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The inner quality of an article: Will time tell?

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Abstract In this paper, we assess whether quality survives the test of time in academia by comparing up to 80 years of academic journal article citations from two top journals, *Econometrica* and the *American Economic Review*. The research setting under analysis is analogous to a controlled real world experiment in that it involves a homogeneous task (trying to publish in top journals) by individuals with a homogenous job profile (academics) in a specific research environment (economics and econometrics). Comparing articles published concurrently in the same outlet at the same time (same issue) indicates that symbolic capital or power due to institutional affiliation or connection does seem to boost citation success at the beginning, giving those educated at or affiliated with leading universities an initial comparative advantage. Such advantage, however, does not hold in the long run: at a later stage, the publications of other researchers become as or even more successful.

Keywords Citations · Quality · Time · Long-run · Biases · Research environment

Each period is dominated by a mood, with the result that most men fail to see the tyrant who rules over them.
Albert Einstein to Maurice Solovine in 1938
(see Einstein and Infeld, 1938, The Evolution of Physics, p. xxii).
Time is the best censor.
Frédérique Chopin (letter to his family, 1846)
How many errors Time has patience for,
W. H. Auden (first stanza of Our Bias).

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Introduction

Does the quality of a scientific contribution survive the test of time? Landes (2003: 144) argues that "[t]ime exposes fads, flash-in-the-pans, and one-time wonders. More controversial is the claim that works that stand time's test tend to be the most important and influential art of the past." This paper addresses this important and challenging question. Of course, if the term *quality* refers to the importance of a scientific contribution, it is difficult to provide a definitive and quantifiable answer. Mazlish (1982) proposes a distinction between an "inside" dimension of scientific quality shaped by the scientific profession's own assessment of scientific work and an "outside" quality decided by social evaluation. Here, we rely on citations to study the academic environment and thus concentrate on the inner dimension.[1] Empirically, this use of citation counts as a measure for quality is very convenient because of ready availability and the objective measurement provided. There is also substantial evidence justifying its use as a (rough) quality measured. For instance, citations are highly correlated with peer ratings of eminence or perceived scientific significance (Albert 1975; Lawani 1986). The seminal work of Merton (1957) even suggests that a paper's quality can be appraised by its citation counts.

In Merton's (1973) theory, a citation has two functions arising from the normative structure of science. First, authors use citations to highlight the work that has influenced their research and to indicate further readings that might be of interest to the reader, which can thus be seen as a cognitive function of citations. Second, scholars use citations to pay an intellectual debt by helping the authors cited to become better known. Thus, citations are a form of recognition. Obviously, however, the likelihood of being cited (and thus citation counts) is influenced by many factors (see, e.g., Bornmann and Daniel 2008), including those related to the timing, field of research, journal, article, and author/readership.

Citations, then, represent a complex phenomenon that cannot be explained simply by the intellectual content of an article. As Stigler et al. (1995: 344) point out, a network of citations is the "product of a complex combination of factors, ranking from scientific influence and social contact to an element of pure chance in the timing of publication of accepted papers." Thus, social context also matters because scientific knowledge is generated through a social process (Latour and Wooglar 1979). As a result, citations are not only used to acknowledge intellectual debt but also as, for example, rhetorical tools. That is, citing certain authors provides support for a paper and persuades the scientific community of the validity of the findings (Gilbert 1977). On the other hand, citations are also subject to bias. For example, "hat-tipping" citations may be introduced to please authors that could be potential referees, to demonstrate that the relevant literature has been read, or in the hope that cited authors will reciprocate in the future (Mayer 2004: 624). In other words, there is contamination through manipulation (Merton 1973). This possibility that distortion may go hand in hand with an unequal distribution of citations has led to the development of various theoretical concepts. Merton, for instance, speaks of "the Matthew effect" (Merton 1968, 1988), referring to a phenomenon in which success breeds success.[2]

[1] For a quantitative analysis of the outside dimension, see Chan, Frey, Gallus, Schaffner, Torgler and Whyte (2013, 2014).

[2] For more recent studies, see Watts and Gilbert (2011) for an agent-based simulation, and Azoulay et al. (2014) and Chan, Frey, Gallus and Torgler (2014a) for the citation patterns of papers published before the bestowal of an award. Although both these latter construct synthetic counterfactuals with the same pre-award citation structure, Azoulay et al. (2014) observe only a small citation boost over a short period because of the award, while Chan, Frey, Gallus and Torgler (2014b) observe a very large and long-lasting effect.

In this dynamic, authors not only profit from their own reputation and that of their institutions and network but also from symbolic capital or power (Bourdieu 1989; Putnam 2009), defined here as power that signals academic legitimacy and thus also academic reputation, status, and authority, thereby promoting comparative advantage. The decision to read a paper may thus be based on whether it is written by someone from a top-tier university or originates from a lesser known department (even when published in a top-tier journal). In that case, authors could benefit from the fame of the institution at which they completed their doctorate or, more visible to the reader, at which they were working at the time of paper publication. Skewed citation distribution could thus lead to a process of advantage or disadvantage accumulation. This question of whether author characteristics and the scope of their work might alter the frequency and adequacy of citation counts through a reputation effect is crucial to our use of them as a quality measure.

Many articles also stress the unequal nature of productivity in science, a reality first revealed by Lotka (1926), who showed that half of all papers were published by only 6 % of publishing scientists.[3] Since then, a large body of literature has specifically explored the dynamics of citations or, in particular, the citation trajectories of papers (see, e.g., Price 1976; Chubin et al. 1984; Aversa 1985; Garfield 1989, 1990; Redner 1998, 2005; Glänzel et al. 2003; Mingers 2008; Levitt and Thelwall 2008; Wallace et al. 2009; Hsu and Huang 2011; Roth et al. 2012; Eom and Fortunato 2011; Ohba and Nakao 2012; Hjørland 2013; Sangwal 2013; Wang et al. 2013; Watts and Gilbert 2011; Bjork et al. 2014; Ponomarev et al. 2014).

In this paper, we are interested in exploring whether articles have an inner quality as opposed to various types of bias that may manifest particularly in the early years after publication. We therefore ask whether effects beyond quality become ever less important over time or are cumulative. We also examine whether potential differences related to social contacts, professional networks, or scientific influence (i.e., through institutional and doctoral affiliation) disappear over time.[4] In other words, does time reveal the inner quality of an article? Peter Carruthers, a former leader of the Los Alamos Theoretical Division, argues that "… the quality [of scientific work] survives miraculously, despite all the human foibles that are translated into the way science is done. That's largely due to the experimentalists, I suppose. Somehow science is self-correcting. Even though credit often is assigned unfairly, the actual evolution goes on, you sort out the better ideas from the junk, and occasionally there are major insights" (Simmons and West 1981: 139).

Obviously, this question of whether quality survives the test of time is interesting even beyond the academic environment. However, the academic context is analogous to an experimental setting in that it features a homogeneous task [trying to publish in top-tier journals, namely *Econometrica* and *American Economic Review* (*AER*)] by individuals with a homogenous job profile (academician) in a specific research environment (economics and econometrics). In addition, comparing papers published at the same time (same issue) provides a comparable group of papers (articles judged as worth publishing by editors and referees). Focusing on a specific journal also allows better control of the channel through which the articles were published.

[3] See, for example, Price (1963), Coles (1970), Allison and Stewart (1974), Allison (1980), Redner (1998, 2005). For one of the journals that we analyse, the *American Economic Review*, 80 % of the citations received within the 1911–2011 period are from 20 % of the articles (Torgler and Piatti 2013).

