The Diminishing Scientific Impact of New Research in Finance*

Zaher Zantout† Kimberly Gleason‡ Anand Systla§

January 31 2022

Abstract

We examine the relative scientific impact of new research in finance and find it declined steadily during the period 2002-2019, more than 60 percent cumulatively, reaching the lowest level in four decades. We also find declining incidence of "home-run" papers during this period. In contrast, the papers published in the period 1985-1999 have strong initial and long-lasting impact collectively. Comparisons to other disciplines, including economics, show that the proliferation of research that advance the finance field only marginally in the past two decades is not typical across research fields. Our findings support the necessity to remove the obstacles hindering innovative research and scientific progress in finance that many prolific researchers and editors of leading journals indicate.

*We thank the editor Ivo Welch, an anonymous referee, Campbell Harvey, Stavros Panageas, Mohammad Arzaghi, Conrado Garcia-Gómez, the participants in the research seminar organized by the Economics and Finance Departments at American University of Sharjah on February 25th, 2020, the participants in the corporate finance session of the 33rd EBES Conference – Madrid (online) – October 2020, David Feldman and the participants in the Finance Symposium, Chania, Crete (online) – August 2021. We thank very much Stavros Panageas for sharing the data of his presentation at the 2019 meeting of the Northern Finance Association. The authors also appreciate the excellent research assistance of Sadath Ali, Ali Bashir, Hajar El Mouttaqui, and Rebecca Robert-Bello.

†American University of Sharjah,; zzantout@aus.edu

‡American University of Sharjah,; kgleason@aus.edu

§Anderson School of Management, UCLA; asystla92@g.ucla.edu.

1 Introduction

Several researchers maintain that in the academic discipline of finance, unlike other disciplines in the social and life sciences, formal dialog among scholars on epistemology, the development of new research paradigms, and the progression of knowledge in the field is rare (e.g., Brooks and Schopohl (2018), Harvey (2017), and Gippel (2015a; 2013)). Yet, as researchers, we ideally would have the intellectual curiosity and interest to assess periodically the state of scientific development of our field. Self-reflection and deliberation on potential new grand paradigms in finance, along with some healthy skepticism regarding our scientific approach to inquiry, may promote innovation and lead to greater progress in generating financial knowledge.

At first glance, research in finance looks vibrant as several indicators suggest, so it appears that knowledge in academic finance is progressing well. For example, the citations-based impact numbers of the leading finance journals have exhibited upward trends over the last two decades (see Figure 1 below). Also, international research collaborations in the field, which may result in new perspectives and innovation, are rising (See Figure 2 below, and see Schwert (2021) and Kim et al. (2009) for evidence on related favorable trends on inclusiveness in the field). Moreover, research activity in the field continues to intensify, based on the number of papers published per year in finance journals (see Figure 3A below and Kelly and Brestle (2011)).

However, a growing number of prolific researchers, from finance and other disciplines, including highly accomplished editors of leading finance journals, are raising serious concerns about the recent and future development of the field. The literature review section that follows explains in detail the major obstacles to innovative research and knowledge progression in finance these leaders of the discipline have articulated. Alluding to a stagnation in the finance discipline, we refer to terms such as "conformity, risk-aversion, and bias", "wrong incentives in the research review process", "lack of paradigmatic diversity", and "insularity and a consequent homogeneity" in academic finance.

Given the major issues raised by these proficient researchers and editors, we ask the following empirical question: Has finance knowledge been expanding well, or is new research merely making small incremental improvements as the years pass? The proliferation of research activity in finance at universities worldwide does not necessarily translate into major scientific progress. Also, growth in the citation-based impact numbers of finance journals is not robust proof of significant progression in finance knowledge, because it is at least partially an expected outcome of the growing number of articles published in finance, and other disciplines that cite finance papers. We need more robust evidence on the progress of the finance field over the past few decades. To that end, we study the relative scientific impact of new finance research.

We believe it is important to investigate this issue empirically. Significant valuable economic resources go

into carrying out academic research to expand knowledge in finance, and efficiency necessitates introspection within the discipline regarding the nature of the output of our collective research activities. Our findings can guide the decision-making of those who influence scientific progress in the field. They are useful for journals in analyzing their editorial policies, for Ph.D. program directors in terms of curriculum development and training emphasis, for universities in formulating their research strategy, and for research funding agencies in setting their policies. We find no study that provides robust evidence on knowledge progression and innovation in finance.

We analyze the relative scientific impact of new financial research using citations data, which arguably form a collective and democratic assessment of scientific significance. We use citations of research published in four leading finance journals made by (1) scholars published in the same four leading finance journals (i.e., intra-disciplinary assessment / impact) and by (2) scholars from various disciplines (i.e., at-large assessment / impact). The four leading finance journals are: Journal of Finance, Journal of Financial Economics, Review of Financial Studies, and Journal of Financial and Quantitative Analysis. We obtain the citations data pertaining to these journals from InCites Journal Citation Reports, Clarivate Analytics (https://jcr.clarivate.com) for the period 1997 to 2019 (i.e., the entire period covered by the database as of the date of this paper).

We find first that finance researchers have been citing more articles in their papers over time. The mean number of references of the papers published in our sample of leading finance journals increased from 30.5 references per article in 1997 to 52.3 in 2019 (see Figure 3B). We analyze the composition of the citations to new versus old research published in our four leading finance journals. We define "old" articles as those published in the leading finance journals ten years ago or longer relative to the publication year of the citing article. We find that the percent of citations made by scholars from various disciplines to old articles increased steadily from 41.0 percent in 1997 to 70.1 percent in 2019, and the percent of the citations made by scholars published in the four leading journals to old articles increased gradually from 30.4 percent in 1997 to 55.4 percent in 2019. Yet, the actual percent of old articles out of the total published in the leading finance journals remained stable over that period, in the range of 77.2 to 81.0 percent (see Figure 4A).

We define and introduce the following measure of the relative scientific impact (RSI_t) of new leading financial research in year t:

$$RSI_t = \left(\begin{array}{c} \text{The ratio of new to old citations} \\ \text{to leading financial research made in year t} \end{array} \right) \times \left(\begin{array}{c} \text{The ratio of actual number of old to actual number} \\ \text{of new leading financial research as of year t} \end{array} \right)$$

This ratio captures the composition of citations to new versus old research while accounting for the actual composition of new and old financial research (see Section 4 for further explanation). A positive (negative) trend for this ratio suggests an increasing (a decreasing) relative scientific impact of new leading financial research. We compute this measure using citations made by (1) scholars published in the same four leading finance journals (i.e., intra-disciplinary RSI_t) and (2) scholars from various disciplines (i.e., at-large RSI_t) for each year during the period 1997- 2019.

We find that the RSI_t of new leading financial research decreased by more than 65 percent (60 percent) cumulatively over the period 1997-2019 (2002-2019) (see Figure 4B). Specifically, the intra-disciplinary RSI_t decreased at the rate of 4.7 percent annually and the at-large RSI_t decreased 5.4 percent annually over the period 1997-2019. Over the period 2002-2019, the decline is most steady and noticeable as the intra-disciplinary RSI_t decreased by 5.4 percent annually and the at-large RSI_t decreased by 6.1 percent annually.

An intuitive follow-up question is whether the sharply diminishing RSI_t of new research in finance that we find is unique to the latter or extends to the field of economics to which it is most related (see Borokhovich et al. (1994), Pieters and Baumgartner (2002), and Chazi et al. (2021)). For this reason, we examine the RSI_t of new research published over the period 1997-2019 in the following four leading economics journals: American Economic Review, Journal of Political Economy, Quarterly Journal of Economics, and Review of Economic Studies.

We find that the intra-disciplinary RSI_t of new leading economics research decreased by about 20 percent over the period 1997-2002 but then remained about level over the period 2002-2019. The at-large RSI_t of new economics research has decreased, but the annual decline is less than half of that observed in finance, at -2.4 percent (-2.5 percent) over the period 1997-2019 (2002-2019) (see Figure 5B). Thus, the results we find for economics reflect better knowledge progression relative to finance, despite economics being a much older discipline.

Next, we apply a different approach to analyzing the scientific impact of new financial research. We analyze the likelihood of a paper published in a particular year being cited by a paper published in subsequent years (cohorts). Specifically, we use the following basic model for the citations: $TC_t = N_t.[\Sigma_{s<t}\lambda_{t,s} \cdot N_s]$ where TC_t denotes the total number of citations made by papers published in year t in JF, JFE, RFS and JFQA to papers published in these same four journals in year $s < t$; N_t denotes the number of papers published in year t in these journals; and $\lambda_{t,s}$ denotes the probability that the "representative" paper in year t cites the representative paper that was published at time $s < t$ in these journals. We examine the plots of $\lambda_{t,s}$, compare them for different cohorts of papers, and identify any trends or patterns.

The results of this analysis (see Figures 6 and 7) indicate that while the scientific impact of new finance research was increasing through approximately 2001, a sudden and sharp reversal occurred thereafter, with a continued and consistent decline in the impact of new finance research from 2002 to present. Our additional tests further indicate that the decline in impact is not unique to the four leading journals; citations have not migrated to non-leading journals such as Journal of Business, Journal of Banking and Finance, and Journal of Corporate Finance (see Figures 8 and 9). Nor is the prevalence of citations to old papers likely to be driven by recent citation of historically significant methodology papers (see Figure 11). The "mother discipline", economics, does not exhibit the same pattern of declining impact of new research (see Figure 10); we should not be experiencing it in finance either.

For further analysis, we examine the existence of "home-run" papers in different cohorts of papers. For each set of articles published in a certain year t, we compute the cross-sectional Gini coefficient (i.e., inequality) of the citations made to them in each year following their birth year t until the present. Then, we group the papers into five-year cohorts starting with the year 1966, and we compute the mean Gini coefficient for each cohort as a function of the paper's age T (see Figure 12). We apply the same process to the leading economics journals (see Figure 13).

We find that the mean Gini coefficients for the finance cohorts after the year 2000 are the lowest over the past five decades. These results indicate the lack of "home-run" finance papers since 2001, which complements the diminishing at-large RSI_t of new finance research that we find. This conclusion is true even upon comparing the mean Gini coefficients of the cohorts years after publication. In economics, there is also a declining incidence of "home-run" papers since 1966; however, the cohorts have maintained collectively their scientific impact as we determined earlier. All together, these findings are consistent with a declining scientific impact of new finance research; not only has impact fallen for the leading four, it has cratered in the three non-leading journals we examine.

Finally, we check whether the declining RSI_t in finance is a phenomenon occurring in other fields over the same time period. In the latter case, we cannot attribute our findings to discipline-specific issues. We use the aggregate category data from InCites Journal Citation Reports which cover the period 2003-2019, and we examine all six business categories in the database, ten social science, ten natural science, and ten engineering categories. These categories are diverse and cover the fields included in the study of Fanelli (2010) to the extent that there is a match (see Appendix).

With reference to Figure 14, we find that the sharp decline in the RSI_t of new research we report for the four leading finance journals extends to the entire finance category (which includes accounting journals)

during the period 2003-2019. Also, consistent with our earlier finding related to the at-large RSI_t, the economics category shows a decline in the RSI_t of new research that is markedly smaller than in finance. The management category displays a sharply declining RSI_t of a magnitude close to that of finance. The business category, which combines management and marketing journals, exhibits a steady decline as well. Yet, the category of operations research and management science shows a higher RSI_t of new research over the 2010-2019 period than earlier years, and the category of information systems displays a level RSI_t during the period 2003-2015 and a sharply rising RSI_t thereafter. Thus, there is no standard pattern across the business fields. Additional categories examined exhibit various patterns, including a steadily rising RSI_t, a decline followed by a rise, or a rise followed by a decline. We conclude that the declining RSI_t of new finance research since 2002 we document is not a standard phenomenon across academic fields.

The decline in the relative scientific impact of new financial research (RSI_t) that we uncover over the period 2002-2019 is alarming by itself, clearly, but more so in light of the fact that it occurred during a period when research activity at U.S. and non-U.S. universities and international research collaborations in the field of finance intensified greatly. These latter phenomena should have led to new perspectives and innovation, and an increased or at least level RSI_t of new research during that period. Instead, we find that knowledge progression has slowed. Evidently (à la Solow (1957)), we find that there is an increasing "... proliferation of papers that are technically well done but that advance finance knowledge only marginally" (Harvey (2017, page 1434)).

We believe our paper contributes to a growing and valuable research area that examines the state of knowledge progression in academic finance (see Harvey and Hirshleifer (2020), Brooks et al. (2019), Brooks and Schopohl (2018), Harvey (2017), Berk et al. (2017), Hirshleifer (2015), Gendron and Smith-Lacroix (2015), Gippel (2015), Spiegel (2012), Ardalan (2008), and Bennis and O'Toole (2005)) in that it is the first to provide a quantitative assessment of innovation and knowledge progression in finance over the past four decades. The sharply declining relative scientific impact of new finance research since 2002 that we find is consistent with the hurdles impeding scientific progress and innovation in finance indicated in these studies, namely risk-aversion, bias, excessive reviewing, conformity, and insularity. Our paper provides an impetus to consider the recommendations of prior work related to: (1) editorial policies (see Akerlof (2020), Harvey and Hirshleifer (2020), Brooks et al. (2019), Berk, et al. (2017), Harvey (2017), Hirshleifer (2015), and Spiegel (2012) and evidence by Hadavand et al. (2020) and Welch (2014)); (2) curriculum development of Ph.D. finance programs and the training of future finance academics (see Brooks et al. (2019), Humphrey and Gendron (2015), Raineri (2015), Starbuck (2007), and Corrado and Ferris (1997)); and (3) the university research environment and incentives that support research that has the highest potential to

advance knowledge and add genuine social value (see Reed et al. (2021), Akerlof (2020), Andrew et al. (2020), Holtfreter et al. (2020), Osterloh and Frey (2020), Yaqub (2020), Tourish and Craig (2018), Muller and de Rijcke (2017), Adler and Harzing (2009), Hopwood (2007), Singh et al. (2007), and Ghoshal (2005)).

We hope our findings will stimulate further research and dialog on the state of the finance field. We argue that the latter may also have value to other disciplines (Brooks et al. (2019, page 25) make a similar argument). As part of our findings, the problems occurring in finance appear to be taking place in some of the other business and non-business disciplines (see Figure 10). We end this section with the following statement by Hopwood (2007, pages 1373-1374):

> "The difficulties that we face [in accounting, with generalization to business management research] are ones that are deeply embedded in complex institutional structures. Change will not be easy, but it will be more likely to occur if we maintain a dialogue and debate."

The rest of this paper is organized as follows. Section 2 reviews the literature. Section 3 discusses the growth of finance research. Section 4 analyzes the relative scientific impact of new finance research in the period 1997-2019. Section 5 probes the same in economics for comparison. Section 6 applies a different approach in analyzing the citations data for robustness, provides a historical perspective, and examines whether high-impact research has migrated to other major finance journals. Section 7 uses the Gini coefficient to shed light on whether the high impact of some cohorts is due to their inclusion of "home-run" papers. Section 8 examines whether our finding is a general phenomenon occurring in other fields. Section 9 concludes our paper.

2 Literature Review

A growing number of prolific researchers from finance and other disciplines have raised serious concerns about the recent and future development of the field. Harvey (2017) discusses how incentives of editors to publish papers with statistically significant findings and authors under systemic pressure to publish regularly are not necessarily compatible with the goal of advancing scientific knowledge in finance (see Fanelli (2010, 2012), Harvey et al. (2016), and Harvey and Hirshleifer (2020)). These significant challenges lead to "conformity and risk-aversion" and hinder innovation and progress in the field. Harvey (2017) points to the resulting proliferation of papers that are technically sound but which advance finance knowledge only marginally. Similarly, Hopwood (2007) points out the risks to researchers striving to develop a reputation for innovation

in (accounting with generalization to) business research. He argues that a form of institutional careerism and the strong individual career emphasis encourage "conservatism and conformity"[1]. Akerlof (2020) discusses three causes that make researchers in economics [but can be generalized to finance] biased in favor of the "hard" and against the "soft". This bias makes them ignore important issues and new topics when they are tough to approach in a "hard" way.

Akerlof (2020), Harvey and Hirshleifer (2020), Subrahmanyam (2019), Berk, et al. (2017), Hirshleifer (2015), and Spiegel (2012, 2019), with their extensive research experience and leadership roles in the academic review process, discuss shortcomings in the latter. Among these shortcomings is the increased number of revisions, robustness checks, and extensions, i.e., "excessive reviewing". Hirshleifer (2015) argues that reviewers' reputation-building incentives may "suppress innovative research" (see evidence by Hadavand, et al. (2020)). Akerlof (2020, page 416) states that "the norms for what should or should not be published, and the selection of the editors and the referees, and their conduct, should be the subject of examination." Berk, et al. (2017, page 243) conclude that:

> "... fundamental change in how researchers review each other's journal submissions is needed to improve the integrity, quality, and efficiency of the review process. ... Such change will improve how new research is developed and communicated, and will allow scholars to reallocate time from navigating the publication process to developing innovative research."

Another shortcoming in the academic review process pertains to the policy (or lack thereof) regarding authors sharing their data and codes for replication studies (see Harvey (2019), Spiegel (2019), Subrahmanyam (2019), and Welch (2019)). Harvey (2019, pages 3-4) states that:

> "Our colleagues in the physical and biological sciences would be perplexed by the history of the replication debate in finance. If an author refuses to share the original data in their fields, it is highly likely that their paper would be retracted. ... There have been no retractions of papers printed in any of the top three finance journals. ... I believe we (in financial economics and other fields) have a much bigger problem with so-called soft misconduct (e.g., strategic data choices and p-hacking; Harvey, 2017)"

Ryan and Tipu (2022, abstract) who examine a sample of leading business journals report that:

> "... most replications are conceptual in nature, support prior findings and represent only 1.47of

[1]See a similar concern about "careerism" by Starbuck (2007) in organization studies. See further Alvesson and Sandberg (2013, pages 131-132) on the negative aspects of gap-spotting research.

within-study or intrastudy designs. Replications by independent researchers are very rare, raising credibility concerns due to author overlap and associated researcher and measurement biases."

