of our work is based on arbitrarily constructed sub-sets of the science and social science JCR categories (are these representative sub-groups?).

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Appendix 1

Composition of JCR/Science Sub-Groups

(a) Life Sciences

Agronomy; Allergy; Anatomy & Morphology; Anesthesiology; Behavioral Sciences; Biochemical Research Methods; Biochemistry & Molecular Biology; Biodiversity Conservation; Biology; Biophysics; Biotechnology & Applied Microbiology; Cardiac & Cardiovascular Systems; Cell Biology; Clinical Neurology; Critical Care Medicine; Dentistry Oral Surgery & Medicine; Dermatology; Developmental Biology; Ecology; Emergency Medicine; Endocrinology & Metabolism; Evolutionary Biology; Gastroenterology & Hepatology; Genetics & Heredity; Geriatrics & Gerontology; Health Care Sciences & Services; Hematology; Horticulture; Immunology; Infectious Diseases; Integrative & Complementary Medicine; Limnology; Marine & Freshwater Biology; Medical Ethics; Medical Informatics; Medical Laboratory Technology; Medicine, General & Internal; Medicine, Legal; Medicine, Research & Experimental, Microbiology; Microscopy; Mycology; Neuroimaging; Neurosciences; Nursing (Science); Nutrition & Dietetics; Obstetrics & Gynecology; Oncology; Ophthalmology; Ornithology; Orthopedics; Otorhinolaryngology; Paleontology; Parasitology; Pathology; Pediatrics; Peripheral Vascular Disease; Pharmacology & Pharmacy; Physiology; Plant Sciences; Public, Environmental & Occupational Health; Radiology, Nuclear Medicine & Medical Imaging; Rehabilitation; Reproductive Biology; Respiratory system; Rheumatology; Sport Sciences; Substance Abuse (Science); Surgery; Toxicology; Transplantation; Tropical Medicine; Urology & Nephrology; Veterinary Sciences; Virology; Zoology.

(b) Natural Sciences

Acoustics; Biophysics; Chemistry, Analytical; Chemistry, Applied; Chemistry, Inorganic & Nuclear; Chemistry, Medicinal; Chemistry, Multidisciplinary; Chemistry, Organic; Chemistry, Physical; Crystallography; Electrochemistry; Geochemistry & Geophysics; Geology; Geosciences, Multidisciplinary; Meteorology, Atmospheric Sciences; Optics; Physics, Applied; Physics, Atomic, Molecular & Chemical; Physics, Condensed Matter; Physics, Fluids & Plasmas; Physics, Mathematical; Physics, Multidisciplinary; Physics, Nuclear; Physics, Particles & Fields; Thermodynamics.

(c) Applied Sciences

Agricultural Engineering; Automation & Control Systems; Cell & Tissue Engineering; Computer Science, Artificial Intelligence; Computer Science, Cybernetics; Computer Science, Hardware & Architecture; Computer Science, Information Systems; Computer Science, Interdisciplinary Applications; Computer Science, Software Engineering; Computer Science, Theory & Methods; Construction & Building Technology; Energy & Fuels; Engineering, Aerospace; Engineering, Biomedical; Engineering, Chemical; Engineering, Civil; Engineering, Electrical & Electronic; Engineering, Environmental; Engineering, Geological; Engineering, Industrial; Engineering, Manufacturing; Engineering, Marine; Engineering,Me3chanica; engineering, Multidisciplinary; Engineering, Ocean; Engineering, Petroleum; Fisheries; Food Science & Technology; Forestry; Imaging Science & Photographic Technology; Instruments & Instrumentation; Materials Science, Biomaterials, Materials Science, Ceramics; Materials Science, Characterization & Testing; Materials Science, Coatings &Films; Materials Science, Composites; Materials Science, Multidisciplinary; Materials Science, Paper & Wood; Materials Science, Textiles, Metallurgy & Metallurgical Engineering; Mineralogy; Mining & Mineral Processing; Nuclear Science & Technology; Remote Sensing; Robotics; Telecommunications; Transportation Science & Technology.