[4] Admittedly, authors who studied at or work at a leading university may not only have better connections or an ability to influence the subject/topic of publications but may also be able to amass substantial experience, gather feedback and inspiration, and be exposed to the type of training that may be used to develop research that increases the inner quality of a paper.

Data

Our citation count data are drawn from almost 80 years of articles. The journals we explore, namely *AER* and *Econometrica,* are recognized as among the best economics journals (Kalaitzidakis et al. 2003, 2011; Wall 2009; Engemann and Wall 2009; Kodrzycki and Yu 2006; Axarloglou and Theoharakis 2003).[5] These two journals do, however, attract slightly different submissions: whereas *AER* is a more general economic journal, *Econometrica* is more theoretically driven. Such a difference is useful in that it allows us to test the robustness of our results and increase the range of their validity. For *Econometrica* we have collected a larger sample. To this end, our primary focus will be on *Econometrica*, with *AER* used for robustness tests. In particular, *Econometrica* is more specialized and thus less driven by such biases as the size of the subfield.

All citation data were generated through the *ISI Web of Knowledge* provided by Thomson Reuters. The first and larger sample comprises 3247 papers published in *Econometrica* between 1933 and 2010. The second sample consists of 409 papers published in issues 1, 3, 4, and 5 of the *AER* between 1984 and 1988.[6] To increase sample homogeneity, we focus on original contributions, excluding all post-publication papers like replies, comments, or corrections whose impact in terms of explanatory variables may not be the same as that of full papers.

To test for the influence of institutional environment, we compare the citation performance of articles by authors from the world's top 10 and top 20 universities against the performance of papers whose authors are unaffiliated with such institutions using the ranking developed by Amir and Knauff (2008). Based on this dichotomy, we develop three categories: (1) none of the authors belong to such a university; (2) all of the authors belong to such a university; (3) at least one author but not all authors belong to such a university (mixed category). In addition, we include a variable for whether author doctorates were completed at a university ranked in the top 10 or top 20 positions. Amir and Knauff's (2008) ranking is based on the strength of its Ph.D. program (see Appendix Table 4). The criterion for this ranking is a department's ability to place doctoral graduates in top-level economics departments or business schools. The authors themselves describe the methodology as follows: "For an n-department sample, the idea is to derive an endogenous relative valuation of each department by specifying a system of n equations wherein the value of department i is a weighted average of the values of all other departments, with the jth weight being the number of placements department i has made in department j. Thus the value of each placement is given by the score of the employing department, which is itself simultaneously determined in the underlying fixed point relationship. The final score of a department is then simply the sum of all the values of its individual placements" (Amir and Knauff 2008: 185). Based on data collected from the Web in April 2006, these authors claim that faculty hires might be a more reliable and stable indicator of influence than journal citations.

The author affiliation at the time of publication is listed on the article itself. When authors report two or more work affiliations, we take the affiliation with the highest institutional ranking. To locate the institutions at which authors earned their doctoral degrees, we search for CVs and check for a thesis/dissertation record under the author's

[5] Kalaitzidakis et al. (2011) rank *Econometrica* and *AER* second and first in economics journals, respectively. The two are also ranked third and fourth, respectively, in the "ambition-adjusted journal ranking" devised by Engemann and Wall (2009).

[6] We exclude the *Papers* and *Proceedings*.

name on digital dissertation archives such as ProQuest Dissertations & Theses Global,[7] as well as any dissertation databases available from the top 20 universities. In the *Econometrica* sample, the authors of 635 out of 3247 articles (19.6 %) are all from a top 10 university versus at least one author (but not all authors) of 289 articles (8.9 %). Of all 409 articles in the *AER* sample, 90 articles (22 %) are by authors with a top 10 university affiliation at the time of publication versus 32 articles (7.8 %) by at least one author (but not all authors). Likewise, the authors of 1225 articles (37.7 %) all obtained a doctorate at a top 10 university versus at least one author (but not all authors) of 531 articles (16.4 %). For *AER*, all the authors of 206 articles (50.4 %) earned their doctorates at a top 10 university versus at least one author (but not all authors) of 68 articles (16.6 %).

Using citation as a measure of article quality, however, is not unproblematic. For example, it is evident that papers with multiple authors attract more citations than single authored papers (Ductor 2014). Thus, simply comparing the citation differences for single authored works with those for multiple authored works could lead to biased results, especially given that our mixed category consists of only multiple authored papers while the other two categories (only top university and only non-top university) have a combination of single and multiple authored contributions. We therefore normalize the raw citation count by dividing it by the square root value of the number of co-authors. Another source of possible bias is that citations often follow a power law distribution (Gupta et al. 2005; Redner 2005), meaning that results could be driven by a handful of frequently cited papers. Thus, following Huang (Huang 2015), for each year we rank the papers based on the yearly citations received relative to the yearly citations received by other papers. Using the citation counts normalized by number of co-authors, we define the citation rank of paper i in year t as

$$\mathrm{Rank}_{it} = \frac{N_{\mathrm{cit<cit,it}} + 1}{N_{\mathrm{total,t}}} \times 100$$

where $N_{\mathrm{cit<cit,it}}$ equals the number of articles with citations received in year t less than that of paper i, and $N_{\mathrm{total},t}$ is the total number of articles published in the same year in the same journal. The citation rank of a paper in a particular year can thus be understood as the percentage (value between 0 and 100) of articles cited less in that year.

Descriptive analysis

To assess the citation differences between articles written by authors of top and non-top university based on the ranking classification, we calculate citation ranks of papers in each category published in the *same issue*. By doing so, we avoid the problem resulting from comparing the citation trajectories of papers from different cohorts. Another advantage is that we can hold the standards for paper acceptance constant, which allows comparison of similar quality articles (i.e., those judged worthy by the same managing editor, co-editors, and editorial board members). Drawing from 385 issues of *Econometrica* and 20 issues of *AER*, we set the citation performance of articles with no author from a top 10 university as the base line (horizontal line at value zero) and then compare it against the citation differences between articles having all authors from a top 10 university (blue) and those

[7] www.proquest.com/products-services/pqdtglobal.html.

having at least one author from a top 10 university (red). We depict these citation rank differences in Fig. 1 on a yearly basis.

In Tables 1 and 2, we report pairwise *t* tests exploring the statistical significance of these differences over time. For both journals, we observe a rapid increase in citation rank difference within 5 years of publication, which suggests that immediately after publication, articles by authors from a top 10 university attract more citations than articles in the same issue by authors from a non-top 10 university. For example, 5 years after the publication year, a *Top 10 Uni* and a *Mixed* article in *Econometrica* are ranked, on average, 6.99 and 9.12 higher than the baseline in terms of cumulative citations, differences that are statistically significant at the 1 % level. On the other hand, the average citation rank differences for *Top 10 Uni* and *Mixed* article in *AER* are 13.09 and 9.16, respectively (statistically significant at the 1 and 10 % levels, respectively). Admittedly, such results may be driven by reputation or more generally by symbolic capital or power. Nevertheless, after year 5, the rate at which the mean citation rank difference increases begins slowing down, in