Duvendack, Palmer-Jones, and Reed (2017, page 49) who examine replication in economics conclude that (see also empirical evidence by Chang and Li (2022)):

"..., the practice of replication in economics lags behind a number of other fields. Whether this is because the problems that plague those disciplines are less severe in economics, or because economics is more resistant to replications, is arguable."

Chang, Gao, and Li (2018, abstract) who analyze p-hacking in experimental accounting studies report that:

"... accounting experimental studies are prone to p-hacking. Extracting p-values from experimental accounting studies published on the three top accounting journals from 1990 to 2016, we find an unusual abundance of p-values that are just significant: the frequency of p- values equal to 0.05 far exceeds what would be expected based on the frequency of neighboring p-values. ... In contrast, we do not find a similar discontinuity from archival accounting articles."

Subrahmanyam (2019, pages 16-17) proposes fine-tuning the existing incentives for researchers:

"First, as referees, should we insist on significant results? It is really OK if not every result goes the way of the paper's central thesis. Second, should we require innumerable robustness checks? Why not worry more about the importance of the topic, rather than whether the results make a "splash" by all lining up one way? ... As members of tenure committees, should we place a little emphasis on whether the author has exercised intellectual honesty (e.g., via reporting results objectively and honestly), rather than on splash and impact?"

Ardalan (2008), Gendron and Smith-Lacroix (2015), Gippel (2015a), and Brooks and Schopohl (2018) indicate that finance research suffers from "lack of paradigmatic diversity" which hinders the progress of the field. Also, Brooks and Schopohl (2018) and evidence by Chazi et al. (2021), Pieters and Baumgartner (2002) and Borokhovich et al. (1994) indicate the "absence of synthesis of knowledge from other fields" and a low level of interdisciplinary research in finance.

Brooks et al. (2019) argue that the incentive structures of finance scholars, combined with a lack of interest by practitioners in working with them, has nurtured "insularity and a consequent homogeneity" in

the discipline. Zingales (2015) addresses the disparity in perceptions of the value of financial research by finance faculty versus society, observing that as finance academics,

> "we are the priests of an esoteric religion, only we understand the academic scriptures and can appreciate the truths therein revealed. For this reason, we almost wallow in public disdain and refuse to engage, rather than wonder whether there is any reason for these feelings"

Similarly, Bennis and O'Toole (2005), Gippel (2015b), and Hopwood (2007) discuss a large divide that exists between academic finance research and the reality of practice. They argue for a two-way engagement between researchers and practitioners in the financial services industry to enhance knowledge progression and social impact (see Rynes et al. (2001), Starbuck (2007), and the 2016 Collective Vision for Business Education by AACSB International)[2].

Finally, an institutional obstacle that may be hampering knowledge progression in finance just as it is found in other fields is the wide-spread use of indicators such as the number of published articles over a certain time period, the number of hits in top-rank journals, and the number of citations of articles to assess the research productivity of universities, in academic ranking systems, and faculty members, in tenure and promotion decisions and remuneration increases (See Lawrence (2008), Colquhoun (2007), Adler and Harzing (2009), Singh et al. (2007), Colquhoun (2017), Brembs et al. (2013), Muller and de Rijcke (2017), Werner (2015), Osterloh and Frey (2020), and Yaqub (2020)). Muller and de Rijcke (2017, pages 165-166) conclude that:

> "... analysis indicates at least two potential consequences: first, epistemic diversity appears limited. It seems that for many researchers the only research questions and projects that appear viable are those that can meet the demands of scoring well in terms of metric performance indicators ... in relatively short amount of time. ... Second, ... other forms of valuing academic work are increasingly harder to maintain or to (re-)introduce..., such as the societal or community relevance of research... This might also mean that academic research becomes a less attractive workplace for individuals committed to societal relevance and the greater public good."

In brief, this literature review identifies several obstacles to innovative research and knowledge progression in finance. We examine the empirical evidence next.

[2]In 2016, AACSB International published "A Collective Vision for Business Education". The component "co-creators of knowledge" of this vision prescribes and recognizes that teamwork among academics from various disciplines and cooperation with practitioners enhance the potential for the development and successful implementation of innovative and comprehensive solutions to the prevailing complex economic and social problems.

3 Absolute Impact and Growth of Financial Research (1997-2019)

We begin our discussion by examining the absolute impact of papers published in the four leading finance journals: *Journal of Finance* (JF), *Journal of Financial Economics* (JFE), *Review of Financial Studies* (RFS), and *Journal of Financial and Quantitative Analysis* (JFQA). The absolute impact is measured by (1) total citations of research of the four leading journals and (2) the impact factor of the four leading journals over the 1997-2019 period. Table 1 shows these data.

Total citations of JF papers rose from 3,413 in 1997 to 40,648 in 2019, corresponding to an annual increase of 11.9 percent. For JFE, a similar phenomenon occurs; citations of JFE papers rose from 2,639 in 1997 to 35,682 in 2019, a 12.6 percent annual increase in citations. RFS and JFQA also experienced large compounded annual increases over the period 1997-2019: for RFS, the annual increase in citations was 16.6 percent and for JFQA, 12.0 percent. These findings are illustrative of an increase in the absolute impact for all four journals. Similarly, the journal impact factors continued an upward trend over the past two decades. The impact factor of JF rose by 5.3 percent annually over the 1997-2019 period. The impact factor of JFE rose by 3.8 percent annually over the 1997-2019 period. For RFS and JFQA, the increase was 5.9 percent and 6.4 percent, respectively. These findings are displayed graphically in Figures 1A and 1B.

At first glance, based on these two widely used measures of journal impact, it appears that all is well in the finance discipline: absolute impact of published papers in the leading four journals has risen dramatically. In fact, academic journals focus on, and advertise, their quality in terms of absolute impact. Yet, these absolute impact numbers may merely reflect a proliferation of papers citing more papers (i.e., a "chain letter effect"), rather than far reaching advances in the field.

As information and telecommunication technology has improved, so has the ability of researchers in finance to collaborate internationally and provide new perspectives that could further develop the field (see also Schwert (2021), Kim et al. (2009), and Agrawal and Goldfarb (2008))[3]. Table 2 provides data regarding international collaboration between authors in the four leading finance journals between 1999 and 2019. While 9.1 percent of articles published in JF in 1999 had authors from more than one country, by 2019, the percentage had risen to 24.4 percent (after reaching 46.3 percent in 2018). In JFE, the corresponding percent rose from 12.7 percent to 50.0 percent. In RFS, articles written by an internationalized research team rose from 7.5 percent to 44.8 percent, and in JFQA, they rose from 13.0 percent to 30.5 percent. These

[3]Schwert (2021) states in the abstract: "Advances in computing power and electronic communication have driven trends toward more empirical work, more coauthorship, and more complex papers. The set of authors, referees, and editors has also evolved as the field spans a much larger geographic footprint and as women have come to play a larger role in all aspects of academic finance." Kim et al. (2009, page 355) find that: "Among all articles published in the top 41 journals written by scholars residing at a top 25 school, the percentage of coauthored papers with faculty in a nonelite school nearly doubled, from about 32% in the beginning of the 1970s to 61% by 2004, suggesting that it has become much easier for authors at non-elite universities to access scholars at elite universities."

trends are shown in Figure 2. This increased access to and participation of the "global hive mind", and the emergence of leading business schools outside of the United States, has the potential to generate novel and path-breaking advances in the finance discipline.

Next, we focus on the growth of the research output in the leading four finance journals specifically. Table 3 provides the number of citations made by papers published in the four leading journals, the number of articles published in the leading four finance journals, and the total citations per article in the leading four finance journals over the 1997 to 2019 period. As Column 1 shows, in 1997, papers published in the four leading finance journals cited 6,138 papers. By 2019, the number of citations made by papers in these four journals was 21,334. Column 2 indicates that the number of articles published in the leading four journals in finance was 201 in 1997, and grew to 408 by 2019. This increase represents a compounded annual growth of 3.3 percent from 1997 to 2019. Column 3 takes the ratio of Column 1 to Column 2 and indicates that total citations per article grew by 2.5 percent annually from 1997 to 2019. Graphically, the proliferation of articles published from 1997 to 2019 is shown in Figure 3A, and the number of references per article is shown in Figure 3B.

All these indicators point to an explanation regarding the finance discipline for the absolute citation based impact factors shown in Table 1: There are more papers being published, and papers published cite increasingly more papers. These trends in turn underlie, at least partially, the increase in the absolute impact of the leading four finance journals. However, these findings do not provide any insights into whether the relative impact of papers published in the finance discipline has increased, which would indicate knowledge progression in finance. We examine next the relative scientific impact of new financial research published in leading finance journals.

4 Relative Scientific Impact of New Financial Research(1997-2019)

In Table 4, we present data regarding the distribution of citations of old and new papers in the four leading journals from 1997 to 2019. Column 1 provides information regarding citations by all journals across disciplines made to articles published in the four leading finance journals from 1997 to 2019. In 1997, there were 7,194 citations made to papers published in the four leading finance journals; in 2019, there were 100,663. Column 2 provides data regarding citations made by all journals to papers published in the leading four finance journals ten or more years ago. Papers published in 1997 (from any discipline) generated 2,946 citations of papers published in the four leading finance journals a decade or more prior. In 2019, there were 70,558 citations to "old" papers in top four finance journals.

Column 3 in Table 4 presents the data for citations made by papers in leading four finance journals to papers published in the leading four finance journals ("intra-disciplinary" citations). In 1997, papers published in the four leading finance journal made 2,528 citations of papers published in the leading four finance journals; in 2019, they made 8,831 citations to papers in the leading four journals. Column 4 also shows data comparable to that presented in Column 2 regarding old research. Papers published in the leading four finance journals in 1997 made 769 citations of "old" leading finance papers. By comparison, papers published in the leading four finance journals in 2019 cited 4,894 "old" leading finance papers.

Next, we present in Table 5 the cumulative number of articles published in each of the four leading finance journals since their inception. For instance, by 1987, the cumulative number of papers published in JF was 5,544, for JFE, the cumulative number of papers published over the journal's lifetime was 360, and for JFQA, the cumulative number of papers published was 1,336. RFS (introduced in 1988) published 19 articles in its first year. In aggregate, the total number of papers published in the four leading finance journals by 2019 was 15,699.

Table 5 provides the composition of articles published ten or more years ago as a percent of the cumulative total number of articles published in the four leading finance journals since their inception. We compute this composition in each year over the 1997-2019 period. We notice that the number of old articles as a percent of the total number of published articles oscillates smoothly between 77.2 and 81.0 percent. Thus, the composition of old and new research in these leading finance journals remained relatively stable over the 1997-2019 period.

Table 6 presents the data regarding the RSI_t corresponding to a given year for each year from 1997 to 2019. Table 6, Column 1 reiterates the final column from Table 5, which is the proportion of old publications to total cumulative publications in the leading four finance journals. Column 2 presents the percent of citations made by all journals published in a given year to papers in the leading four finance journals which were published over ten years ago. For instance, of all citations made by all journals (from various disciplines) of leading finance articles in 1997, 41.0 percent of these citations were of leading four finance journal papers published ten or more years ago. Over time, this ratio increased, and by 2019, it was 70.1 percent. Correspondingly, Column 3 illustrates the following: of all articles in the four leading finance journals cited by papers in the same four leading finance journals, what the percent published ten years ago or longer was. This proportion increased from 30.4 percent in 1997 to 55.4 percent in 2019, indicating that the reliance on old papers has grown over the last two decades.

In Columns 4 and 5 of Table 6, we define and introduce the following measure of the relative scientific impact (RSI_t) of new leading financial research in year t:

$$RSI_t = \left(\begin{array}{c} \text{Of citations made to leading financial research,} \\ \text{the percent made to new leading financial research} \\ \textit{divided by} \\ \text{the actual percent of new leading financial} \\ \text{research out of total stock of old and new} \end{array} \right) \times \left(\begin{array}{c} \text{Of citations made to leading financial research,} \\ \text{the percent made to old leading financial research} \\ \textit{divided by} \\ \text{the actual percent of old leading financial} \\ \text{research out of total stock of old and new} \end{array} \right)$$

This ratio can also be simplified algebraically to the following:

$$RSI_t = \left(\begin{array}{c} \text{The ratio of new to old citations} \\ \text{to leading financial research made in year t} \end{array} \right) \times \left(\begin{array}{c} \text{The ratio of actual number of old to actual number} \\ \text{of new leading financial research as of year t} \end{array} \right)$$

This ratio captures the composition of researchers' citations to new versus old research while accounting for the actual composition of the stock of new and old financial research. This measure is expected to be greater than one for several reasons. The emergence of new topics (new regulation, new asset classes, etc.) and the publication of innovative research usually stimulate the interest of other researchers, increasing citations to the new research. In addition, citations to even major old contributions usually diminish eventually as these latter become part of the general body of knowledge that new researchers take for granted (Anderson et al. (1989)). Moreover, newer knowledge may replace some old ones due to new theories or more robust empirical evidence. Further, researchers may feel compelled to cite recently published research in the journal where they want to publish their paper because they think it improves their chance of acceptance.

We analyze the time-series changes in this ratio. A positive (negative) trend suggests an increasing (decreasing) RSI_t of new leading financial research. We also note that while journal metrics such as total cites per year and the journal impact factor are bound to increase over time as more researchers conduct more research in finance (i.e., a "chain letter effect"), this measure is not endogenously affected by the increasing research activity over time.

In Table 6, Column 4 presents the RSI_t of new research published in leading finance journals, computed using citations made by scholars from various disciplines (i.e., at-large RSI_t) for each year during the 1997-2019 time period, and Column 5 presents the RSI_t computed with citations of papers published in the leading four finance journals made by papers published in the same four leading finance journals (i.e., intra-disciplinary RSI_t). As shown in Column 4, the at-large RSI_t of new research in finance fell rather steadily

from 5.1 in 1997 to 1.5 by the end of 2019, which represents a decline of 70.6 percent cumulatively (5.4 percent annually). From 2002 to 2019, it declined from 4.4 to 1.5, corresponding to a total decline of 65.9 percent (6.1 percent annually). In Column 5, we find a comparable decline in the intra-disciplinary RSI_t, which fell from 8.1 in 1997 to 2.8 in 2019, a decrease of 65.4 percent cumulatively (4.7 percent annually). From end of 2002 to end of 2019, intra-disciplinary RSI_t shrunk by 61.1 percent cumulatively (5.4 percent per year).

Figure 4A presents the data from Table 6 for Columns 1, 2, and 3. We observe that while the stock of old articles as a percent of the total stock of old and new papers oscillates in the narrow range 77.2 to 81.0 percent, the at-large and the intra-disciplinary citations have been increasingly made to old finance articles. Figure 4B shows the at-large and intra-disciplinary RSI_t of new finance research in the 1997-2019 period (i.e., Columns 4 and 5). Clearly, Figure 4B reveals steady decay in the relative scientific impact of new research in finance, most sharply in the 2002-2019 period. We examine next whether the same phenomenon exists in the related field of economics.

5 Is the Diminishing Relative Scientific Impact Prevalent in the Field of Economics?

We assess the relative scientific impact of research articles published in four leading journals in economics: *American Economic Review* (AER), *Journal of Political Economy* (JPE), *Quarterly Journal of Economics* (QJE), and *Review of Economic Studies* (RES). AER, JPE, QJE, and RES were launched in 1911, 1892, 1886, and 1933, respectively. We hand-collect the data on the number of articles published in these journals prior to 1997.

Table 7, Column 1 provides a breakdown of the percent of publications in the leading four economics journals that are old relative to the cumulative number of publications in these journals by year. Column 2 presents the following: Of all articles in four leading economics journals cited by all journals, what percent was published ten or more years? Column 3 displays the following: Of all articles in four leading economics journals cited by same four leading economics journals, what percent was published ten or more years ago? Columns 4 and 5 show the at-large and intra-disciplinary RSI_t of new economics research, respectively, over the 1997-2019 period.

The data in Columns 1, 2, and 3 are shown graphically in Figure 5A. We observe that the percent of old articles of the total cumulative number of articles of leading economics journals rises initially from

81.1 percent in 1997 to 85.1 percent in 2004, but then remains essentially stable in the range of 85.1 to 85.9 percent during the remainder of the study period. However, the percent old of all articles of leading economics journals cited by all journals rose rather steadily from 57.2 percent in 1997 to 76.3 percent in 2019. The percent old of all articles of leading economics journals cited by same journals increased from 39.6 percent in 1997 to 53.5 percent in 2019, but it was about level during the period 2002- 2016.

With reference to Table 7, Columns 4 and 5 and Figure 5B, the results indicate that the at-large RSI_t of new research in the top four economics journals fell steadily from 3.2 in 1997 to 1.9 by the end of 2019, a decline in impact for new economics research of 41 percent in total (-2.4 percent annually). Over the 2002 to 2019 period, the at-large RSI_t of new economics research declined by 34.5 percent cumulatively (-2.5 percent annually). The intra-disciplinary RSI_t of new research in the top four economics journals fell from 6.5 in 1997 to 5.3 by the year 2019, a decline of 18.7 percent from the end of 1997 to the end of 2019 (-0.9 percent annually). However, over the period 2002 to 2019, the intra-disciplinary RSI_t of new leading economics research increased by 2.2 percent cumulatively (+0.1 percent annually).

These findings are troubling for both the finance and economics disciplines. In both fields, the number of new papers per year has increased over the past two decades, while the reliance on older papers for citation in newly published articles has increased. Yet, economics research appears to have experienced a smaller decline in terms of the RSI_t. Notably, the decline in the intra-disciplinary RSI_t of new leading financial research (-4.7 percent annually) is more than five times that of new leading economics research (-0.9 percent annually) over the period 1997-2019.

Our results support the conclusion that while there is proliferation of finance research that is technically well executed during the past two decades, this research advances finance knowledge only marginally. Historically, however, our field benefited from the development of major theories (e.g., Markowitz (1952), Modigliani and Miller (1958), Sharpe (1964), Akerlof (1970), Black and Scholes (1973), Jensen and Meckling (1976), Kahneman and Tversky (1979), etc.).

6 Alternative Approach to Analyzing the Scientific Impact of New Finance Research

In this section, we analyze the citations in a different way following the highly appreciated comments of the anonymous reviewer. We use the following basic model for the citations:

$$TC_t = N_t \cdot [\Sigma_{s<t} \cdot \lambda_{t,s} \cdot N_s]$$

TC_t : denotes the total number of citations made by papers published in year t in JF, JFE, RFS, and JFQA to papers published in these same four journals in year $s < t$;

N_t : denotes the number of papers published in year t in JF, JFE, RFS, and JFQA; and

$\lambda_{t,s}$: denotes the probability that the "representative" paper in year t cites the representative paper that was published at time $s < t$ in JF, JFE, RFS, and JFQA.

We present the main findings of this analysis by examining the plots of $\lambda_{t,s}$ and comparing them for different cohorts of papers. As the anonymous reviewer correctly explains, the plots enable us demonstrate both the "age effect" and the decline in impact, as well as to identify the point in time where the decline in relative impact began.

The method to obtain the data required to compute lambdas is as follows. Web of Science provides the references made by each publication. As the goal is to identify the references made to the top seven finance and the top five economics journals, and because the DOIs are not available for all the references, we parse the title of the journal using the "regex" library in Python, a text pattern-matching tool based on regular expressions. Each reference is compared to the list of twelve journal source titles (shown below).

Journal Source Title	**Abbreviated Journal Name**
Journal of Finance	JF
Journal of Financial Economics	JFE
Journal of Political Economy	JPE
Review of Financial Studies	RFS
Journal of Corporate Finance	JCF
American Economic Review	AER
Journal of Financial and Quantitative Analysis	JFQA
Quarterly Journal of Economics	QJE
Journal of Business	JB
Review of Economics Studies	RES
Journal of Banking and Finance	JBF
Econometrica	ECMA

There can be either an exact match of the title of the journal in the reference or a partial match. Partial matches can arise due to heterogeneity in styles of referring to publications, for example – "J FINANC", "JOURNAL OF FINANCE", "J FINANCE IN PRESS" or "UNPUB J FINANCE"; all refer to the Journal of Finance. We perform a manual check of approximately five hundred such styles for the twelve journals listed above to ensure the quality of the match. Once the title of the journal has an exact or a partial match,

the journal source title, the abbreviated journal name, and the year of publication are used to compute the lambdas.

6.1 Additional evidence on the decay in relative scientific impact based on $\lambda_{t,s}$

The results of our analysis using $\lambda_{t,s}$ as a measure of scientific impact are shown numerically in Table 8 and graphically in Figure 6. Figure 6 indicates that moving forward in time with cohort publication year (i.e., 1980, 1985, 1990, 1992 cohorts), the mean lambdas exhibit an upward trend over all horizons (i.e., the lambda of the [+1,+3], [+7,+9], [+10, +12], [+13,+15]...[+28, +30]) horizons for the 1996 cohort exceeds that of the 1990 cohort and the 1988 cohort). In other words, the "staying power" of new papers published in cohorts during this pre-2001 time period is increasing, providing additional evidence that scientific impact was increasing up to 2001.

The upwards trend in lambda continues to increase through the 2001 cohort group, and then an important shift occurs. As of 2001, lambda reverses the upwards trend in lambdas over time horizons, and abruptly declines thereafter. In other words, moving forward in time for cohort groups (i.e., 2004, 2010, 2015), the mean lambda begins to deteriorate across horizons (i.e., [+1,+3] vs. [+4,+6] vs. [+7,+9]), rather than increasing as it did for the pre-2001 cohorts. Thus, for post 2001 cohorts, the persistence of impact begins a sharp decline across all time horizons.

In addition, a divergence begins between early horizons and later horizons with an increasingly steep decline in lambda for the cohorts in or around the 1996 cohort, indicating that papers are increasingly being forgotten in time by authors of papers published over horizons more distant in the future. In other words, the impact persistence of papers published between 1996 and 2001 is still increasing, but papers published between 1996 and 2001 are becoming less impactful for the [+7,+9], [+10,+12], [+13, +15], ...[19,+21] horizons than they are for the [+1,+3] horizon. By the time we reach the 2000 cohorts, the divergence in mean lambdas between the nearer horizons, such as [+1,+3] and [+4,+7] and later horizons is much greater than it was in the 1990 and 1980 cohorts. Papers are coming out, and citations are increasing, but new papers have lower "staying power" and the impact decays relatively faster.

Also of note, the divergence between nearer [+1,+3] and later horizons falls around the 2012 cohort group for the [+4,+6] and [+7,+9] horizons, indicating comparable persistence in impact between immediate horizons and horizons further in the future; however, the relative impact has also fallen, indicating that we have recently entered a where impact is declining, impact is low, and impact dissipates quickly. It appears that these recent papers are briefly viewed or cited and then discarded for good. Taken together, the results

from Table 8 and Figure 6 support our previous findings of a diminishing scientific impact of new finance research in the past two decades.

6.2 The lasting impact (duration) of different cohorts of papers since the mid-1960s

Table 9 and Figure 7 demonstrate that the field of finance did not always have a low pace of knowledge progression. Over the earlier time periods of the 1970s, 1980s, and 1990s, when the theories of information asymmetry, agency theory, and respective explanations for managerial behavior regarding MA activity, asset pricing, dividend policy, capital structure, managerial compensation, and mutual fund performance (and so forth) were being developed and refined, the relative scientific impact of the articles published was high, and remained relatively stable throughout the late 1980s and most of the 1990s. In contrast, much of the research in the post-2000 period is evidently characterized by a much lower RSI_t and stagnating knowledge progression. Regrettably, the period of decline in knowledge progression in finance coincided with a period over which research activity and international collaborations in finance intensified greatly.

6.3 Did the impactful / innovative research migrate to other major finance journals?

An additional concern raised by the anonymous reviewer is that "some readers might want to know whether the lower citations to newer papers have not actually disappeared, but rather they have shown up in other journals." For this reason, we expand our sample of leading finance journals and include the Journal of Business (JB, founded in 1928 and active until 2006), the Journal of Banking and Finance (JBF, founded in 1977), and the Journal of Corporate Finance (JCF, founded in 1999). We present in Table 10 and Figure 8 the duration of scientific impact of cohorts of papers following their publication in the expanded sample of seven significant finance journals. We also present in Table 11 and Figure 9 the probability ($\lambda_{t,s}$) that the "representative" paper published during year t in JF, JFE, RFS, and JFQA cites the representative paper that was published at time $s < t$ in JB, JBF, and JCF.

In Figure 8, we show that for papers published in more recent cohort groups (post 2000 cohorts), the decline in lambda observed for the full sample still occurs, and the decline in lambda is steeper in later cohorts than in earlier cohorts. With reference to Figure 9, where we have documented a decline in scientific impact of the leading four finance journals, we observe a collapse in scientific impact for non-leading journals' post 2000 cohorts, with all pre-2000 cohorts exhibiting greater relative scientific impact than the post-2000 cohorts.

In particular, the impact of papers published in the 2006-2010 cohort was initially low (with an impact at publication equal to the lowest lambda observed by any pre-2000 cohort), increased marginally through year 3, and then decayed quickly thereafter, essentially forgotten in the time series of finance research. The 2011-2015 is also not off to a promising start, with impact out to seven years post-publication lower than any cohort through seven years, including the 2006-2010 cohort.

Our exploration yields additional grim discoveries. We find that lambda of the cohorts of papers published in JB, JBF, and JCF between 2001 and 2005 twelve years after publication is lower than the relative scientific impact of the 1991-1995 cohort published in JB, JBF, and JCF twenty-seven years after their publication. Another grotesquerie is observed in the predominantly JBF and JCF 2006-2010 cohort (as JB ceased publication in 2006); the mean lambda for the 2006-2010 cohort twelve years after publication (0.04) has the equivalent impact as the average paper published in the 1981-1985 and 1991-1995 issues of JB, JBF, and JCF thirty years after publication and the 1971-1975, 1976-1980, and 1986-1990 cohorts 29 years post-publication. This is an unsettling display of declining scientific impact at reputable journals outside the top four journals.

6.4 How do the findings regarding research in finance compare to economics?

Table 12 and Figure 10 provide an analysis of relative scientific impact for the five leading economics journals. We observe that all cohorts have a similar pattern of lambdas over time (i.e., all of the lines corresponding to five year cohorts are bunched together, indicating that the cohort lambdas for recent cohorts are not substantially different than they are for older cohorts). Mean lambdas have not declined; cohorts in 2006-2010 and 2011-2015 exhibit less difference in decay than in prior periods. The incidence of citing new economics research in the leading journals does not decline moving forward in time for newer cohorts. This suggests that any recent declining relative scientific impact is not as severe in economics as it is in finance.

An anonymous reviewer made another valuable suggestion for improving our paper. He/she points out that: "One possible explanation for the findings is that finance researchers stopped making methodological contributions. So everyone is citing old and established methodologies." As it is difficult to characterize a paper as methodological or not, he/she recommends looking at economics and studying the behavior of citations made to Econometrica (ECMA). If this hypothesis is correct, the phenomena that we find should be much more visible for papers published in ECMA rather than the other top journals. For this reason, we examine in Table 13 and Figure 11 the probability ($\lambda_{t,s}$) that the "representative" paper published during year t in AER, JPE, QJE, and RES cites the representative paper that was published at time $s < t$ in ECMA.

The results in Table 13 and Figure 11 indicate that there is robust innovation in methodology development published in ECMA; relatively new cohorts appear to continue to have an impact in terms of citations by journals in the top 4 economics journals, and for some recent cohorts, there is even a resurgence of citations in the years following publication. For example, for the 2011 to 2015 cohort (shown by the black dashed line in Figure 11), spikes in citations have occurred 5 and 7 years after publication, and for the 2006 to 2010 cohort (shown by the red dashed line in Figure 11), the trend in lambda has been increasing recently. Thus, it is not likely that the old papers being cited are the established methods papers. In fact, assuming that Econometrica (ECMA) is an adequate proxy for methodology papers, these findings indicate that new methods papers are possibly the only new research related to finance being cited by the top four finance journals.

7 Which Cohorts Have "Home-Run" Papers?

In this section, we perform final analyses of the citations data to determine whether the high scientific impact of a certain cohort of papers is attributed to the collective impact of several papers included in the cohort or rather to few "home-run" papers. For each set of papers published in the four leading finance (five leading economics) journals in a particular year t, we compute the cross-sectional Gini coefficients of the citations made to that set of papers in each year following year t. We group the articles in the sample of four leading finance (five leading economics) journals into five-year cohorts starting with 1966 (i.e., 1966-1970, 1971-1955, etc.). We then compute the mean Gini coefficient of the citations made to these as a function of their age. The Gini coefficient is a measure of inequality that takes values between 0 and 1. A value close to one indicates that the cohort includes "home-run" papers that received the most citations compared to the others in that cohort. On the other hand, a Gini coefficient close to zero indicates that all articles in that cohort are equally cited (i.e., no outstanding / "home-run" papers within the cohort).

Our primary data are taken from the Web of Science (http://www.webofknowledge.com/). The first data set contains list of publications and annual cumulative citations for each publication. The second data set contains the references used in each publication. The two data sets are merged on the unique Digital Object Identifiers (DOI) codes. Publications with missing DOI codes are matched based on the title of the paper. The finance and economics journals used for analysis are again: JF, JFE, RFS, JFQA, AER, JPE, QJE, RES and ECMA. Our final filter drops publications that are less than seven pages in length, which likely removes any notes published in these journals.

Table 14 and Figure 12 present the Gini coefficients of the citations to the leading finance research papers,

whereas Table 15 and Figure 13 show the Gini coefficients of the citations to the leading economics research papers. It is apparent from the two figures that the mean Gini coefficients of citations for the recent five-year cohorts start at lower values. Evidently, there are fewer papers in recent years that every paper feels they should cite. We also observe the persistently lower level of the Gini coefficients of newer cohorts even years after publication.

These additional results complement the earlier findings to reveal a comprehensive and robust empirical evidence on innovation and knowledge progression in the academic field of finance. Regrettably, during the past two decades, finance knowledge progression has declined sharply and we find lack of highly innovative papers despite the concurrent increase in research activity and international collaborations. In contrast, the much older economics field, while showing no "home-run" papers in recent years, continues to progress at about the same rate as in recent decades (or just a little slower) due to the collective contributions of its new research.

8 Is the Diminishing Impact a Concurrent Common Phenomenon in Other Disciplines?

In this section, as a final robustness check, we examine whether the declining relative scientific impact is a general phenomenon occurring in other business or non-business fields during the same period. Various research fields are likely to have different challenges to knowledge progression and uncorrelated timing of major discoveries. Thus, we hypothesize that the time-series changes in the RSI_t of new research will vary across research categories unless there is a common factor affecting progress in all of them. In the latter case, we cannot attribute our findings to field-specific challenges that hinder innovation and scientific progress in finance, such as those discussed by Harvey (2017), Brooks et al. (2019), Brooks and Schopohl (2018), Gendron and Smith-Lacroix (2015), Gippel (2015), Ardalan (2008), and Hopwood (2007).

This examination is performed over the period 2003-2019 as category-level metrics are not available prior to the 2003 JCR year. We examine all six business categories in the InCites Journal Citation Reports database (business, finance; economics; management; business; operations research and management science; and computer science, information systems), ten social sciences, ten natural / life sciences, and ten engineering fields. These categories include many of the traditional academic disciplines that exist at universities. They also include or match (to the extent possible) the categories listed in the study of Fanelli (2010). For example, Fanelli (2010) combines the research categories "Plant and Animal Sciences" into one. It also includes "Space

Science" and "Clinical Medicine" for which we find no similar categories in InCites Journal Citation Reports. The appendix to the paper provides the description of the thirty-six research categories. We present the at-large RSI_t of new research in these disciplines in Figure 14.

There are no data on the stock of articles published in each category. For this reason, we estimate the at-large RSI_t of new articles in each research category by considering different scenarios for the ratio of stock of articles published ten years ago or longer to current total stock ranging from 65% to 95%. The ratio of stock of articles published ten years ago or longer $(X_t - 10)$ to current total stock of articles (X_t) of a category in a particular year t is equal to $(1 + g) - 10$ where g is the annual compounded growth rate of the number of articles over the ten year period. The assumption of a steady composition of new versus old research articles is a reasonable approximation observed in the case of the disciplines of economics and finance earlier in the paper. The graphs in Figure 14 are based on a ratio of stock of old articles to current cumulative total stock of 80%. Using a different ratio changes the scale of the vertical axis but neither the shape of the curves nor the percent change in the at-large RSI_t of new research over the period 2003-2019. The range of the vertical axes in the graphs of Figure 10 is always 10.0 for ease of comparison.

Figure 14 indicates that for the research category of finance, which includes the leading accounting journals (Journal of Accounting Research, Accounting Review, and Journal of Accounting and Economics), the at-large RSI_t of new articles declined rather steadily by 33.9 percent in total over the 2003-2019 period. Finance and management experienced the largest declines among the business research categories. The category of economics, which includes the leading finance journals (JF, JFE, RFS, and JFQA) and one of the leading accounting journals (the Journal of Accounting and Economics), had a smaller decline in the at-large RSI_t of new articles, of 16.5 percent. The research category business, which includes the leading management journals, the leading marketing journals and journals such as Journal of International Business Studies and the Harvard Business Review but none of the leading economics, finance, or accounting journals, exhibited a steady decline reaching cumulatively 23.2 percent over the period.

In contrast, the research fields of operations research management science and computer science, information systems had positive changes in the at-large RSI_t of new articles, of 8.8 percent and 34.1 percent, respectively. The category of operations research management science exhibited a level at-large RSI_t of new research in the earlier years of the period in the range of 4.5 to 5 which increased and remained at a higher level in later years. The category computer science, information systems experienced some variation in at-large RSI_t of new articles around the level of 8.5 until the year 2015, but then its at-large RSI_t rose sharply thereafter, reaching its highest level by 2019. Thus, the decline in the RSI_t of new research in finance we report earlier in the paper is not confined to the sample of four leading finance journals. Rather,

it extends to the category of finance as defined in the database of InCites Journal Citation Reports. Also, the decline in the RSI_t of new research in finance is not a common phenomenon across the business research categories.

We examine the at-large RSI_t of new research in the following ten social sciences: Anthropology; Psychology; Sociology; Communication; Ethics; Education Educational Research; Political Science; Industrial Relations Labor; History Philosophy of Science (SSCI); and Social Sciences, Interdisciplinary. We also inspect the at-large RSI_t of new research in the following ten natural / life sciences: Biology; Physics, Applied; Environmental Sciences; Plant Sciences; Geosciences, Multidisciplinary; Materials Science, Multidisciplinary; Pharmacology and Pharmacy; Immunology; Neurosciences; and Multidisciplinary Sciences. We further study the at-large RSI_t of new research in the following ten engineering fields: Chemical; Civil; Electrical Electronic; Mechanical; Environmental; Agricultural; Metallurgy Metallurgical; Biomedical; Manufacturing; and Industrial Engineering.

An initial review of the graphs in Figure 14 reveals the following. The at-large RSI_t of new research is lower at the end than it was at the beginning of the 2003-2019 period in nine out of the ten social science categories, in nine out of the ten natural / life science categories, and in six out of the ten engineering categories we examine, consistent with the finding reported above that four among the six business categories had a lower at-large RSI_t of new research at the end of the period. The top five categories in terms of the percentage change in the at-large RSI_t of new research over the 2003-2019 period are: Agricultural Engineering (+76.7 percent); Chemical Engineering (+54.9 percent); Computer Science, Information Systems (+34.1 percent); Civil Engineering (+31.0 percent); and History Philosophy of Science – SSCI (+9.5 percent). The bottom five categories are: Immunology (-56.8 percent); Neurosciences (-48.6 percent); Engineering, Manufacturing (-45.8 percent); Management (-35.9 percent); and Plant Sciences (-35.3 percent). Clearly, neither the top five nor the bottom five belong to one set of categories. By comparison, the category of Business, Finance has the rank of 30th among the thirty-six categories we examine.