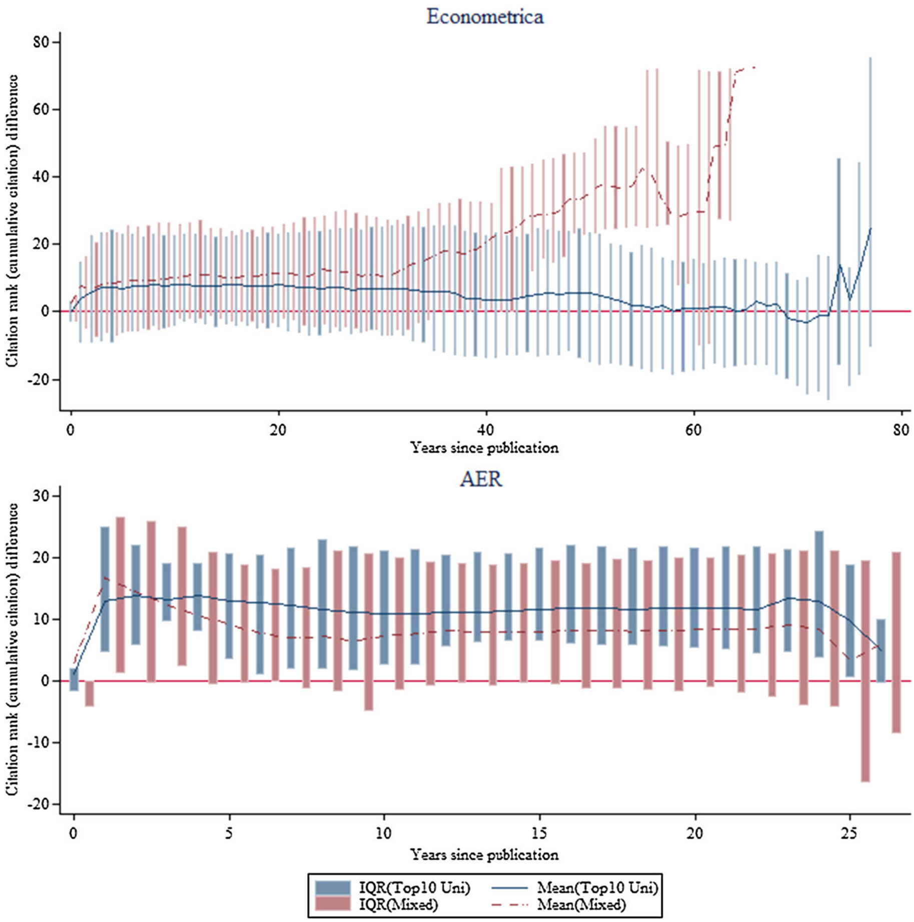

Fig. 1 Citation rank difference over time for authors belonging or not to a top ten university: The IQRs (interquartile ranges) represent the ranges between observations at the 25th and 75th percentiles. IQRs for the *Mixed* category are offset by +0.5 years for better visualization. (Color figure online)

Table 1 Mean citation rank difference in *Econometrica*, by year since publication

Year since publication	Top ten university versus non top ten university			Mixed versus non top ten university		
	# issues	Citation rank difference	Citation rank difference (cumulative citation)	# issues	Citation rank difference	Citation rank difference (cumulative citation)
0	305	2.1	0.34	187	6.13***	2.23***
1	300	8.16***	3.97***	181	14.61***	7.79***
2	296	6.43***	5.86***	176	6.96***	7.06***
3	293	9.03***	7.30***	172	10.26***	7.91***
4	288	6.85***	7.36***	167	13.16***	8.68***
5	283	5.97***	6.99***	164	13.29***	9.12***
6	278	11.49***	7.60***	159	11.64***	9.23***
7	272	9.32***	7.55***	154	12.89***	9.51***
8	266	11.01***	7.87***	150	10.44***	9.35***
9	262	8.99***	7.71***	146	14.41***	9.61***
10	258	10.82***	7.90***	141	16.13***	10.27***
11	254	9.51***	7.92***	138	13.42***	10.50***
12	250	10.58***	7.79***	132	16.45***	10.97***
13	247	8.52***	7.59***	128	15.49***	10.86***
14	242	12.20***	7.72***	126	12.56***	10.64***
15	237	10.95***	8.09***	121	14.15***	10.29***
16	233	11.46***	7.90***	116	16.01***	10.31***
17	229	10.72***	7.77***	112	16.91***	10.56***
18	224	9.79***	7.53***	108	18.99***	10.75***
19	219	9.60***	7.69***	105	19.02***	11.06***
20	213	10.08***	7.95***	101	19.40***	11.50***
21	208	9.12***	7.76***	96	14.55***	11.30***
22	203	9.57***	7.43***	91	11.52***	10.88***
23	197	7.97***	7.19***	86	16.60***	10.65***
24	191	6.35***	7.01***	81	21.61***	12.53***
25	185	10.62***	7.14***	77	16.45***	12.30***
26	179	7.69***	7.05***	74	12.25**	11.89***
27	174	6.92***	6.60***	69	12.87***	11.70***
28	169	5.16**	6.66***	63	11.13**	10.74***
29	163	6.22**	6.68***	60	9.76**	11.22***
30	157	6.50**	6.78***	56	13.15**	10.49***
31	150	6.39**	6.72***	52	10.19**	10.98***
32	144	6.95***	6.87***	48	7.57	12.66***
33	138	6.00**	6.30***	45	15.10**	14.35***
34	130	4.99*	6.00***	40	15.35***	14.96***
35	127	5.54**	5.81**	37	21.51***	16.63***
36	123	4.83*	5.82**	34	10.87*	18.19***
37	117	9.04***	5.49**	31	14.41**	17.91***
38	111	6.31**	4.12*	29	12.86*	17.34***
39	105	2.57	4.08*	28	14.76*	18.57***

Table 1 continued

Year since publication	Top ten university versus non top ten university			Mixed versus non top ten university		
	# issues	Citation rank difference	Citation rank difference (cumulative citation)	# issues	Citation rank difference	Citation rank difference (cumulative citation)
40	100	2.66	3.47	26	5	20.49***
41	96	6.53*	3.66	22	23.57***	23.15***
42	92	1.61	3.53	22	31.77***	23.33***
43	90	5.25	3.86	21	23.42***	25.10***
44	87	1.19	4.72*	19	33.12***	28.09***
45	83	4.87	5.08*	16	12.95	28.71***
46	79	0.84	5.61*	16	26.79**	28.72***
47	77	4.23	5.31*	15	25.82**	29.85***
48	74	6.06	5.60*	14	30.65**	33.42***
49	71	3.9	5.74*	14	24.59*	33.33***
50	68	5.15	5.45	12	27.07**	35.64***
51	64	1.71	4.73	10	34.00**	37.72***
52	60	2.06	3.97	9	25.93	37.05***
53	56	1.05	3.16	9	17.91	36.88***
54	53	3.48	1.74	9	46.44***	37.05***
55	51	0.63	1.98	7	41.60**	42.36**
56	48	2.89	1.19	6	35.75	40.56**
57	45	2.95	1.68	5	32.14	32.60*
58	43	−5.51	0.29	4	21.16	28.26
59	39	−0.23	0.83	4	37.46	28.81
60	37	3.39	0.94	3	20.14	29.55
61	34	0.15	1.09	3	−4.44	29.55
62	34	0.57	1.23	2	34.42	49.23
63	33	0.3	1.49	2	55.29	49.37
64	31	4.52	0.27	1	67.13	71.27
65	29	1.39	0.61	1	87.79	71.92
66	26	0.27	2.95	1	87.23	72.53
67	25	−4.8	1.7			
68	24	0.36	2.17			
69	21	2.99	−1.79			
70	19	−2.92	−2.56			
71	16	−5.79	−3.15			
72	13	−7.67	−1.12			
73	11	−18.22	−0.91			
74	8	20.19	13.75			
75	6	6.06	3.64			
76	4	12.08	12.79			
77	3	8.5	25.12			

One sample t test on the significance of citation differences not equal to 0

*, **, *** represent statistical significance at the 10, 5 and 1 % levels, respectively

Table 2 Mean citation rank difference in *AER*, by year since publication

Year since publication	Top ten university versus non top ten university			Mixed versus non top ten university		
	# issues	Citation rank difference	Citation rank difference (cumulative citation)	# issues	Citation rank difference	Citation rank difference (cumulative citation)
0	20	1.36	1.16	16	2.47	2.88
1	20	12.24**	13.10***	16	22.29***	16.86**
2	20	14.33***	14.01***	16	15.81**	14.49**
3	20	14.04***	13.16***	16	14.43**	12.37**
4	20	19.49***	14.00***	16	9.03	10.68*
5	20	12.46***	13.09***	16	10.91*	9.16*
6	20	10.36*	12.74***	16	4.76	7.84
7	20	10.87*	12.22***	16	8.03	7.07
8	20	7.04	11.64***	16	12	7.22
9	20	10.41*	11.25***	16	7.14	6.44
10	20	8.53	11.06***	16	13.02	7.39
11	20	13.87***	10.99***	16	15.65**	7.68
12	20	11.90**	11.09***	16	14.64*	8.3
13	20	14.12**	11.22***	16	9.99	7.95
14	20	15.20***	11.38***	16	15.12**	7.97
15	20	19.31***	11.71***	16	13.72*	8.08
16	20	13.89***	11.78***	16	15.09**	8.17
17	20	13.86***	11.95***	16	17.45*	8.32
18	20	7.77	11.69***	16	11.14	8.11
19	20	14.04***	11.79***	16	12.81	8.23
20	20	18.87***	11.80***	16	12.49*	8.35
21	20	19.02***	11.92***	16	11.29	8.39
22	20	6.06	11.68***	16	18.71***	8.44
23	20	14.93***	13.52***	16	10.56	9.13
24	16	12.10**	13.05***	15	13.28	8.49
25	12	-3.54	9.82*	11	12.43	3.28
26	8	21.09	4.82	8	4.3	6.21
27	4	1.36	1.16	4	2.47	2.88

particular for *Top 10 Uni* in *Econometrica* and *Top 10 Uni* and *Mixed* in *AER*. This finding suggests no Matthew effect and a deterioration of the importance of symbolic capital. The *t* test results even show that 40 years after publication, the citation rank difference (based on cumulative citation) for *Top 10 Uni* in *Econometrica* has become insignificantly different from 0 (at the 10 % level), indicating a convergence in the two groups' citation patterns. In *AER*, this difference remains significant until 25 years after publication, but the statistical significance of the difference in the cumulative citation rank drops after 5 years.[8]

[8] Here, the sample size is reduced due to a lack of observations.

The *t* test results for top 20 universities show a similar adjustment process. Authors based on doctoral university rather than current affiliation show smaller differences between those with and without a top 10 or top 20 doctorate but a slower adjustment process.[9]

Surprisingly, 30 years after publication, the mean citation rank difference for *Mixed* articles in *Econometrica* suddenly increases after remaining relatively flat for three decades. We therefore take a closer look by splitting the sample by decade (see Fig. 2). We observe that the patterns of citation rank difference in both categories remain flat over time (relative to the baseline) for articles published in most decades except the 1960s and 1940s, during which the citation rank difference for *Mixed* continues to increase. The results for the 1940s, however, should be treated with caution as the sample size decreases in the later years while there are only a limited number of *Mixed* papers in the early years. For instance, prior to 1950, only three issues (out of 67) contain at least one article classified in the *Mixed* category. We obtain a similar result for the same citation rank difference based on top 20 universities (see Appendix Figs. 4, 5). However, the interquartile ranges (IQR) in Figs. 4 and 5 are wider than those in Figs. 1 and 2 (top ten universities) because the IQR contain a greater number of low values for citation rank difference. The citation rank differences based on author doctorates shows a similar pattern (see Appendix Figs. 6, 7); however, the IQRs are substantially larger and lower. Such a result is in line with our expectations based on the fact that information on author doctorate is less visible than current institutional affiliation.

This descriptive analysis highlights the influence of several factors on the pattern of mean citations over time. The working environment at the time of publication shows a skewed distribution of citations in favor of the top environments in the early years after publication. It thus seems to be a potential advantage that can increase an article's citations relative to the intrinsic quality of the paper itself. Nevertheless, although the descriptive facts help us establish a correlation between the different variables studies (raw effect), a multivariate analysis is needed to uncover causality.

Multivariate analysis

To estimate the effect that an author's affiliation with or doctorate from a particular category of university (top ten versus non-top ten) exerts on citation ranks, we model the citation rank (based on citation count adjusted by number of authors) of paper *i* in year *t* using a random effect generalized least squares (GLS) model (Table 3). Since the aim of our study is to analyze the influence of time on citation rank, we include a time variable, *number of years since publication,* as an explanatory variable. This inclusion puts all articles on equal footing with respect to the citation count in 1 year. We also include two dummy categories for the author's university affiliation at the time of publication and another two for doctoral program (i.e., top ten institutions and top ten Ph.D. institutions). Since we want to estimate whether the effect of the university environment depends on the number of years since publication, we also include interaction terms between this variable and the two university variables, which allows analysis of the differential effects of an additional year between the categories. As best fit for the time effect, we identify a quadratic relation for *AER* but a cubic relation for *Econometrica*. As control variables, we include paper length (*length*); proportion of male authors (*share male*), and mean academic age of the authors, defined as the year of publication minus the year the doctorate was

[9] Results are available from the authors upon request.