A more thorough analysis of the graphs in Figure 14 uncovers seven distinct patterns in the change in the at-large RSI_t of new research in these thirty categories over the 2003-2019 period. None of the three sets of categories had one pattern only. The description of these patterns follows:

- The most frequent pattern for the at-large RSI_t of new research across categories is a decline followed by a reversal. The categories that experienced that pattern are eight: Electrical Electronic Engineering (having almost a U-shape); Multidisciplinary Sciences (having a V-shape); Mechanical Engineering; Environmental Sciences; Industrial Engineering; Manufacturing Engineering; Industrial

Relations Labor; and Pharmacology Pharmacy. In six of these eight categories, the reversal did not outweigh the initial decline. Time will tell about the strength and sustainability of the reversal in these six categories.

- The second most frequent pattern for the at-large RSI_t of new research across categories is a rise followed by a reversal. The categories that experienced that pattern are the following six: Agricultural Engineering; Civil Engineering; Applied Physics; Metallurgy Metallurgical Engineering; Biology; Materials Science, Multidisciplinary. In some of these categories, the decline may have bottomed, but again time will tell.

- The third most frequent pattern is the at-large RSI_t of new research essentially having declined in most of our study period. This pattern occurred in the following five categories: Immunology; Psychology; Sociology; Plant Sciences; and Geosciences, Multidisciplinary.

- The fourth most frequent pattern is the at-large RSI_t of new research essentially having oscillated in a relatively narrow range around a certain constant level in about the first half of the period, and then having fallen essentially steadily during the second half of the period. This pattern transpired in the following four research categories: Anthropology; Communication; Education Educational Research; and Biomedical Engineering.

- The fifth most frequent pattern is the at-large RSI_t of new research having fluctuated rather widely during about the first half of the period, and then having decreased during the second half of the period reaching basically its lowest level in the graph by the year 2019. This pattern happened in the following research categories: Ethics; Political Science; Social Sciences, Interdisciplinary; and Neurosciences.

- The sixth most frequent pattern is the at-large RSI_t of new research having oscillated around a certain level throughout the 2003-2019 period. This pattern materialized in two categories: Environmental Engineering and History Philosophy of Sciences - SSCI.

- The least frequent (seventh) pattern is the at-large RSI_t of new research having increased steadily throughout the 2003-2019 period. The research category Chemical Engineering is the only one that had this pattern.

In brief, these results indicate that the steadily and sharply declining RSI_t of new research in finance is not a systematic phenomenon across other business or non-business research categories during the period 2003-2019. In fact, there were seven patterns in the non-business categories we examined, with various frequency of occurrence, and the categories of Operations Research Management Science and Computer

Science, Information Systems exhibited two additional patterns. These results indicate that it does not have to be this way in finance. Also, many disciplines that experienced declining RSI_t of new research had a reversal.

9 Conclusion and Discussion

Over the past two decades, the number of finance articles published and the international research collaborations in finance has more than doubled. Yet, the relative scientific impact of new finance research declined steadily during the period 2002-2019, reaching by 2019 its lowest level in the past four decades. This finding is robust to several alternative analyses. Also, this increasing "... proliferation of papers that are technically well done but that advance finance knowledge only marginally" (Harvey (2017, page 1434)) is not standard across academic research fields, indicating that it does not have to be this way in finance. Our results indicate that the concerns that many prolific researchers and editors are raising regarding risk-aversion, excessive reviewing, conformity, and insularity in finance research are justified empirically.

The finance discipline is too young to exhibit this decline in impact (particularly when compared to economics, an older discipline). There is a clear need, in light of our findings, to consider the recommendations that leaders in the finance field have made related to editorial policies, the training of future finance academics, and the university research environment, promotion considerations, and incentive structures that can support research with the highest potential to advance knowledge. For instance, relating to editorial policy, Harvey (2017) recommends that editors of finance journals publish papers and "registered reports" that raise intriguing research questions even if the results are statistically insignificant, accept replication studies (which raises the cost of p-hacking), not reject papers in certain areas, and maintain a long-term view for their journals as opposed to simply pursuing impact factors. Brooks et al. (2019, page 48) recommend that elite outlets embrace research that uses new methods, that illustrates different perspectives, or that integrates new insights from other disciplines.

Further, regarding university research strategy and incentives structures that can promote research with the highest potential to advance knowledge, Ghoshal (2005, page 82) states that:

> "... Boyer (1990) described four different kinds of scholarship: the scholarship of discovery (research), the scholarship of integration (synthesis), the scholarship of practice (application), and the scholarship of teaching (pedagogy). Historically, business schools have celebrated and accommodated as equals the practitioners of all four kinds of scholarship. Over the last 30 years, we have lost this taste for pluralism."

Adler and Harzing (2009, page 92) state:

> "Competitive pressure—especially to publish only, or primarily, in A-listed journals—may, in fact, foster attempts to boost scores on assessment metrics, but not necessarily to maximize the quality and significance of the underlying research. Might it be that more generous, collaborative environments inspire and support higher quality research than do environments defined by rankings-based competition?"

As we conclude this discussion, there is a relevant and perhaps valid viewpoint that

> "... when we, as academics, plead powerlessness in choosing what we research and how we do it because of incentive and reward systems (particularly after achieving tenure), we dehumanize and degrade our careers and our lives."

There are many ways in which financial economists, with their valuable knowledge and advanced skills, can offer new and efficient solutions to existing societal problems. Poverty reduction, financial inclusion and democratization, the evolution of corporate governance, reversal of environmental degradation, etc. are all noble causes financial economists are well trained to contribute to (see a similar argument made by Starbuck (2007, pages 23-24) relating to researchers in organizational studies). Yet, these solutions will not be developed if we remain in a paradigmatic straightjacket, focusing on one type of scholarship, and "thinking with indicators" (à la Muller and de Rijcke (2017))[4]. We hope our findings will stimulate further the currently burgeoning research and dialog on the state of our field.

[4]Important research on the subject of the social value of finance includes Brooks et al. (2019), Zingales (2015), Gippel (2015b), and Hopwood (2008). Zingales (2015, pages 1328-1329) argues that "... [we should] use our research and our teaching to curb the rent-seeking dimension of finance. We should use our research to challenge existing practices in finance ... We should be the watchdogs of the financial industry, not its lapdogs (Zingales (2013)). Examples such as the paper of Christie and Schultz (1994) on the odds eighths scandal on the NASDAQ and the paper of Li (2005) on the backdating of executive option awards had clearly significant social impact.

10 Figures and Tables

Table 1: **Citations-Based Absolute Scientific Impact of Four Leading Finance Journals (1997–2019)**

Year	Total Cites				Journal Impact Factor (JIF)			
	JF	JFE	RFS	JFQA	JF	JFE	RFS	JFQA
1997	3413	2639	601	541	2.17	2.51	1.33	0.69
1998	3791	2676	547	388	2.14	1.77	1.01	0.73
1999	3949	2364	767	412	2.65	1.71	1.45	0.54
2000	4610	3093	935	520	2.75	1.9	1.34	0.6
2001	5446	3570	1099	741	2.96	2.58	1.67	0.9
2002	5997	4014	1307	820	3.49	3.25	1.85	1.26
2003	6739	4590	1484	929	3.27	2.72	2.2	0.85
2004	7051	4529	1604	922	3.11	2.55	1.62	1.22
2005	8235	5404	1984	1027	2.55	2.39	1.89	1
2006	10344	6615	2302	1335	3.26	2.49	1.7	1.24
2007	10473	6980	2330	1382	3.35	2.99	2.16	1.34
2008	14679	10013	3365	2018	4.02	3.54	2.64	1.23
2009	18039	12058	4416	2490	3.76	4.02	3.55	1.6
2010	17621	11815	4958	2350	4.15	3.81	4.6	1.59
2011	18293	12976	5510	2414	4.22	3.73	4.75	1.78
2012	18729	13075	6280	2571	4.33	3.42	3.26	1.64
2013	21843	15508	7614	2991	6.03	3.77	3.53	1.88
2014	23535	17271	8671	3460	5.42	4.05	3.17	1.57
2015	24013	18347	9405	3585	5.29	3.54	3.12	1.63
2016	29644	24083	11581	4500	6.04	4.51	3.69	1.67
2017	34342	28511	13600	5135	5.4	5.16	4.27	2.05
2018	39005	32678	15972	6054	6.2	4.7	4.98	2.27
2019	40648	35682	17761	6572	6.81	5.73	4.65	2.71
Compounded annual increase 1997-2019	11.9%	12.6%	16.6%	12%	5.3%	3.8%	5.9%	6.4%

Description : This table shows the number of citations made in a particular year to documents published in the following four leading finance journals: Journal of Finance (JF), Journal of Financial Economics (JFE), Review of Financial Studies (RFS), and Journal of Financial and Quantitative Analysis (JFQA). It also shows the journal impact factor (JIF) which is the number of citations made in a particular year to documents published in a particular journal in the preceding two years divided by the total number of documents published in that journal in the preceding two years. Data below are obtained from InCites Journal Citation Reports, Clarivate Analytics (https://jcr.clarivate.com) on March 21st, 2019. Data for the year 2018 are added on June 24th, 2019. Data for the year 2019 are retrieved on February 26th, 2021.

Interpretation : The citations-based impact numbers (total citations and journal impact factors) of the leading finance journals have exhibited upward trends over the last two decades. However, this conclusion is not robust proof of significant progression in finance knowledge, because it is at least partially an expected outcome of the growing number of articles published in finance and other disciplines that cite finance research.

Table 2: **International Research Collaborations in Four Leading Finance Journals (1999–2019)**

Year	Percent of published articles with authors from more than one country			
	JF	JFE	RFS	JFQA
1999	9.1	12.7	7.5	13
2000	4.5	23.2	2.8	17.2
2001	18.8	11.5	7.9	12
2002	11.2	17.2	19.3	17.2
2003	16.1	14.8	23.1	29
2004	11.8	30.3	27	26.3
2005	25.3	21.5	35	27.8
2006	28.4	20.5	20.9	13.5
2007	25.3	26	28.8	26.8
2008	19.5	32.7	78.3	40.5
2009	23.5	28	32	31.5
2010	28.6	38.6	30.4	43.3
2011	20	38.2	27.3	38.9
2012	35.9	43.7	37.1	44
2013	20.3	43.5	35.7	42.9
2014	32.4	44.1	33	34.6
2015	31.2	43.8	38.2	58.1
2016	18.7	41.5	35.2	57
2017	29.7	43.6	45.8	45.7
2018	46.3	54.9	46.8	33
2019	24.4	50	44.8	30.5

Description : This table provides the distribution of percent of articles published in four leading finance journals with authors from more than one country. It illustrates the inclusiveness of international research talent in the published articles of the leading finance journals. These four leading finance journals are: Journal of Finance (JF), Journal of Financial Economics (JFE), Review of Financial Studies (RFS), and Journal of Financial and Quantitative Analysis (JFQA). The data presented below on percent of published articles with authors from more than one country are retrieved on March 10th, 2021 from the website https://www.scimagojr.com/journalrank.

Interpretation : The data in this table show that international research collaborations in the academic field of finance have risen since 1999, which hopefully resulted in new perspectives and innovative research.

Table 3: **Number of Articles and Number of References per Article Published in Four Leading Finance Journals (1997 - 2019)**

Year of Publication of Citing Journals	Column 1 Total citations made by four leading finance journals	Column 2 Number of articles published in four leading finance journals	Column 1/Column 2 Total citations per article
1997	6138	201	30.5
1998	5429	177	30.7
1999	6382	195	32.7
2000	7362	210	35.1
2001	6270	173	36.2
2002	7835	221	35.5
2003	8322	228	36.5
2004	8910	239	37.3
2005	9510	241	39.5
2006	10214	252	40.5
2007	11216	287	39.1
2008	12748	293	43.5
2009	16334	372	43.9
2010	15810	345	45.8
2011	16969	356	47.7
2012	14943	321	46.6
2013	17124	360	47.6
2014	14554	306	47.6
2015	15423	318	48.5
2016	17242	344	50.1
2017	19655	386	50.9
2018	20330	381	53.4
2019	21334	408	52.3
Compounded annual inc. 1997-2019		3.3%	2.5%

Description : This table provides the number of citable documents (i.e., published articles and reviews) and the number of their references in four leading finance journals: Journal of Finance (JF), Journal of Financial Economics (JFE), Review of Financial Studies (RFS), and Journal of Financial and Quantitative Analysis (JFQA). These data are obtained from Incites Journal Citation Reports, Clarivate Analytics (https://jcr.incites.thomsonreuters.com) on February 18th, 2018. Upon logging in, "Browse by Journal", select the journal, select the JCR year, and download "Citing Journal Data". This table was updated for the year 2018 on October 16th, 2019 and for the year 2019 on February 26th, 2021.

Interpretation : There are more papers being published, and papers published cite increasingly more papers. These trends underlie, at least partially, the increase in the absolute impact of the leading four finance journals shown in Table 1 and Figures 1A and 1B. We need more robust evidence on knowledge progression in finance.

Table 4: **Distribution of Citations to Articles Published in Four Leading Finance Journals (1997–2019)**

Year of Publication of Citing Journals	Total citations made by all journals to articles published in the four leading finance journals (i.e., All journals)	Citations made by all journals to articles published in the four leading finance journals 10 years ago or more relative to the date of publication of citing article	Total citations made by the four leading finance journals to articles published in the same journals (i.e., Intra-disciplinary citations)	Citations made by the four leading finance journals to articles published in the same journals 10 years ago or more relative to the date of publication of citing article
1997	7194	2946	2528	769
1998	7402	3064	2190	804
1999	7492	3442	2490	849
2000	9158	4402	3155	1202
2001	10856	5287	2572	1004
2002	12138	5888	3810	1396
2003	13742	7200	3757	1582
2004	14106	7408	3791	1662
2005	16650	8907	3868	1646
2006	20596	11156	4413	1941
2007	21165	12169	4461	2143
2008	30075	17721	5360	2428
2009	37003	22474	6883	3252
2010	36744	22076	6592	3038
2011	39193	23720	7008	3315
2012	40655	25080	6570	3162
2013	47956	29266	7342	3458
2014	52937	32884	6128	2804
2015	55350	34975	6073	2869
2016	69808	45530	7248	3764
2017	81588	54675	7926	3841
2018	93709	63591	8227	4360
2019	100663	70558	8831	4894

Description : This table presents the number of citations made by (1) researchers from various disciplines (i.e., "All Journals") and (2) researchers published in four leading finance journals (i.e., "Intra-disciplinary") to leading finance articles (i.e., articles published in the four leading finance journals. It also shows the part of these citations that relate to old leading financial research (i.e., articles published in the four leading finance journals ten years ago or longer relative to the publication year of the citing article). The four leading finance journals are: Journal of Finance (JF), Journal of Financial Economics (JFE), Review of Financial Studies (RFS), and Journal of Financial and Quantitative Analysis (JFQA). Citations data are downloaded from InCites Journal Citation Reports, Clarivate Analytics (https://jcr.clarivate.com) on March 20th, 2019. Data for the year 2018 are added on June 25th, 2019. Data for the year 2019 are retrieved on February 26th, 2021.
Interpretation : The data above enable the computation of (1) the percent of the citations made by all journals to old leading finance research, and (2) the percent of the citations made by the four leading finance journals to old leading finance research. These data are essential to compute the relative scientific impact of new finance research.

Table 5: **Composition of Old and New Stocks of Articles Published in Four Leading Finance Journals (1997–2019)**

Year	Cumulative number of articles published						Articles published 10 years ago or longer as percent of current cumulative total
	JF	JFE	RFS	JFQA	Cumulative Total	Annual Increase (%)	
1987	5544	360	-	1336	7240	2.5	
1988	5637	403	19	1372	7431	2.6	
1989	5733	450	45	1408	7636	2.8	
1990	5841	500	78	1446	7865	3	
1991	5940	527	107	1489	8063	2.5	
1992	6048	555	134	1530	8267	2.5	
1993	6159	586	166	1569	8480	2.6	
1994	6258	613	192	1606	8669	2.2	
1995	6351	655	228	1643	8877	2.4	
1996	6441	702	265	1677	9085	2.3	
1997	6525	758	300	1703	9286	2.2	78
1998	6602	807	327	1727	9463	1.9	78.5
1999	6679	862	367	1750	9658	2.1	79.1
2000	6768	918	403	1779	9868	2.2	79.7
2001	6817	979	441	1804	10041	1.8	80.3
2002	6905	1037	488	1832	10262	2.2	80.6
2003	6998	1097	526	1869	10490	2.2	80.8
2004	7087	1172	563	1907	10729	2.3	80.8
2005	7173	1251	603	1943	10970	2.2	80.9
2006	7260	1338	644	1980	11222	2.3	81
2007	7344	1441	703	2021	11509	2.6	80.7
2008	7425	1537	782	2058	11802	2.5	80.2
2009	7503	1630	929	2112	12174	3.2	79.3
2010	7572	1730	1048	2169	12519	2.8	78.8
2011	7632	1866	1156	2221	12875	2.8	78
2012	7692	1990	1251	2263	13196	2.5	77.8
2013	7764	2143	1334	2315	13556	2.7	77.4
2014	7835	2245	1427	2355	13862	2.3	77.4
2015	7905	2363	1514	2398	14180	2.3	77.4
2016	7976	2486	1596	2466	14524	2.4	77.3
2017	8039	2607	1708	2556	14910	2.7	77.2
2018	8104	2720	1827	2640	15291	2.6	77.2
2019	8175	2854	1949	2721	15699	2.7	77.5

Description : This table presents the actual cumulative number of articles published in four leading finance journals since their beginning. The first issue of Journal of Finance (JF) was in the year 1946. The first issue of Journal of Financial Economics (JFE) was in the year 1974. The first issue of Review of Financial Studies (RFS) was in the year 1988. The first issue of Journal of Financial and Quantitative Analysis (JFQA) was in the year 1966.

Interpretation : The actual composition of old and new research in the four leading finance journals remained relatively stable over the 1997-2019 period.