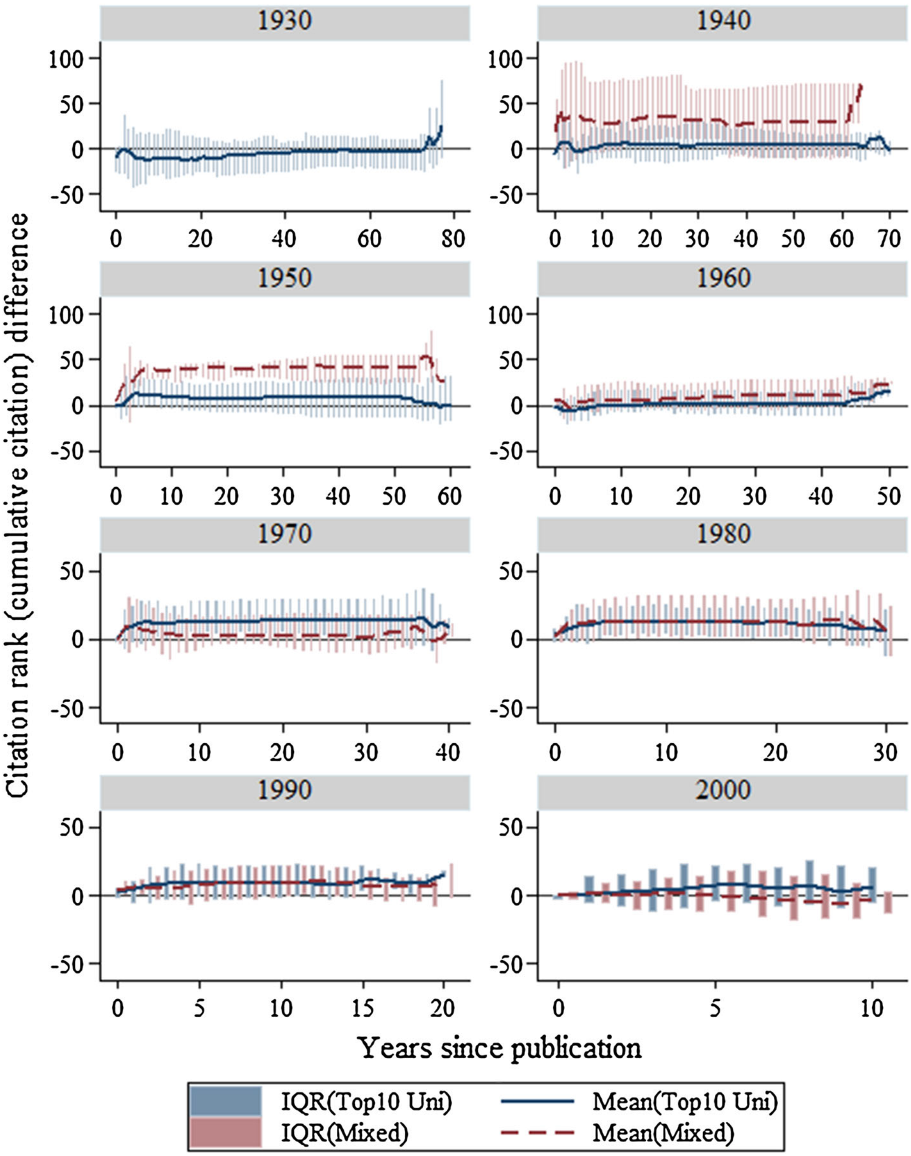

Fig. 2 Citation rank difference over time in *Econometrica*, by decade of publication: The 1930s decade includes articles published from 1933 to 1939, but this category contains no authors from the mixed category. Articles published in 2010 are also included in the 2000s

obtained (*academic age*). To ensure closeness to the pairwise comparison in the descriptive analysis, we further include dummy variables for each issue to hold them constant in the estimates.

Table 3 presents the estimates for the *Econometrica* papers in columns (1) and (2) and those for *AER* in columns (3) and (4) based on top ten affiliations. To better depict the quantitative effects, we show the estimated adjusted means for all years since publication (in 1-year increments) for the two top ten groups in relation to the baseline (see Fig. 3).

Table 3 Results of random-effects GLS regression models (top ten university and Ph.D.)

Variables	*Econometrica*		*AER*	
	(1)	(2)	(3)	(4)
Years since publication (YP)	0.329*** (0.078)	0.174 (0.090)	1.668*** (0.243)	1.229*** (0.347)
Years since publication^2 (YPSQ)	−0.028*** (0.003)	−0.022*** (0.003)	−0.065*** (0.009)	−0.045*** (0.013)
Years since publication^3 (YP3)	3.6e−04*** (3.2e−05)	3.0e−04*** (3.5e−05)		
All top ten uni	5.215*** (1.191)		3.577 (2.869)	
Mixed top ten uni	−0.620 (1.758)		2.975 (4.572)	
All top ten uni*YP	0.588*** (0.176)		0.769 (0.480)	
Mixed top ten uni*YP	2.515*** (0.352)		0.474 (0.744)	
All top ten uni*YPSQ	−0.021** (0.007)		−0.029 (0.017)	
Mixed top ten uni*YPSQ	−0.120*** (0.018)		−0.019 (0.026)	
All top ten uni*YP3	2.2e−04** (7.9e−05)			
Mixed top ten uni*YP3	1.4e−03*** (2.5e−04)			
All top ten Ph.D.		1.778 (1.081)		−0.776 (2.556)
Mixed top ten Ph.D.		−4.602** (1.445)		−3.472 (3.643)
All top ten Ph.D.*YP		0.544*** (0.151)		0.881* (0.443)
Mixed top ten Ph.D.*YP		1.942*** (0.287)		1.222 (0.640)
All top ten Ph.D.*YPSQ		−0.022*** (0.006)		−0.038* (0.016)
Mixed top ten Ph.D.*YPSQ		−0.091*** (0.015)		−0.053* (0.022)
All top ten Ph.D.*YP3		2.2e−04** (6.7e−05)		
Mixed top ten Ph.D.*YP3		1.1e−03*** (2.1e−04)		
Article length	0.658*** (0.050)	0.692*** (0.050)	2.052*** (0.230)	2.152*** (0.230)
Share male	−3.823* (1.765)	−3.639* (1.815)	1.743 (6.029)	1.816 (6.034)
Academic age	−0.118** (0.045)	−0.095* (0.046)	0.941 (1.447)	1.227 (1.448)
Issue fixed effect	Yes	Yes	Yes	Yes
Observations	93,423	93,423	10,177	10,177
Number of articles	2960	2960	407	407

Table 3 continued

Issue fixed effect	Yes	Yes	Yes	Yes
R-square	0.473	0.462	0.263	0.254

The paper type reference group is no author affiliated with a top ten university in models (1) and (3), and no author completed a doctorate in a top ten university in models (2) and (4). Standard errors are in parentheses

*, **, *** represent statistical significance at the 10, 5, and 1 % levels, respectively

[2] and [3] referred to the squared and cubic term of "Years since publication"

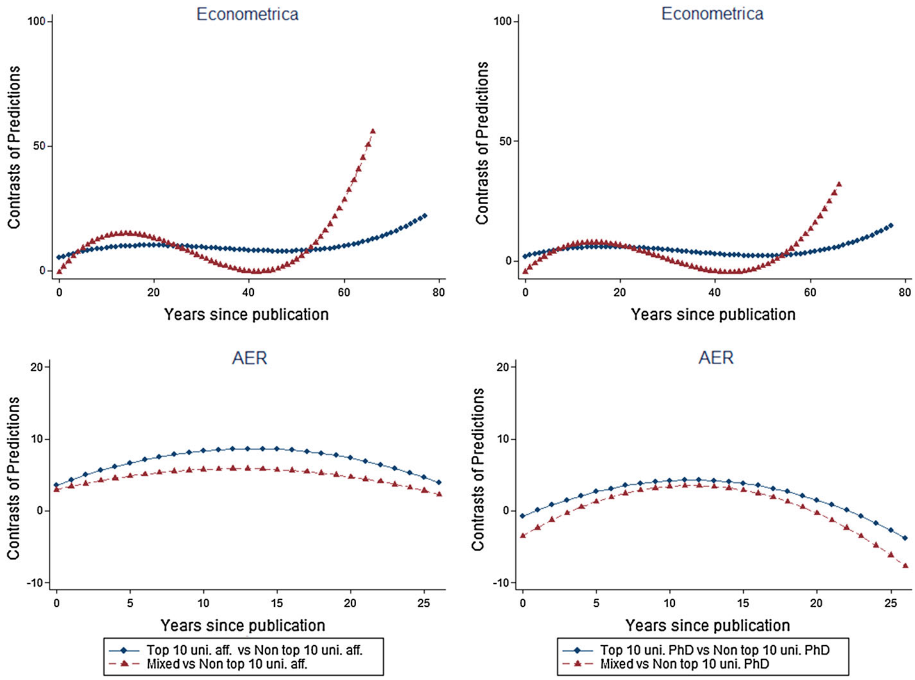

Fig. 3 Contrasts of predictive margins (by top ten university)

This arrangement allows us to test the equality of these groups to the reference group (papers by authors of non-top ten institutions). The quadratic relation in *AER* indicates an increase in the difference to the baseline over time, reaching its strongest point in year 13 and decreasing thereafter. The cubic relation, however, shows that after a while this difference increases yet again. Nevertheless, the *Mixed* author results should be treated with caution because the number of such papers is limited early in the history of *Econometrica* (Table 1). Thus, we must warn the reader when interpreting the exploding tail of the curves as it may be caused by the decreasing number of observations during the early years or the cubic (and quadratic) polynomial. Figure 3 also shows that the patterns for doctoral affiliation are very similar to the institutional one. Moreover, results extending it to top 20 places are also comparable (see Fig. 8).

Among the other control variables, only paper *length* seems to have a consistently and significantly positive robust effect on citation rank, which echoes Hudson's (2007) finding for *AER* and the *Economic Journal*. The effect of *academic age* is statistically significant in

Econometrica but not in *AER*, suggesting that younger scientists are more successful in the former than the latter. The effect of *gender*, however, is unclear: the proportion of males even has a significantly negative effect in the *Econometrica* regression that is inconsistent with studies addressing this question. Based on earlier research, men should receive significantly more citations than women. Not only do Cole and Singer (Cole and Singer 1991) demonstrate that being a man has a positive effect on the number of citations received, but Stack (2004) shows that the research productivity of women is lower, even when the number of young children is controlled for. Moreover, Baldi (1998: 842), after modeling a citation as a dyadic relationship between a cited and citing author, concludes that "scientists are significantly less likely to cite articles written by female authors."

As a whole, the multivariate analysis confirms that the work and educational environment influences the number of citations received, particularly during the first few years after publication. This finding seems to indicate that symbolic capital or power matters in this time period. The interaction of this variable with the time component confirms that this early advantage tends to stabilize, although it also shows a catching-up effect in some cases. This effect is particularly noticeable for the *AER* sample in which the interaction terms between years since publication and its squared term and the categorical variable for publication environment indicates that the negative effect of the squared years overwhelms the positive effect after 13 years. Thus, after an advantageous start, articles that profit from symbolic capital are caught up with in terms of citation count, implying that the inner quality of an article is revealed over time. *Econometrica* also shows adjustments that support this argument. In particular, we observe stabilization in the pure top 10 or top 20 category relative to the baseline and even a decrease for the mixed group up to year 42, after which the difference from the baseline is even below zero. For a small sample of articles, however, the relative difference in citation success increases again over time in later years.

Conclusions

The interesting question of whether the quality of a scientific contribution survives the test of time has as yet not been intensively empirically explored. In this paper, by comparing articles published at the same time in the same outlet (i.e., the same issue of a volume), we find evidence of potential biases due to institutional affiliation or connection, which suggests that authors profit from the symbolic capital or power of a top university. Such a comparative advantage disappears over time, however, through stabilization of the relative difference and, except for a few articles, even decreases over time. Interpreting this result in light of our hypothesis, we conclude that the inner quality of the papers published in these top journals is revealed over time.

Admittedly, this analysis has certain limitations, especially in terms of the fundamental assumptions that are crucial to our model. First, we assume that papers published in the same journal are roughly of the same (perceived) quality. We also assume that categorization of the authors (by top 10 or top 20 universities versus others) is a valid proxy for the type of research environment. Such an assumption might be justifiable *prima facie*, but other elements (e.g., author reputation) may also be relevant. We were also unable to distinguish self-citations, a distinction that might improve the relevance of the results. For example, Johnston et al. (2013) note that although some argue that self-citation is self-serving, others believe it is central to the progression of scientific communication. There is also evidence that self-citation has no significant quantitative effect on the total number of citations. A further drawback is the possibility of selection bias in the original publication process as a result of editor or referee predilections.

With respect to the use of citations as our variable of interest, a consideration of the context in which the citations are made (e.g., the quality of the journal in which the article is cited) might improve analytic quality. However, not only would it be difficult in this present analysis to account for context over the extremely long investigatory period, but such deconstruction of citation incidence is still in its infancy and thus lacks a developed theoretical framework. Our analysis thus makes a contribution by helping lay the groundwork for this conceptual development.

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Appendix

See Tables 4 and 5 and Figs. 4, 5, 6, 7, 8.

Table 4 Institutional ranking

Rank	University
1	MIT
2	Harvard University
3	Stanford University
4	Princeton University
5	University of Chicago
6	Yale University
7	University of California, Berkeley
8	Oxford University
9	University of Minnesota
10	Northwestern University
11	London School of Economics
12	University of Pennsylvania
13	Carnegie Mellon University
14	University of Rochester
15	University of California, Los Angeles
16	University of Wisconsin
17	University of Michigan
18	Duke University
19	Cambridge University
20	Columbia University

Source: Amir and Knauff (2008, p. 188)

Table 5 Results of random-effects GLS regression models (top 20 university and Ph.D.)

Variables	*Econometrica*		*AER*	
	(1)	(2)	(3)	(4)
Years since publication (YP)	0.242** (0.087)	0.547*** (0.071)	1.556*** (0.279)	0.509 (0.510)
Years since publication^2 (YPSQ)	−0.025*** (0.003)	−0.037*** (0.003)	−0.062*** (0.010)	−0.023 (0.018)
Years since publication^3 (YP3)	3.3e−04*** (3.4e−05)	4.5e−04*** (3.1e−05)		
All top 20 uni	5.774*** (1.055)		4.599 (2.608)	
Mixed top 20 uni	−1.806 (1.650)		5.733 (4.279)	
All top 20 uni*YP	0.526*** (0.148)		0.772 (0.428)	
Mixed top 20 uni*YP	2.669*** (0.335)		0.442 (0.670)	
All top 20 uni*YPSQ	−0.019** (0.006)		−0.027 (0.015)	
Mixed top 20 uni*YPSQ	−0.129*** (0.017)		−0.017 (0.023)	
All top 20 uni*YP3	1.8e−04** (6.5e−05)			
Mixed top 20 uni*YP3	0.002*** (2.4e−04)			
All top 20 Ph.D.		8.644*** (2.605)		−1.345 (3.052)
Mixed top 20 Ph.D.		1.977 (2.871)		−3.482 (4.575)
All top 20 Ph.D.*YP		0.009 (0.388)		1.594** (0.559)
Mixed top 20 Ph.D.*YP		2.035*** (0.577)		1.933* (0.794)
All top 20 Ph.D.*YPSQ		−0.004 (0.016)		−0.058** (0.020)
Mixed top 20 Ph.D.*YPSQ		−0.099** (0.035)		−0.073** (0.027)
All top 20 Ph.D.*YP3		5.5e−05 (1.6e−04)		
Mixed top 20 Ph.D.*YP3		0.001* (5.7e−04)		
Article length	0.657*** (0.049)	0.687*** (0.049)	1.990*** (0.237)	2.086*** (0.226)
Share male	−4.003* (1.800)	−3.545* (1.798)	0.071 (6.155)	1.011 (5.744)
Academic age	−0.104* (0.046)	−0.109* (0.044)	1.313 (1.423)	1.320 (1.455)
Issue fixed effect	Yes	Yes	Yes	Yes
Observations	93,423	93,423	10,177	10,177
Number of articles	2960	2960	407	407

Table 5 continued

Issue fixed effect	Yes	Yes	Yes	Yes
R-square	0.475	0.463	0.274	0.260

The paper type reference group is no author affiliated with a top 20 university in models (1) and (3), and no author completed a doctorate in a top 10 university in models (2) and (4). Standard errors are in parentheses