Table 6: **Relative Scientific Impact of New Articles Published in Leading Finance Journals, (1997–2019)**

Year	Column 1 Of all articles published in four leading finance journals, percent published ten years ago or longer	Column 2 Of all articles in four leading finance journals cited by all journals, percent published ten years ago or longer	Column 3 Of all articles in four leading finance journals cited by same four leading finance journals, percent published ten years ago or longer	Column 4 At-large relative scientific impact of new articles published in four leading finance journals	Column 5 Intra-disciplinary relative scientific impact of new articles published in four leading finance journals
1997	78	41	30.4	5.1	8.1
1998	78.5	41.4	36.7	5.2	6.3
1999	79.1	45.9	34.1	4.4	7.3
2000	79.7	48.1	38.1	4.2	6.4
2001	80.3	48.7	39	4.3	6.4
2002	80.6	48.5	36.6	4.4	7.2
2003	80.8	52.4	42.1	3.8	5.8
2004	80.8	52.5	43.8	3.8	5.4
2005	80.9	53.5	42.6	3.7	5.7
2006	81	54.2	44	3.6	5.4
2007	80.7	57.5	48	3.1	4.5
2008	80.2	58.9	45.3	2.8	4.9
2009	79.3	60.7	47.2	2.5	4.3
2010	78.8	60.1	46.1	2.5	4.4
2011	78	60.5	47.3	2.3	3.9
2012	77.8	61.7	48.1	2.2	3.8
2013	77.4	61	47.1	2.2	3.8
2014	77.4	62.1	45.8	2.1	4.1
2015	77.4	63.2	47.2	2	3.8
2016	77.3	65.2	51.9	1.8	3.1
2017	77.2	67	48.5	1.7	3.6
2018	77.2	67.9	53	1.6	3
2019	77.5	70.1	55.4	1.5	2.8
Percentage change over period from end of 1997 to end of 2019				-70.6%	-65.4%
Annual compounded change				-5.4%	-4.7%
Percentage change over period from end of 2002 to end of 2019				-65.79%	-61.1%
Annual compounded change				-6.1%	-5.4%

Description : This table examines the relative scientific impact of new financial research over the period 1997-2019. Column 1 is copied from Table 6. Columns 2 and 3 show the number of citations made by (1) researchers from various disciplines (i.e., "All Journals") and (2) researchers published in four leading finance journals (i.e., "Intra-disciplinary") of old leading finance articles (i.e., articles published in the four leading finance journals ten years ago or longer relative to the publication year of the citing article) as a percent of their total citations of leading finance articles (i.e., old and new finance articles published in four leading finance journals). The four leading finance journals are: JF, JFE, RFS, and JFQA. Citations data are downloaded from InCites Journal Citation Reports, Clarivate Analytics (https://jcr.clarivate.com) on March 20th, 2019. Data for the year 2018 are added on June 25th, 2019. Data for the year 2019 are retrieved on February 26th, 2021.

Interpretation : The reliance on old papers has grown over the last two decades. Yet, the actual composition of old and new research in the four leading finance journals remained relatively stable over the 1997-2019 period as shown in Table 5. Thus, the at-large and the intra-disciplinary relative scientific impact of new financial research declined significantly over the period 1997-2019. Please see also Figures 4A and 4B.

Table 7: **Relative Scientific Impact of New Articles Published in Leading Economics Journals (1997–2019)**

Year	Column 1 Of all articles published in 4 leading economics journals, percent published 10 years ago or longer	Column 2 Of all articles in 4 leading economics journals cited by all journals, percent published 10 years ago or longer	Column 3 Of all articles in 4 leading economics journals cited by same 4 journals, percent published 10 years ago or longer	Column 4 At-large relative scientific impact of new articles published in 4 leading economics journals	Column 5 Intra-disciplinary relative scientific impact of new articles published in 4 leading economics journals
1997	81.1	57.2	39.6	3.2	6.5
1998	81.8	58	40.1	3.2	6.7
1999	82.4	57.8	41.6	3.4	6.6
2000	83.1	60	41.3	3.3	7
2001	83.7	62.9	45.5	3	6.1
2002	84.2	64.8	50.6	2.9	5.2
2003	84.7	66.2	47.8	2.8	6
2004	85.1	66.9	48.8	2.8	6
2005	85.2	67.9	50.8	2.7	5.6
2006	85.4	68.2	50.5	2.7	5.7
2007	85.5	68.7	50.7	2.7	5.7
2008	85.6	69.9	47.9	2.6	6.5
2009	85.6	73.4	51.4	2.2	5.6
2010	85.7	71.7	51.4	2.4	5.7
2011	85.6	72.6	51	2.3	5.7
2012	85.6	73.3	50.2	2.2	5.9
2013	85.8	74	51.4	2.1	5.7
2014	85.7	74.1	51.1	2.1	5.7
2015	85.7	75.2	52.8	2	5.4
2016	85.6	76	50.2	1.9	5.9
2017	85.4	76.8	57.4	1.8	4.4
2018	85.7	76.7	54.3	1.8	5.1
2019	85.9	76.3	53.5	1.9	5.3
Percentage change over period from end of 1997 to end of 2019				-41%	-18.7%
Annual compounded change				-2.4%	-0.9%
Percentage change over period from end of 2002 to end of 2019				-34.5%	+2.2%
Annual compounded change				-2.5%	+0.1%

Description : This table examines the relative scientific impact of new economics research over the period 1997-2019. The four leading economics journals are: American Economic Review (AER) launched in 1911, Journal of Political Economy (JPE) launched in 1892, Quarterly Journal of Economics (QJE) launched in 1886, and Review of Economic Studies (RES) launched in 1933. Data on number of articles published prior to 1997 are hand-collected to compute Column 1. Columns 2 and 3 show the number of citations made by (1) researchers from various disciplines (i.e., "All Journals") and (2) researchers published in four leading economics journals (i.e., "Intra-disciplinary") of old leading economics articles (i.e., articles published in the four leading economics journals ten years ago or longer relative to the publication year of the citing article) as a percent of their total citations of leading economics articles (i.e., old and new economics articles published in four leading economics journals). Citations data are downloaded from InCites Journal Citation Reports, Clarivate Analytics (https://jcr.clarivate.com) on 4/6/2019 and updated for the year 2018 on 6/25/2019 and the year 2019 on 2/26/2021.
Interpretation : In economics and finance, alike, the reliance on older papers for citation in newly published articles has increased. However, new economics research has experienced a much smaller decline in its RSI_t.

Table 8: **Scientific Impact of Cohorts of Papers Published in Four Leading Finance Journals, Cohorts Starting in 1966**

Cohort	Mean Lambda (%) in three-year period following the publication of the cohort									
	[+1,+3]	[+4,+6]	[+7,+9]	[+10,+12]	[+13,+15]	[+16,+18]	[+19,+21]	[+22,+24]	[+25,+27]	[+28,+30]
1966	0.029	0.035	0.045	0.045	0.043	0.025	0.02	0.019	0.008	0.013
1967	0.026	0.03	0.029	0.023	0.028	0.011	0.013	0.007	0.006	0.008
1968	0.027	0.032	0.024	0.037	0.025	0.014	0.021	0.017	0.015	0.015
1969	0.025	0.036	0.035	0.034	0.034	0.029	0.018	0.011	0.01	0.011
1970	0.036	0.049	0.053	0.035	0.03	0.028	0.021	0.015	0.023	0.019
1971	0.036	0.038	0.046	0.034	0.025	0.024	0.016	0.009	0.011	0.013
1972	0.036	0.08	0.07	0.052	0.05	0.029	0.033	0.025	0.016	0.021
1973	0.044	0.087	0.072	0.069	0.067	0.057	0.048	0.038	0.048	0.059
1974	0.041	0.074	0.067	0.049	0.035	0.024	0.016	0.024	0.028	0.025
1975	0.044	0.062	0.05	0.031	0.03	0.02	0.015	0.016	0.015	0.015
1976	0.079	0.107	0.108	0.104	0.086	0.064	0.053	0.055	0.045	0.04
1977	0.096	0.15	0.132	0.134	0.09	0.065	0.058	0.054	0.056	0.043
1978	0.098	0.109	0.093	0.07	0.056	0.044	0.043	0.043	0.03	0.032
1979	0.098	0.127	0.108	0.077	0.067	0.06	0.052	0.051	0.048	0.037
1980	0.131	0.15	0.13	0.113	0.104	0.09	0.079	0.076	0.059	0.049
1981	0.202	0.216	0.161	0.159	0.095	0.082	0.09	0.064	0.06	0.052
1982	0.195	0.187	0.154	0.135	0.093	0.074	0.079	0.063	0.046	0.045
1983	0.278	0.297	0.21	0.158	0.14	0.086	0.099	0.063	0.057	0.058
1984	0.258	0.249	0.222	0.157	0.15	0.109	0.112	0.106	0.087	0.076
1985	0.335	0.338	0.256	0.225	0.219	0.183	0.15	0.116	0.109	0.094
1986	0.392	0.349	0.28	0.244	0.251	0.182	0.156	0.131	0.119	0.096
1987	0.379	0.342	0.293	0.265	0.222	0.167	0.142	0.15	0.13	0.104
1988	0.503	0.422	0.331	0.264	0.235	0.194	0.161	0.165	0.133	0.098
1989	0.426	0.361	0.283	0.244	0.21	0.172	0.146	0.133	0.132	0.096
1990	0.39	0.399	0.306	0.281	0.228	0.201	0.164	0.14	0.133	0.104
1991	0.387	0.423	0.356	0.299	0.236	0.203	0.17	0.155	0.125	
1992	0.376	0.398	0.336	0.25	0.208	0.185	0.179	0.123	0.117	
1993	0.391	0.454	0.425	0.297	0.283	0.25	0.21	0.194	0.168	
1994	0.447	0.453	0.327	0.292	0.214	0.182	0.148	0.127		
1995	0.533	0.542	0.38	0.295	0.254	0.21	0.154	0.132		
1996	0.541	0.563	0.407	0.322	0.258	0.235	0.198	0.179		
1997	0.578	0.604	0.418	0.357	0.339	0.283	0.26			
1998	0.645	0.57	0.439	0.39	0.304	0.266	0.226			
1999	0.648	0.529	0.386	0.341	0.278	0.226	0.213			
2000	0.641	0.56	0.44	0.393	0.301	0.23				
2001	0.711	0.699	0.56	0.44	0.356	0.31				
2002	0.606	0.556	0.463	0.372	0.269	0.267				
2003	0.523	0.547	0.459	0.355	0.294					
2004	0.423	0.524	0.419	0.334	0.27					
2005	0.413	0.483	0.39	0.305	0.292					
2006	0.409	0.449	0.334	0.302						
2007	0.34	0.416	0.309	0.281						
2008	0.354	0.435	0.345	0.323						
2009	0.377	0.408	0.314							
2010	0.376	0.366	0.303							
2011	0.313	0.331	0.31							
2012	0.362	0.407								
2013	0.289	0.33								
2014	0.335	0.373								

Description : In this table, we use the following basic model for the citations: $TC_t = N_t \cdot [\Sigma_{s<t} \cdot \lambda_{t,s} \cdot N_s]$ where TC_t denotes the total number of citations made by papers published in year t in JF, JFE, RFS, and JFQA to papers published in these same four journals in year $s < t$; N_t denotes the number of papers published in year t in JF, JFE, RFS, and JFQA; and $\lambda_{t,s}$ denotes the probability that the "representative" paper in year t cites the representative paper that was published at time s ¡ t. This table enables us to examine the plots of $\lambda_{t,s}$, compare them for different cohorts of papers, show both the decline in impact and the age effect, and pinpoint the exact year the decline in relative impact started occurring. Web of Science provides the references made by each publication. The results of our analysis using $\lambda_{t,s}$ as a measure of scientific impact are shown numerically in this table and graphically in Figure 6. Section 6 contains additional details on construction of lambdas.
Interpretation : Moving forward in time with cohort publication year, the mean lambdas exhibit an upward trend over all horizons. In other words, the "staying power" of new papers published in cohorts during the pre-2001 time period is increasing, providing additional evidence that scientific impact was increasing up to 2001. However, an important shift occurs afterwards: the mean lambda begins to deteriorate. Also, a divergence begins between early horizons and later horizons with an increasingly steep decline in lambda for the cohorts in or around the 1996 cohort, indicating that papers are increasingly being forgotten in time by authors of papers published over horizons more distant in the future. In brief, papers are coming out, and citations are increasing, but new papers have lower "staying power" and the impact decays relatively faster. Finance research has entered recently a stage where impact is declining, impact is low, and impact dissipates quickly. These results support our previous findings of a diminishing scientific impact of new finance research in the past two decades.

Table 9: **Duration of Scientific Impact of Cohorts of Papers Following their Publication in Four Leading Finance Journals, Five-Year Cohorts Starting in 1966**

Year following	Mean lambda (%) of cohort of papers published in top 4 finance journals cited by subsequent top 4 finance papers journals									
publication of cohort	1966-1970	1971-1975	1976-1980	1981-1985	1986-1990	1991-1995	1996-2000	2001-2005	2006-2010	2011-2015
1	0.019	0.024	0.067	0.191	0.364	0.325	0.457	0.394	0.246	0.239
2	0.03	0.04	0.1	0.283	0.443	0.457	0.682	0.59	0.416	0.347
3	0.037	0.056	0.134	0.287	0.447	0.499	0.692	0.621	0.452	0.375
4	0.036	0.063	0.119	0.272	0.398	0.494	0.623	0.619	0.445	0.365
5	0.036	0.073	0.135	0.258	0.394	0.445	0.56	0.554	0.41	0.357
6	0.036	0.069	0.132	0.242	0.331	0.423	0.512	0.513	0.39	0.358
7	0.039	0.069	0.118	0.208	0.285	0.406	0.453	0.481	0.344	0.31
8	0.04	0.062	0.112	0.205	0.321	0.353	0.421	0.47	0.323	
9	0.032	0.052	0.113	0.189	0.289	0.336	0.38	0.423	0.295	
10	0.046	0.05	0.107	0.179	0.274	0.335	0.373	0.396	0.312	
11	0.029	0.048	0.102	0.17	0.267	0.275	0.361	0.359	0.272	
12	0.029	0.043	0.09	0.151	0.238	0.251	0.348	0.329	0.311	
13	0.035	0.041	0.083	0.136	0.254	0.271	0.304	0.306		
14	0.036	0.044	0.08	0.148	0.23	0.218	0.305	0.299		
15	0.025	0.038	0.079	0.133	0.205	0.228	0.279	0.287		
16	0.025	0.032	0.066	0.113	0.182	0.221	0.266	0.283		
17	0.02	0.033	0.065	0.115	0.196	0.206	0.253	0.321		
18	0.02	0.029	0.063	0.093	0.171	0.192	0.224			
19	0.017	0.026	0.057	0.109	0.158	0.183	0.236			
20	0.017	0.025	0.06	0.102	0.156	0.177	0.226			
21	0.022	0.026	0.054	0.108	0.146	0.156	0.209			
22	0.016	0.018	0.063	0.087	0.152	0.149	0.179			
23	0.014	0.024	0.056	0.083	0.143	0.152				
24	0.011	0.025	0.049	0.077	0.136	0.139				
25	0.013	0.028	0.052	0.077	0.139	0.148				
26	0.011	0.021	0.043	0.073	0.131	0.109				
27	0.014	0.022	0.049	0.066	0.117	0.114				
28	0.014	0.022	0.044	0.075	0.099					
29	0.011	0.029	0.038	0.059	0.102					
30	0.014	0.028	0.04	0.06	0.096					

Description : In this table, we present the duration of the scientific impact (measured by $\lambda_{t,s}$). The data below are another way of presenting the results we display in Table 8 and Figure 6.

Interpretation : During the pre-2001 period, the scientific impact of each new cohort was surpassing the one of its precedent. During the post-2000 period, the scientific impact of each new cohort has been lower than its precedent. Much of the research in the post-2000 period is evidently characterized by a much lower RSI_t and stagnating knowledge progression. Regrettably, the period of decline in knowledge progression in finance coincided with a period over which research activity and international collaborations in finance intensified greatly.

Table 10: **Duration of Scientific Impact of Cohorts of Papers Following their Publication in Seven Significant Finance Journals, Five-Year Cohorts Starting in 1966**

Year following	Mean lambda (%) of cohort of papers published in top 7 finance journals cited by subsequent top 7 finance papers journals									
publication of cohort	1966-1970	1971-1975	1976-1980	1981-1985	1986-1990	1991-1995	1996-2000	2001-2005	2006-2010	2011-2015
1	0.03	0.028	0.055	0.088	0.161	0.147	0.202	0.134	0.149	0.142
2	0.043	0.048	0.076	0.13	0.208	0.217	0.301	0.219	0.223	0.206
3	0.048	0.067	0.081	0.144	0.216	0.257	0.309	0.25	0.244	0.218
4	0.047	0.073	0.066	0.136	0.205	0.248	0.289	0.263	0.238	0.21
5	0.043	0.074	0.076	0.136	0.201	0.23	0.267	0.254	0.238	0.203
6	0.044	0.063	0.068	0.123	0.18	0.22	0.252	0.252	0.222	0.201
7	0.047	0.057	0.066	0.114	0.161	0.202	0.234	0.237	0.192	0.18
8	0.046	0.043	0.062	0.102	0.17	0.182	0.218	0.246	0.181	
9	0.039	0.033	0.059	0.097	0.151	0.174	0.204	0.228	0.168	
10	0.046	0.032	0.059	0.093	0.14	0.172	0.21	0.22	0.159	
11	0.028	0.028	0.056	0.092	0.138	0.147	0.201	0.201	0.132	
12	0.023	0.026	0.051	0.083	0.116	0.141	0.199	0.184	0.137	
13	0.026	0.023	0.049	0.076	0.121	0.139	0.185	0.167		
14	0.02	0.026	0.044	0.079	0.114	0.125	0.186	0.167		
15	0.017	0.023	0.047	0.066	0.11	0.122	0.179	0.157		
16	0.014	0.019	0.04	0.061	0.095	0.122	0.168	0.148		
17	0.013	0.021	0.036	0.059	0.102	0.119	0.154	0.17		
18	0.014	0.018	0.037	0.051	0.087	0.112	0.138			
19	0.01	0.015	0.035	0.054	0.086	0.11	0.134			
20	0.012	0.015	0.032	0.054	0.082	0.107	0.126			
21	0.012	0.017	0.03	0.055	0.086	0.1	0.121			
22	0.01	0.012	0.032	0.046	0.087	0.092	0.108			
23	0.009	0.015	0.031	0.042	0.081	0.087				
24	0.008	0.015	0.027	0.045	0.079	0.08				
25	0.008	0.015	0.026	0.041	0.081	0.08				
26	0.007	0.014	0.024	0.042	0.076	0.068				
27	0.009	0.012	0.027	0.04	0.067	0.067				
28	0.007	0.012	0.026	0.043	0.06					
29	0.008	0.015	0.024	0.037	0.058					
30	0.007	0.013	0.022	0.04	0.054					

Description : We use the following model for the citations: $TC_t = N_t \cdot [\Sigma_{s<t} \cdot \lambda_{t,s} \cdot N_s]$ where TC_t where TC_t denotes the total number of citations made by papers published in year t in Journal of Finance (JF), Journal of Financial Economics (JFE), Review of Financial Studies (RFS), Journal of Financial and Quantitative Analysis (JFQA), Journal of Business (JB), Journal of Banking and Finance (JBF), and Journal of Corporate Finance (JCF) to papers published in these same seven journals in year s ¡ t; Nt denotes the number of papers published in year t in these journals; and t,s denotes the probability that the "representative" paper in year t cites the representative paper that was published at time s ¡ t. Web of Science provides the references made by each publication. To identify the references made to these seven significant finance journals, and because the DOIs are not available for all the references, we parse the title of the journal using the "regex" library in Python, a text pattern-matching tool based on regular expressions.
Interpretation : Even upon expanding the sample of finance journals, the results are the same. For papers published in more recent cohort groups (post 2000 cohorts), the decline in scientific impact still occurs, and the decline in lambda is steeper in later cohorts than in earlier cohorts.