*, **, *** represent statistical significance at the 10, 5, and 1 % levels, respectively

[2] and [3] referred to the squared and cubic term of "Years since publication"

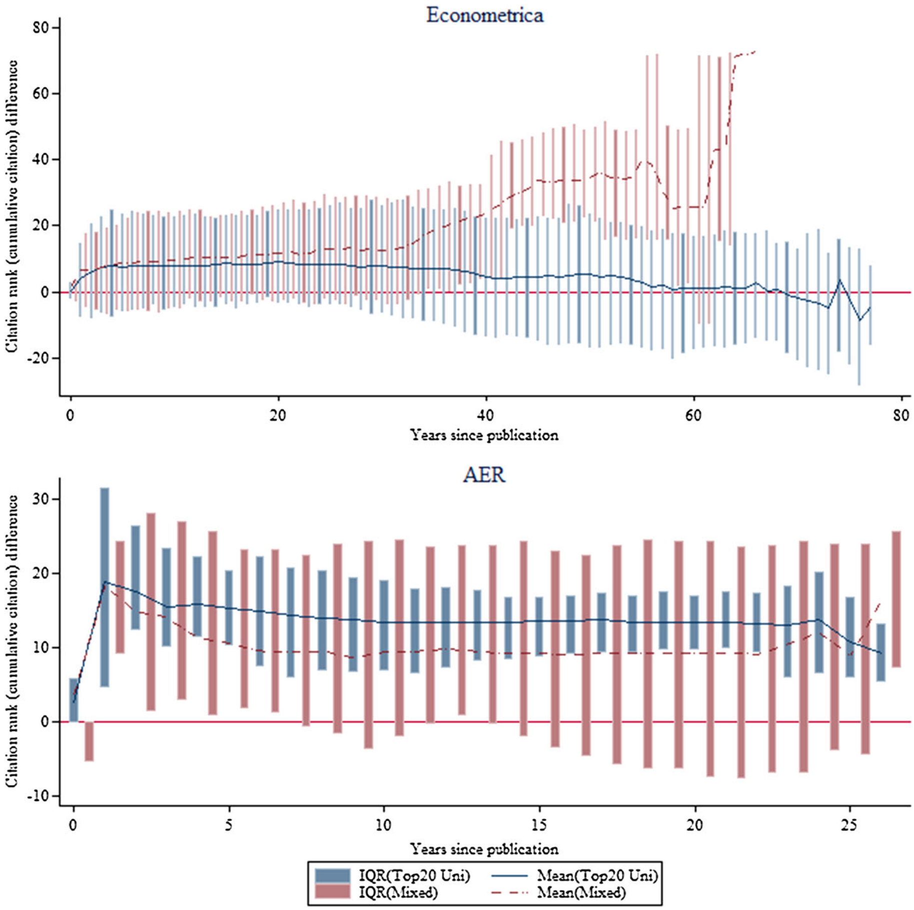

Fig. 4 Citation rank difference over time for authors belonging or not to a top 20 university

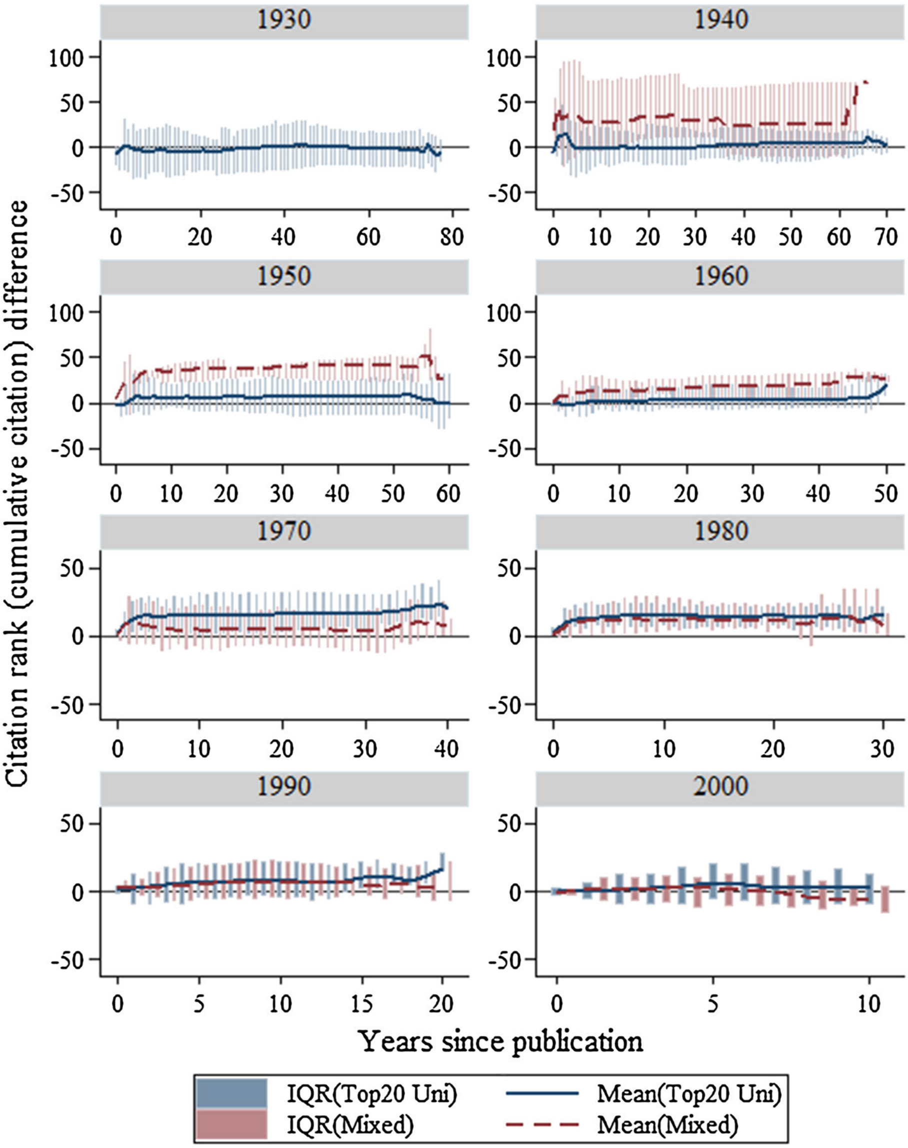

Fig. 5 Citation rank difference over time, by decade of publication (top 20 university)