Table 11: **Duration of Scientific Impact of Cohorts of Papers Following their Publication in JB, JBF and JCF, Five-Year Cohorts Starting in 1966**

Year following	Mean lambda (%) of cohort of papers published in JB,JBF & JCF journals cited by subsequent JF, JFE, RFS & JFQA papers									
publication of cohort	1966-1970	1971-1975	1976-1980	1981-1985	1986-1990	1991-1995	1996-2000	2001-2005	2006-2010	2011-2015
1	0.143	0.11	0.177	0.255	0.379	0.302	0.277	0.141	0.107	0.108
2	0.212	0.203	0.28	0.302	0.487	0.453	0.423	0.217	0.16	0.14
3	0.202	0.271	0.317	0.354	0.375	0.476	0.415	0.229	0.193	0.175
4	0.187	0.269	0.282	0.339	0.417	0.473	0.412	0.252	0.164	0.162
5	0.18	0.287	0.354	0.374	0.392	0.428	0.383	0.174	0.171	0.154
6	0.187	0.233	0.284	0.28	0.356	0.353	0.297	0.189	0.148	0.138
7	0.19	0.295	0.328	0.252	0.31	0.384	0.323	0.184	0.139	0.132
8	0.149	0.258	0.242	0.247	0.236	0.278	0.29	0.164	0.12	
9	0.151	0.205	0.208	0.214	0.229	0.31	0.254	0.159	0.121	
10	0.139	0.188	0.241	0.203	0.238	0.269	0.235	0.131	0.115	
11	0.104	0.206	0.243	0.175	0.243	0.252	0.218	0.115	0.078	
12	0.104	0.173	0.282	0.186	0.193	0.187	0.201	0.099	0.04	
13	0.127	0.146	0.257	0.134	0.195	0.232	0.171	0.091		
14	0.105	0.119	0.202	0.163	0.206	0.194	0.158	0.099		
15	0.078	0.125	0.223	0.144	0.213	0.187	0.136	0.124		
16	0.077	0.106	0.186	0.151	0.189	0.14	0.157	0.081		
17	0.042	0.142	0.127	0.135	0.178	0.159	0.137	0.087		
18	0.09	0.107	0.15	0.114	0.146	0.128	0.138			
19	0.026	0.045	0.099	0.107	0.144	0.128	0.107			
20	0.055	0.057	0.151	0.117	0.133	0.122	0.097			
21	0.047	0.061	0.112	0.117	0.122	0.118	0.108			
22	0.036	0.068	0.136	0.053	0.132	0.128	0.126			
23	0.039	0.067	0.097	0.052	0.11	0.098				
24	0.004	0.047	0.145	0.084	0.096	0.102				
25	0.029	0.053	0.075	0.065	0.099	0.102				
26	0.016	0.047	0.097	0.085	0.078	0.083				
27	0.025	0.061	0.089	0.068	0.064	0.129				
28	0.034	0.054	0.112	0.053	0.063					
29	0.029	0.057	0.107	0.052	0.069					
30	0.026	0.033	0.068	0.035	0.088					

Description : This table presents the probability ($\lambda_{t,s}$) that the "representative" paper published during year t in JF, JFE, RFS, and JFQA cites the representative paper that was published at time $s < t$ in JB, JBF, and JCF.
Interpretation : Where we have documented a decline in scientific impact of the leading four finance journals, we observe in this figure a collapse in scientific impact for non-leading journals' post 2000 cohorts, with all pre-2000 cohorts exhibiting greater relative scientific impact than the post-2000 cohorts. The impact of papers published in the 2006-2010 cohort was initially low (with an impact at publication equal to the lowest lambda observed by any pre-2000 cohort), increased marginally through year 3, and then decayed quickly thereafter. The 2011-2015 is also not off to a promising start, with impact out to seven years post-publication lower than any cohort through seven years, including the 2006-2010 cohort. Additional grim discoveries, we find that lambda of the cohorts of papers published in JB, JBF, and JCF between 2001 and 2005 twelve years after publication is lower than the relative scientific impact of the 1991-1995 cohort published in JB, JBF, and JCF twenty-seven years after their publication. Also, the mean lambda for the 2006-2010 cohort twelve years after publication has the equivalent impact as the average paper published in the 1981-1985 and 1991-1995 issues of JB, JBF, and JCF thirty years after publication. This is an unsettling display of declining scientific impact at reputable journals outside the top four journals.

Table 12: **Duration of Scientific Impact of Cohorts of Papers Following their Publication in Five Leading Economics Journals, Five-Year Cohorts Starting in 1966**

Year following	Mean lambda (%) of cohort of papers published in top 5 econ journals cited by subsequent top 5 econ journal papers									
publication of cohort	1966-1970	1971-1975	1976-1980	1981-1985	1986-1990	1991-1995	1996-2000	2001-2005	2006-2010	2011-2015
1	0.22	0.164	0.16	0.193	0.209	0.218	0.218	0.183	0.229	0.197
2	0.324	0.281	0.281	0.305	0.342	0.317	0.343	0.259	0.306	0.28
3	0.35	0.368	0.337	0.338	0.345	0.343	0.345	0.255	0.307	0.301
4	0.379	0.358	0.272	0.329	0.335	0.366	0.315	0.241	0.297	0.301
5	0.286	0.305	0.255	0.287	0.31	0.322	0.289	0.226	0.257	0.29
6	0.265	0.259	0.232	0.263	0.258	0.286	0.272	0.23	0.257	0.27
7	0.234	0.211	0.176	0.209	0.231	0.258	0.223	0.195	0.245	0.246
8	0.227	0.206	0.167	0.188	0.207	0.215	0.223	0.18	0.225	0.222
9	0.185	0.18	0.143	0.176	0.197	0.203	0.229	0.174	0.226	
10	0.159	0.166	0.12	0.168	0.163	0.193	0.199	0.166	0.214	
11	0.144	0.147	0.111	0.139	0.155	0.157	0.195	0.15	0.212	
12	0.129	0.126	0.113	0.137	0.155	0.149	0.164	0.155	0.197	
13	0.131	0.118	0.096	0.113	0.138	0.158	0.178	0.149	0.184	
14	0.107	0.09	0.093	0.104	0.117	0.119	0.165	0.134		
15	0.084	0.072	0.084	0.106	0.108	0.143	0.142	0.131		
16	0.06	0.088	0.072	0.096	0.103	0.143	0.147	0.133		
17	0.063	0.081	0.068	0.085	0.096	0.126	0.133	0.137		
18	0.057	0.075	0.062	0.09	0.101	0.122	0.13	0.132		
19	0.05	0.083	0.059	0.085	0.097	0.117	0.128			
20	0.035	0.047	0.06	0.083	0.098	0.115	0.131			
21	0.056	0.045	0.051	0.066	0.098	0.11	0.138			
22	0.027	0.056	0.053	0.073	0.097	0.107	0.145			
23	0.044	0.044	0.045	0.066	0.082	0.115	0.173			
24	0.031	0.05	0.05	0.059	0.085	0.097				
25	0.051	0.037	0.042	0.074	0.077	0.102				
26	0.044	0.045	0.045	0.059	0.07	0.094				
27	0.023	0.039	0.035	0.056	0.078	0.084				
28	0.021	0.033	0.031	0.059	0.078	0.052				
29	0.023	0.043	0.049	0.065	0.082					
30	0.034	0.029	0.034	0.055	0.063					

Description : We use the following model for the citations: $TC_t = N_t \cdot [\Sigma_{s<t} \cdot \lambda_{t,s} \cdot N_s]$ where TC_t denotes the total number of citations made by papers published in year t in American Economic Review (AER), Journal of Political Economy (JPE), Quarterly Journal of Economics (QJE), Review of Economic Studies (RES, and Econometrica (ECMA) to papers published in these same five journals in year s ¡ t; Nt denotes the number of papers published in year t in these journals; and t,s denotes the probability that the "representative" paper in year t cites the representative paper that was published at time s ¡ t. Web of Science provides the references made by each publication. To identify the references made to the five leading economics journals, and because the DOIs are not available for all the references, we parse the title of the journal using the "regex" library in Python, a text pattern-matching tool based on regular expressions.
Interpretation : We observe that the lambdas for recent cohorts are not substantially different than they are for older cohorts. Mean lambdas have not declined; cohorts in 2006-2010 and 2011-2015 exhibit less difference in decay than in prior periods. The incidence of citing new economics research in the leading journals does not decline moving forward in time for newer cohorts. This suggests that any recent declining relative scientific impact is not as severe in economics as it is in finance.

Table 13: **Duration of Scientific Impact of Cohorts of Papers Following their Publication in Econometrica (ECMA), Five-Year Cohorts Starting in 1966**

Year following	Mean lambda (%) of cohort of papers published in ECMA cited by subsequent top 4 economics journal papers									
publication of cohort	1966-1970	1971-1975	1976-1980	1981-1985	1986-1990	1991-1995	1996-2000	2001-2005	2006-2010	2011-2015
1	0.112	0.121	0.177	0.31	0.304	0.267	0.282	0.207	0.268	0.172
2	0.23	0.297	0.424	0.497	0.42	0.37	0.447	0.375	0.415	0.336
3	0.186	0.38	0.441	0.476	0.423	0.395	0.411	0.267	0.392	0.363
4	0.205	0.332	0.371	0.377	0.466	0.435	0.351	0.282	0.37	0.322
5	0.17	0.295	0.308	0.388	0.433	0.385	0.285	0.239	0.317	0.347
6	0.138	0.352	0.356	0.349	0.327	0.373	0.28	0.267	0.303	0.313
7	0.092	0.166	0.274	0.241	0.314	0.311	0.24	0.204	0.318	0.323
8	0.091	0.151	0.189	0.244	0.236	0.282	0.287	0.183	0.271	0.284
9	0.082	0.177	0.191	0.238	0.262	0.251	0.207	0.187	0.277	
10	0.095	0.179	0.196	0.192	0.215	0.179	0.24	0.16	0.228	
11	0.09	0.165	0.174	0.115	0.19	0.197	0.266	0.173	0.252	
12	0.049	0.158	0.156	0.183	0.192	0.169	0.192	0.173	0.251	
13	0.036	0.085	0.127	0.17	0.173	0.193	0.208	0.169	0.305	
14	0.071	0.1	0.094	0.104	0.131	0.139	0.19	0.13		
15	0.039	0.07	0.125	0.122	0.134	0.175	0.15	0.124		
16	0.026	0.098	0.084	0.131	0.112	0.162	0.172	0.157		
17	0.039	0.054	0.062	0.122	0.109	0.149	0.156	0.196		
18	0.024	0.055	0.056	0.109	0.114	0.13	0.15	0.139		
19	0.009	0.067	0.063	0.105	0.099	0.143	0.159			
20	0.005	0.026	0.047	0.118	0.087	0.117	0.121			
21	0.021	0.049	0.076	0.041	0.109	0.117	0.158			
22	0.002	0.036	0.084	0.094	0.134	0.094	0.13			
23	0.026	0.034	0.046	0.053	0.08	0.112	0.139			
24	0.02	0.051	0.052	0.043	0.103	0.105				
25	0.029	0.032	0.051	0.065	0.066	0.129				
26	0.029	0.035	0.039	0.065	0.081	0.117				
27	0.003	0.039	0.031	0.054	0.074	0.051				
28	0.001	0.018	0.034	0.052	0.083	0.015				
29	0.01	0.03	0.044	0.061	0.077					
30	0.002	0.008	0.047	0.05	0.063					

Description : This table examines the possible explanation for our main findings that finance researchers stopped making methodological contributions and everyone is citing old and established methodologies. As it is difficult to characterize a paper as methodological or not, we follow the reviewer's recommendation to look at economics and study the behavior of citations made to Econometrica (ECMA).

Interpretation : The results indicate that there is robust innovation in methodology development published in ECMA; relatively new cohorts appear to continue to have an impact in terms of citations by journals in the top 4 economics journals, and for some recent cohorts, there is even a resurgence of citations in the years following publication. Thus, it is not likely that the old papers being cited are the established methods papers.

Table 14: **Inequality of Citations to Cohorts of Papers Published in Four Leading Finance Journals, by Paper Age**

Year since	Mean Gini coefficient for the following five-year cohorts of finance research papers									
publication of article	1966-1970	1971-1975	1976-1980	1981-1985	1986-1990	1991-1995	1996-2000	2001-2005	2006-2010	2011-2015
2	0.774	0.714	0.729	0.649	0.588	0.572	0.547	0.513	0.509	0.505
3	0.736	0.662	0.681	0.614	0.558	0.551	0.522	0.494	0.492	0.492
4	0.704	0.635	0.676	0.601	0.55	0.546	0.514	0.487	0.489	0.485
5	0.683	0.619	0.672	0.602	0.548	0.544	0.511	0.485	0.491	0.485
6	0.673	0.615	0.669	0.602	0.548	0.545	0.511	0.487	0.496	0.491
7	0.675	0.611	0.671	0.604	0.548	0.543	0.516	0.491	0.502	0.498
8	0.677	0.608	0.674	0.605	0.548	0.549	0.521	0.496	0.509	
9	0.674	0.613	0.677	0.609	0.551	0.553	0.528	0.502	0.527	
10	0.678	0.614	0.68	0.612	0.554	0.557	0.536	0.507	0.529	
11	0.679	0.613	0.684	0.616	0.558	0.561	0.543	0.514	0.53	
12	0.679	0.616	0.687	0.619	0.562	0.568	0.552	0.521	0.537	
13	0.682	0.621	0.691	0.621	0.565	0.574	0.56	0.526		
14	0.684	0.624	0.695	0.625	0.569	0.583	0.567	0.539		
15	0.685	0.631	0.699	0.627	0.574	0.59	0.575	0.548		
16	0.687	0.635	0.704	0.629	0.579	0.597	0.582	0.553		
17	0.688	0.639	0.708	0.631	0.586	0.605	0.588	0.549		
18	0.69	0.642	0.711	0.634	0.591	0.612	0.594			
19	0.693	0.646	0.715	0.636	0.597	0.618	0.609			
20	0.696	0.647	0.718	0.639	0.603	0.625	0.616			
21	0.701	0.65	0.72	0.644	0.609	0.631	0.634			
22	0.703	0.653	0.724	0.648	0.615	0.636	0.581			
23	0.706	0.654	0.726	0.653	0.62	0.641				
24	0.709	0.656	0.729	0.658	0.625	0.657				
25	0.712	0.658	0.733	0.661	0.63	0.678				
26	0.715	0.661	0.737	0.666	0.634	0.656				
27	0.717	0.664	0.741	0.67	0.639	0.649				
28	0.719	0.667	0.746	0.675	0.643					
29	0.721	0.669	0.751	0.679	0.655					
30	0.723	0.673	0.756	0.684	0.678					
31	0.723	0.678	0.762	0.687	0.676					
32	0.726	0.684	0.767	0.692	0.668					

Description : This table presents the mean Gini coefficient of citations to cohorts of papers published in four leading finance journals, as a function of the paper age (i.e., years since publication). For each set of articles published in a particular year t, we compute the cross-sectional Gini coefficient of the citations made to them in each year following their birth year t until the present. Then, we group the papers into five-year cohorts starting with the year 1966, and we compute the mean Gini coefficient for each cohort as a function of the paper's age T. The four leading finance journals are: Journal of Finance (JF) launched in the year 1946; Journal of Financial Economics (JFE) launched in the year 1974; Review of Financial Studies (RFS) launched in the year 1988; and Journal of Financial and Quantitative Analysis (JFQA) launched in the year 1966. The source of the citations data is Web of Science.

Interpretation : The mean Gini coefficients of citations for the recent five-year cohorts start at lower values. Evidently, there are fewer papers in recent years that every paper feels they should cite. We also observe the persistently lower level of the Gini coefficients of newer cohorts even years after publication. These additional results complement the earlier findings to reveal a comprehensive and robust empirical evidence on innovation and knowledge progression in the academic field of finance. Regrettably, during the past two decades, finance knowledge progression has declined sharply, and we find lack of highly innovative papers despite the concurrent increase in research activity and international collaborations.

Table 15: **Inequality of Citations to Cohorts of Papers Published in Five Leading Economics Journals, by Paper Age**

Year following	Mean Gini coefficient for the following five-year cohorts of economics research papers									
publication of cohort	1966-1970	1971-1975	1976-1980	1981-1985	1986-1990	1991-1995	1996-2000	2001-2005	2006-2010	2011-2015
2	0.759	0.679	0.668	0.649	0.651	0.612	0.587	0.578	0.561	0.55
3	0.737	0.654	0.654	0.635	0.62	0.589	0.573	0.562	0.54	0.539
4	0.733	0.658	0.651	0.632	0.606	0.585	0.574	0.561	0.537	0.539
5	0.737	0.667	0.656	0.635	0.609	0.591	0.576	0.566	0.535	0.543
6	0.739	0.675	0.66	0.641	0.612	0.595	0.578	0.571	0.538	0.546
7	0.744	0.683	0.664	0.645	0.617	0.6	0.584	0.575	0.541	0.534
8	0.746	0.69	0.669	0.652	0.621	0.604	0.589	0.581	0.546	
9	0.75	0.697	0.674	0.657	0.627	0.609	0.595	0.586	0.545	
10	0.755	0.702	0.678	0.661	0.632	0.614	0.602	0.593	0.548	
11	0.759	0.707	0.683	0.667	0.636	0.618	0.608	0.599	0.552	
12	0.763	0.713	0.687	0.67	0.64	0.624	0.614	0.605	0.538	
13	0.767	0.718	0.69	0.675	0.643	0.628	0.62	0.611		
14	0.771	0.723	0.693	0.679	0.646	0.634	0.626	0.62		
15	0.774	0.727	0.696	0.683	0.651	0.639	0.631	0.626		
16	0.777	0.731	0.699	0.687	0.655	0.645	0.636	0.614		
17	0.781	0.734	0.701	0.69	0.659	0.65	0.641	0.623		
18	0.784	0.738	0.704	0.694	0.664	0.655	0.646			
19	0.787	0.741	0.706	0.697	0.669	0.661	0.651			
20	0.79	0.744	0.709	0.701	0.674	0.666	0.656			
21	0.793	0.747	0.711	0.705	0.679	0.671	0.642			
22	0.795	0.75	0.713	0.708	0.684	0.676	0.588			
23	0.798	0.753	0.715	0.712	0.689	0.68				
24	0.8	0.756	0.718	0.717	0.694	0.692				
25	0.803	0.758	0.721	0.721	0.699	0.712				
26	0.805	0.761	0.723	0.725	0.703	0.732				
27	0.807	0.764	0.726	0.729	0.707	0.743				
28	0.81	0.766	0.729	0.733	0.711					
29	0.812	0.769	0.732	0.737	0.706					
30	0.814	0.772	0.736	0.741	0.717					
31	0.816	0.775	0.74	0.744	0.727					
32	0.819	0.778	0.743	0.748	0.799					

Description : This table presents the mean Gini coefficient of citations to cohorts of papers published in five leading economics journals, as a function of the paper age (i.e., years since publication). For each set of articles published in a particular year t, we compute the cross-sectional Gini coefficient of the citations made to them in each year following their birth year t until the present. Then, we group the papers into five-year cohorts starting with the year 1966, and we compute the mean Gini coefficient for each cohort as a function of the paper's age T. The five leading economics journals are: American Economic Review (AER) launched in 1911, Journal of Political Economy (JPE) launched in 1892, Quarterly Journal of Economics (QJE) launched in 1886, Review of Economic Studies (RES) launched in 1933, and Econometrica (ECMA) launched in 1933. The source of the citations data is Web of Science.

Interpretation : The mean Gini coefficients of citations for the recent five-year cohorts start at lower values. Evidently, there are fewer papers in recent years that every paper feels they should cite. We also observe the persistently lower level of the Gini coefficients of newer cohorts even years after publication. However, despite showing no "home-run" papers in recent years, the economics field while being much older than the finance field continues to progress at about the same rate as in recent decades (or just a little slower) due to the collective contributions of its new research as we find earlier.

Figure 1A
Total Cites to Four Leading Finance Journals, 1997 - 2019 Period

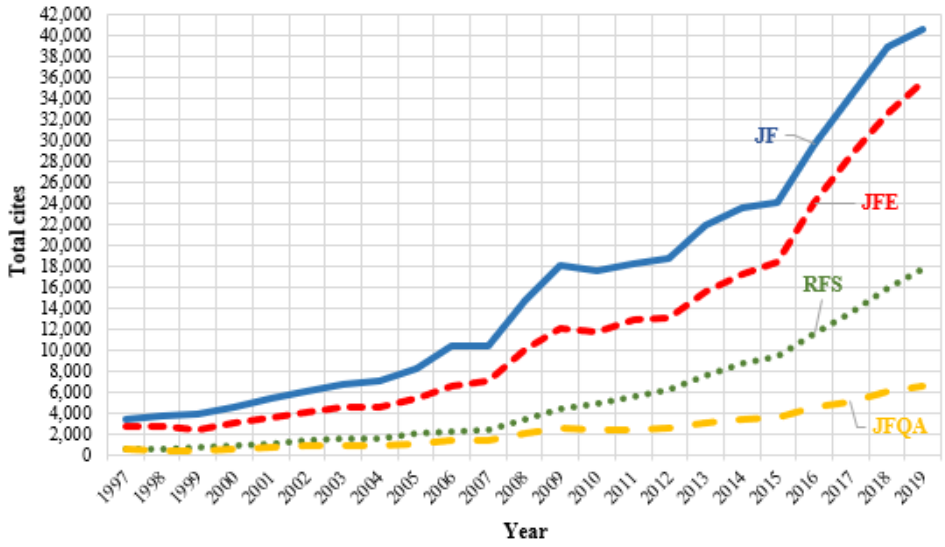
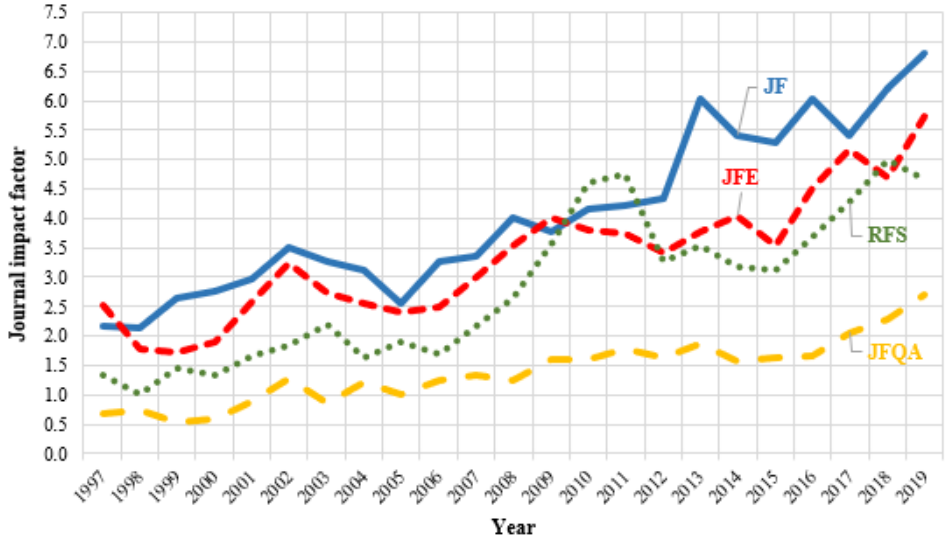
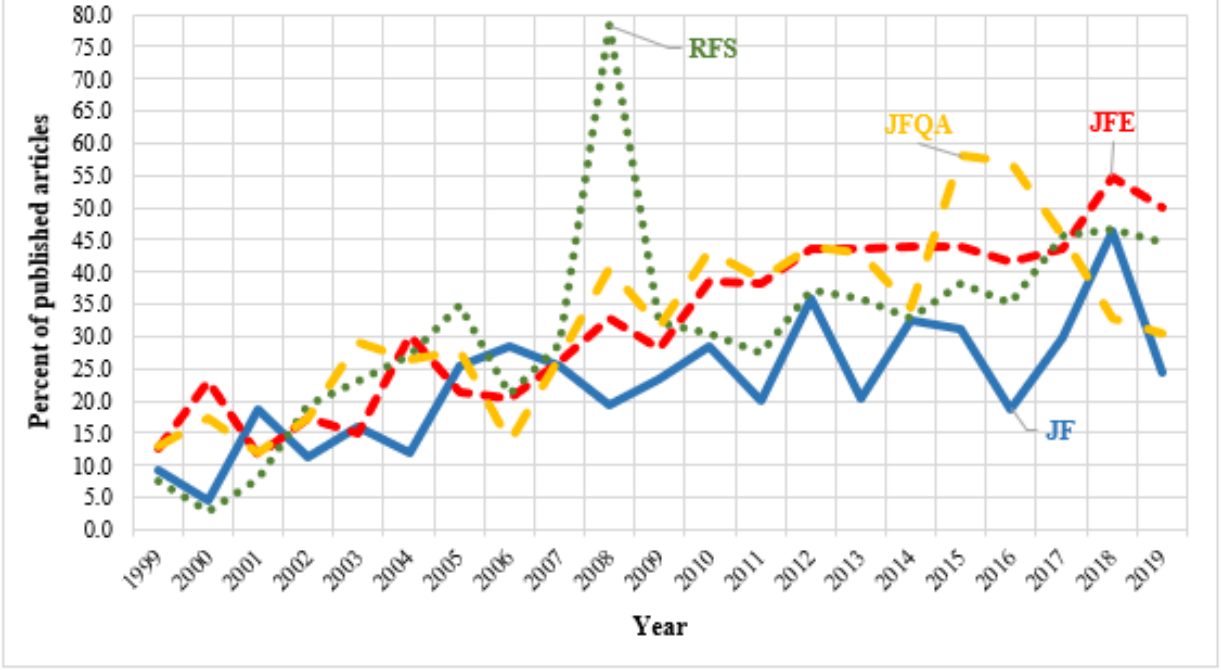


Figure 1B
Journal Impact Factor of Four Leading Finance Journals, 1997 - 2019 Period

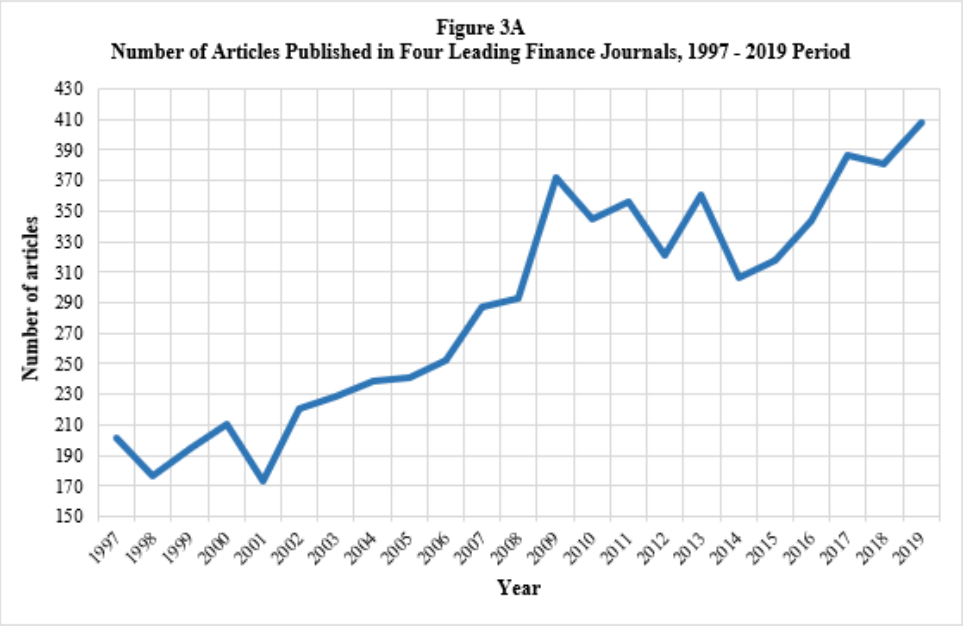


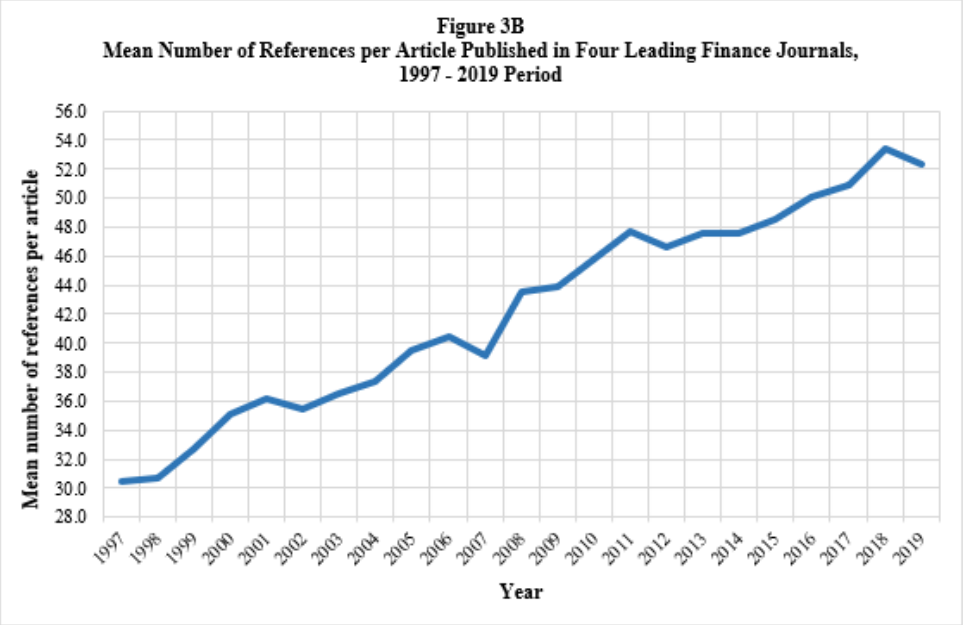
Description : This figure is a graphical illustration of the total citations data in Table 1.
Interpretation Fig 1A: The total citations of the leading finance journals have exhibited upward trends over the last two decades. However, this conclusion is not robust proof of significant progression in finance knowledge, because it is at least partially an expected outcome of the growing number of articles published in finance and other disciplines that cite finance research.
Interpretation Fig 1B : The journal impact factors of the leading finance journals have exhibited upward trends over the last two decades. However, this conclusion is not robust proof of significant progression in finance knowledge, because it is at least partially an expected outcome of the growing number of articles published in finance and other disciplines that cite finance research.

Figure 2
Percent of Articles in Leading Finance Journals Representing International Research Collaborations, 1999 - 2019 Period



Description : This figure is a graphical illustration of the international research collaboration data in Table 2.
Interpretation : This figure shows that international research collaborations in the academic finance field have risen since 1999, which hopefully resulted in new perspectives and innovative research.





Description : This figure is a graphical illustration of the number of published articles data in Column 2 of Table 3.
Interpretation Fig 3A: The total citations of the leading finance journals have exhibited upward trends over the last two decades. However, this conclusion is not robust proof of significant progression in finance knowledge, because it is at least partially an expected outcome of the growing number of articles published in finance and other disciplines that cite finance research.
Interpretation Fig 3B : The journal impact factors of the leading finance journals have exhibited upward trends over the last two decades. However, this conclusion is not robust proof of significant progression in finance knowledge, because it is at least partially an expected outcome of the growing number of articles published in finance and other disciplines that cite finance research.

Figure 4A
Proportion of Old Articles of Leading Finance Journals versus Proportion of Citations of Old Articles of Leading Finance Journals, 1997 - 2019 Period