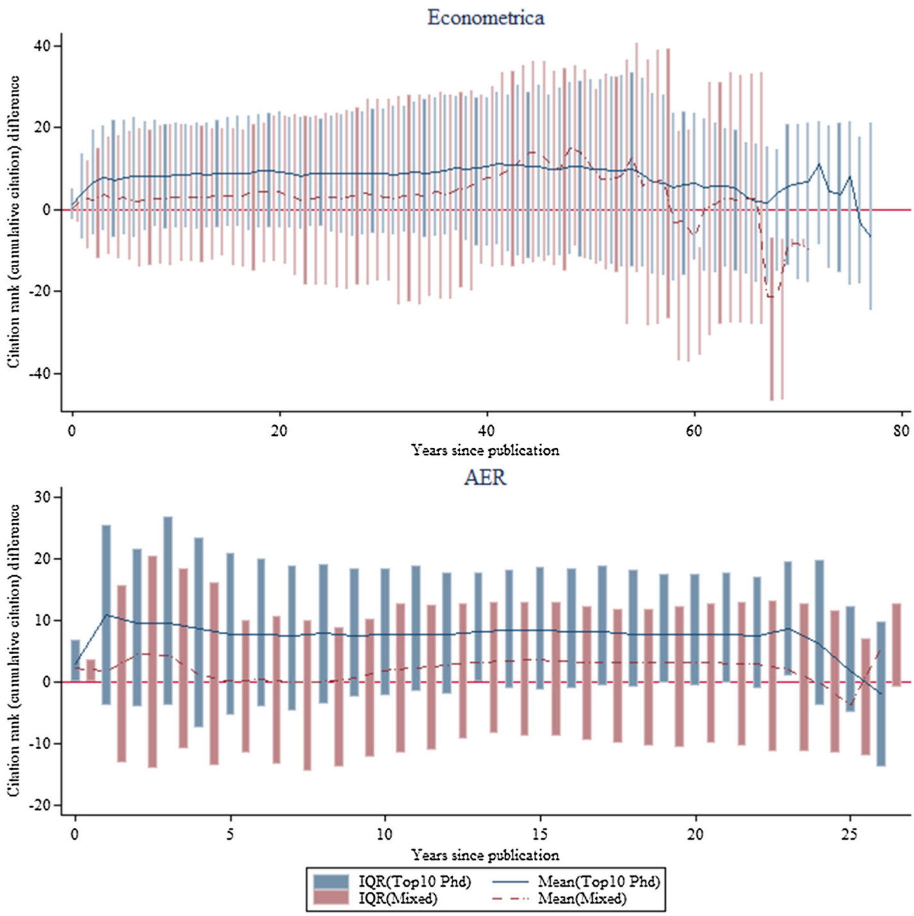

Fig. 6 Citation rank difference over time for authors obtaining a Ph.D. in a top ten university

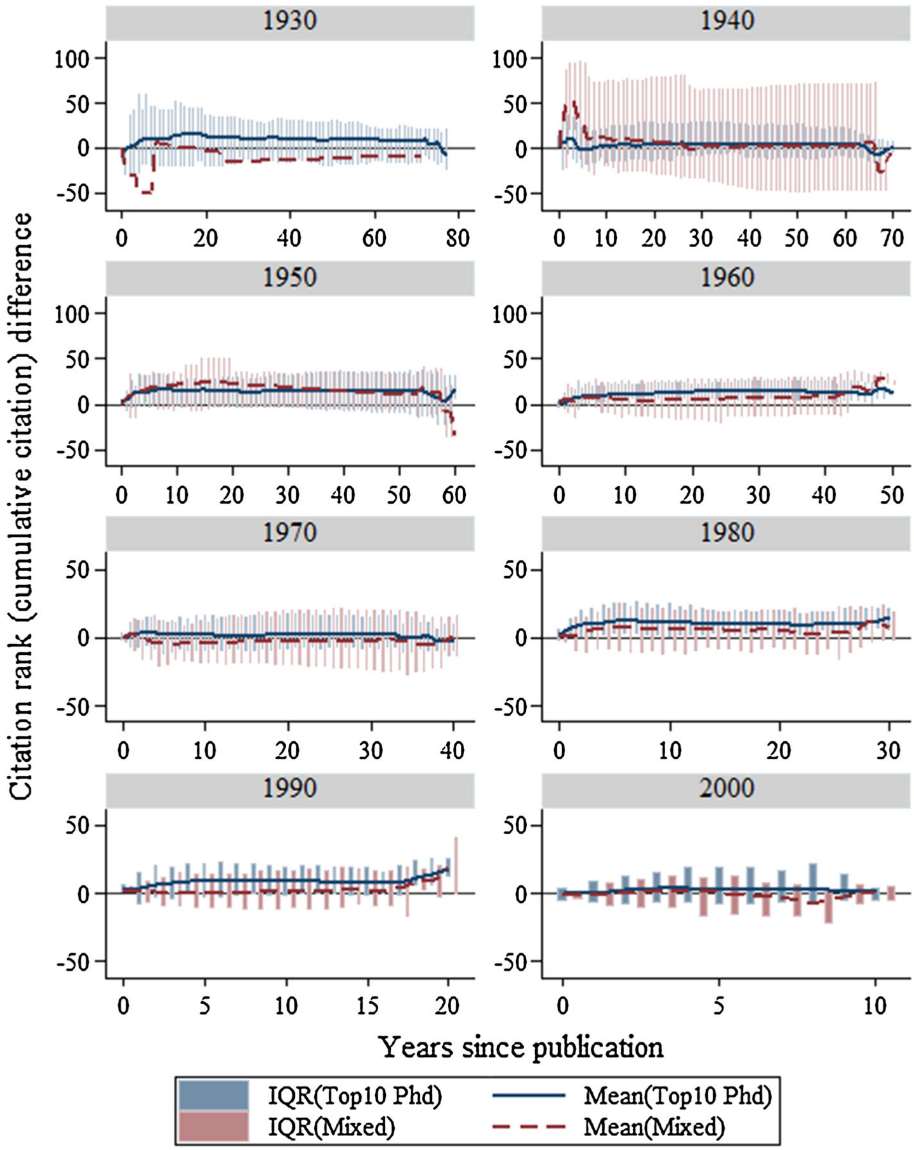

Fig. 7 Citation rank difference over time, by decade of publication (top ten Ph.D.)

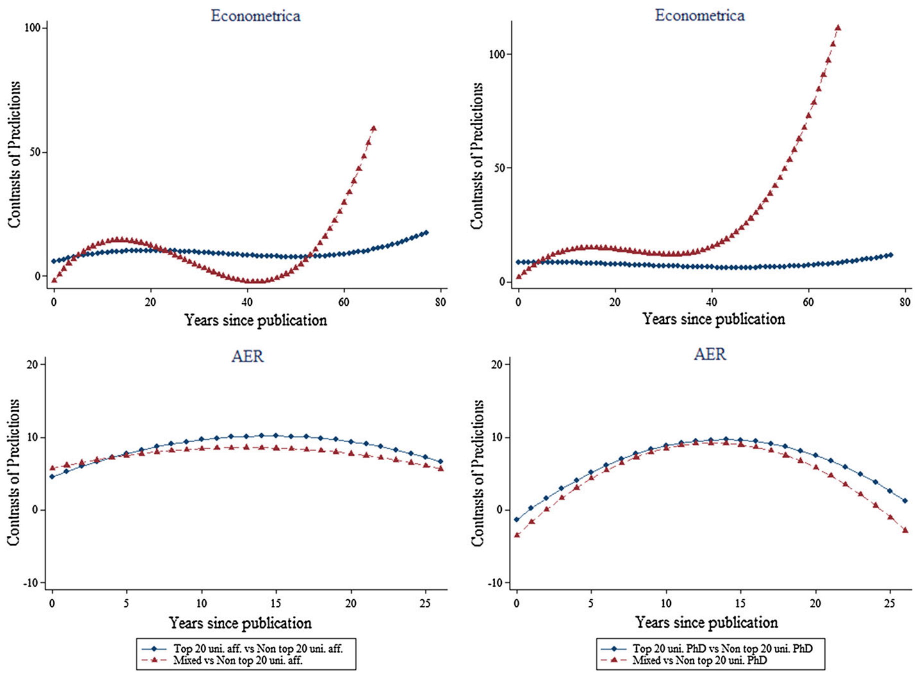

Fig. 8 Contrasts of predictive margins (by top 20 university and Ph.D.)

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