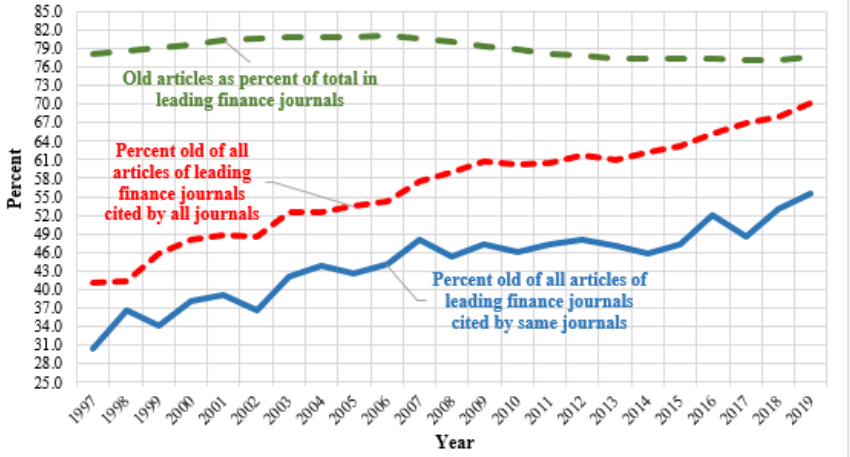
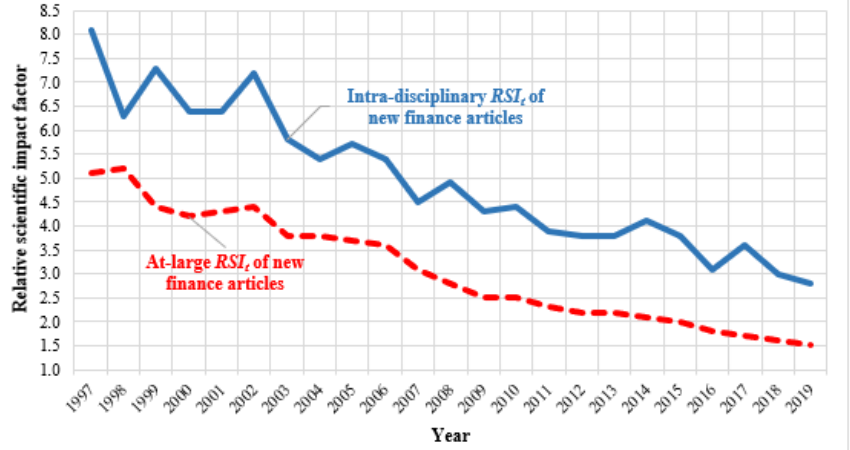
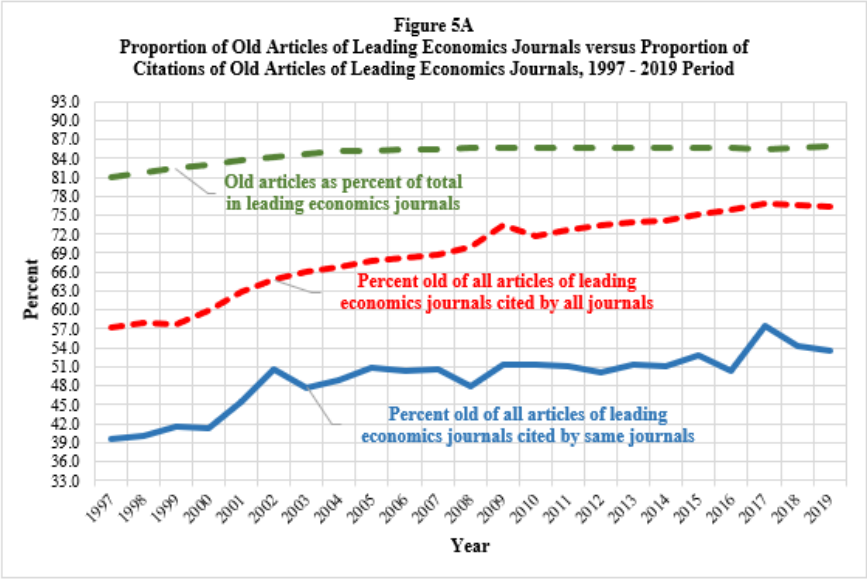
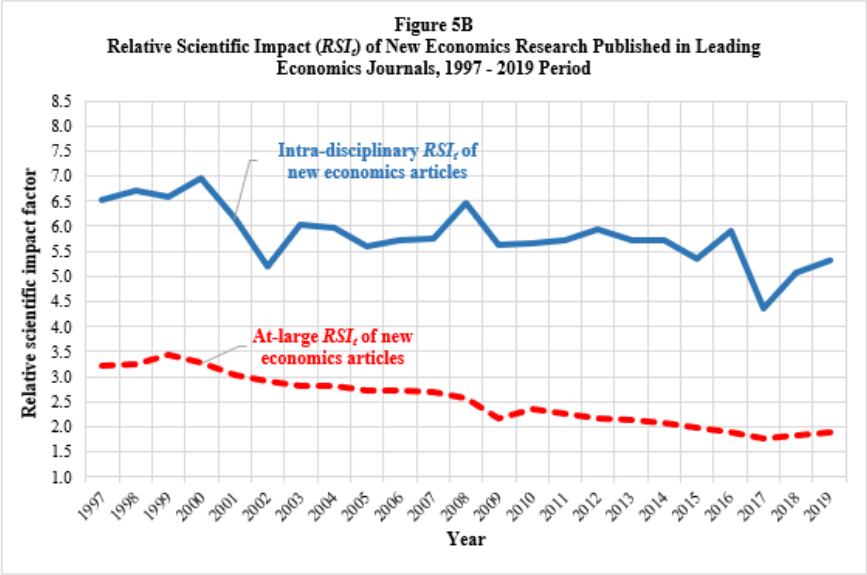


Figure 4B
Relative Scientific Impact (RSI_p) of New Finance Research Published in Leading Finance Journals, 1997 - 2019 Period



Description : This figure is a graphical illustration of the data shown in Columns 4 and 5 of Table 6.
Interpretation Fig 4A: We observe that while the stock of old articles as a percent of the total stock of old and new papers has oscillated in a narrow range, the at-large and the intra-disciplinary citations have been increasingly made to old finance articles.
Interpretation Fig 4B : This figure reveals steady decay in the relative scientific impact of new research in finance, most sharply in the 2002-2019 period.



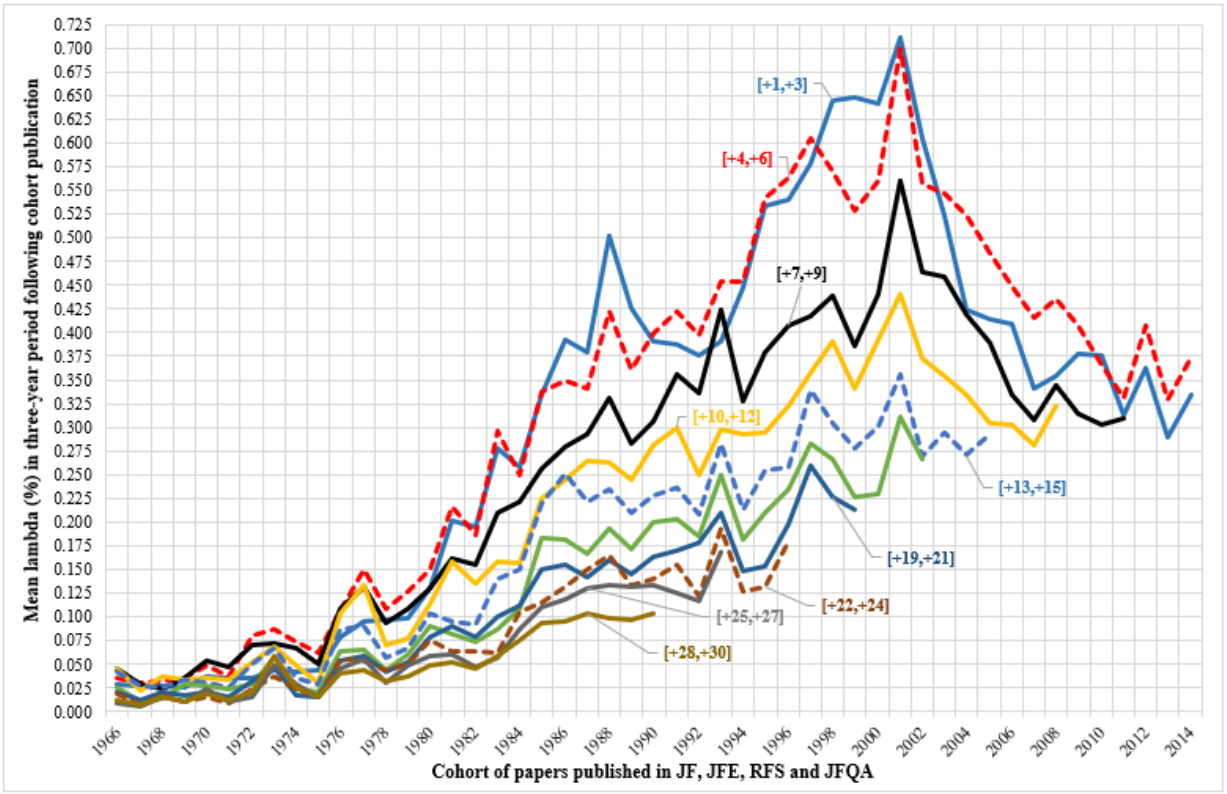


Description : This figure is a graphical illustration of the data shown in Columns 1, 2 and 3 of Table 7.

Interpretation Fig 5A: The percent of old articles of the total cumulative number of articles of leading economics journals has risen in the period 1997-2004, but then has remained essentially stable during the remainder of the study period. In contrast, the percent old of all articles of leading economics journals cited by all journals has risen rather steadily. The percent old of all articles of leading economics journals cited by same journals has increased over the study period, but it was about level during the period 2002- 2016. The implications of these findings relating to the relative scientific impact of new economics research are shown in Figure 5B.

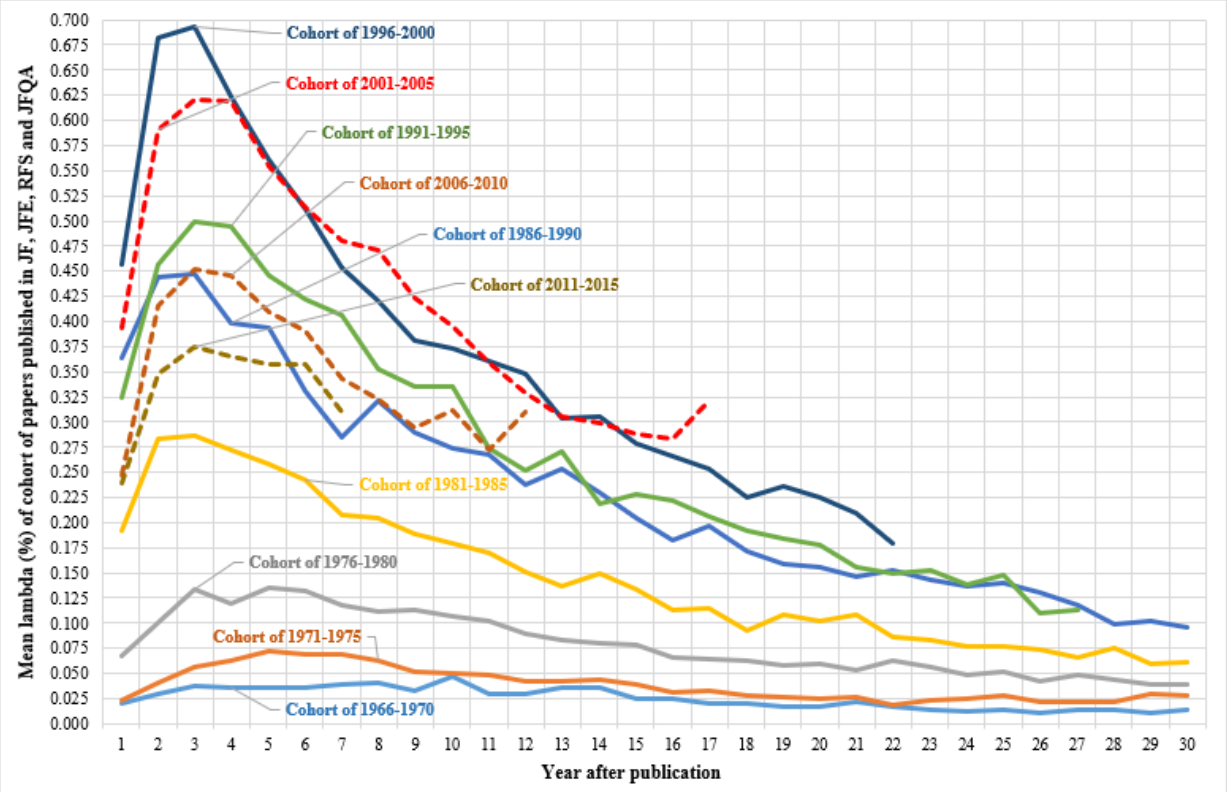
Interpretation Fig 5B : In economics and finance, alike, the reliance on older papers for citation in newly published articles has increased over the period 1997-2019. However, new economics research has experienced a much smaller decline in its RSI_t. Notably, the decline in the intra-disciplinary RSI_t of new leading financial research is more than five times that of new leading economics research.

Figure 6
Scientific Impact of Cohorts of Papers Following their Publication in Four Leading Finance Journals, Three-Year Mean Lambdas (%)



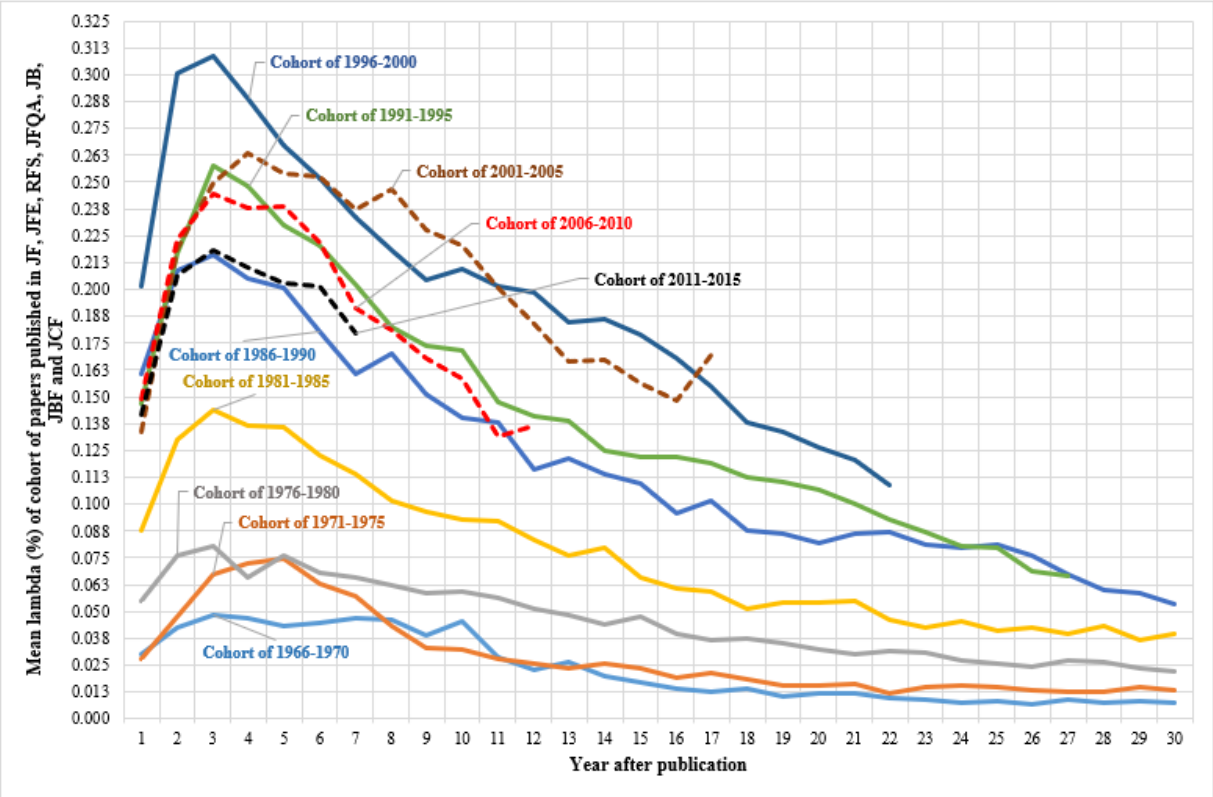
Description : This figure is a graphical illustration of the data shown in Table 8.
Interpretation : The mean lambdas exhibit an upward trend over all horizons during the pre-2001 time period, providing additional evidence that scientific impact was increasing up to 2001. Finance research has entered recently a stage where impact is declining, impact is low, and impact dissipates quickly. These results support our previous findings of a diminishing scientific impact of new finance research in the past two decades.

Figure 7
Duration of Scientific Impact of Cohorts of Papers Following their Publication in Four Leading Finance Journals, Five-Year Cohorts Starting in 1966



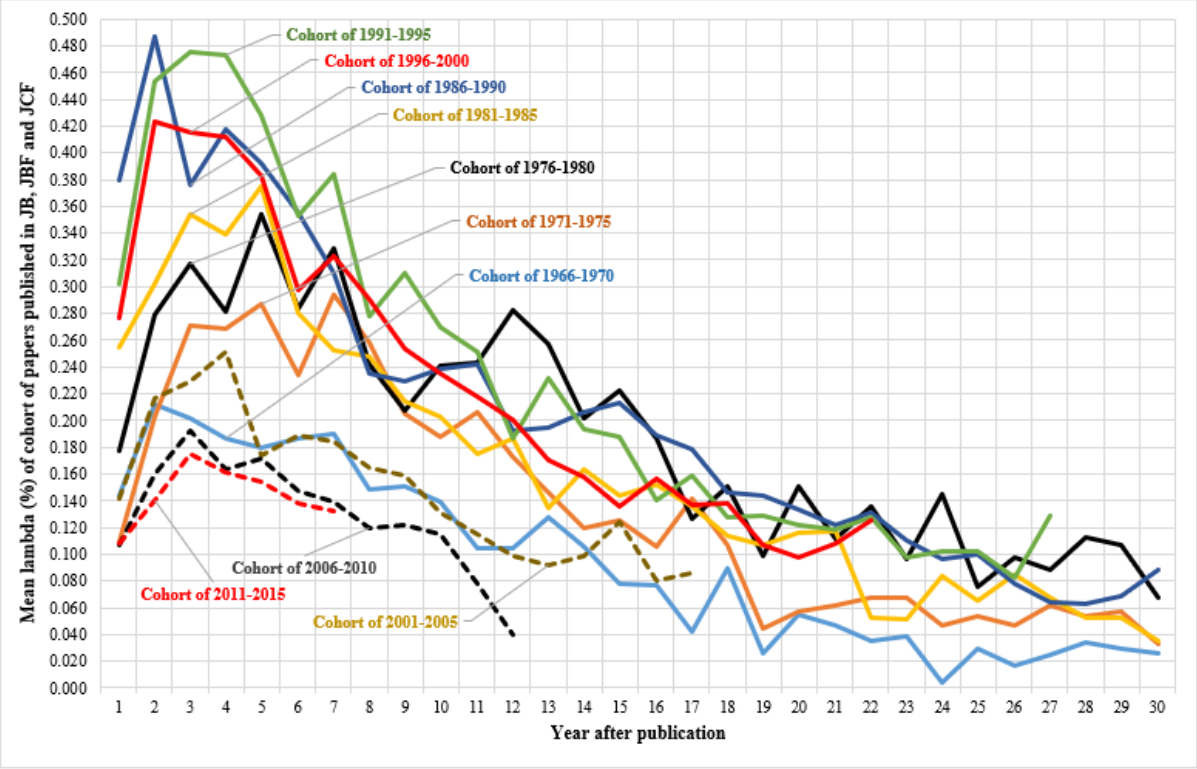
Description : This figure is a graphical illustration of the data shown in Table 9.
Interpretation : During the pre-2001 period, the scientific impact of each new cohort was surpassing the one of its precedent. During the post-2000 period, the scientific impact of each new cohort has been lower than its precedent. Much of the research in the post-2000 period is evidently characterized by a much lower RSIt and stagnating knowledge progression. Regrettably, the period of decline in knowledge progression in finance coincided with a period over which research activity and international collaborations in finance intensified greatly.

Figure 8
Duration of Scientific Impact of Cohorts of Papers Following their Publication in Expanded Sample of Seven Significant Finance Journals



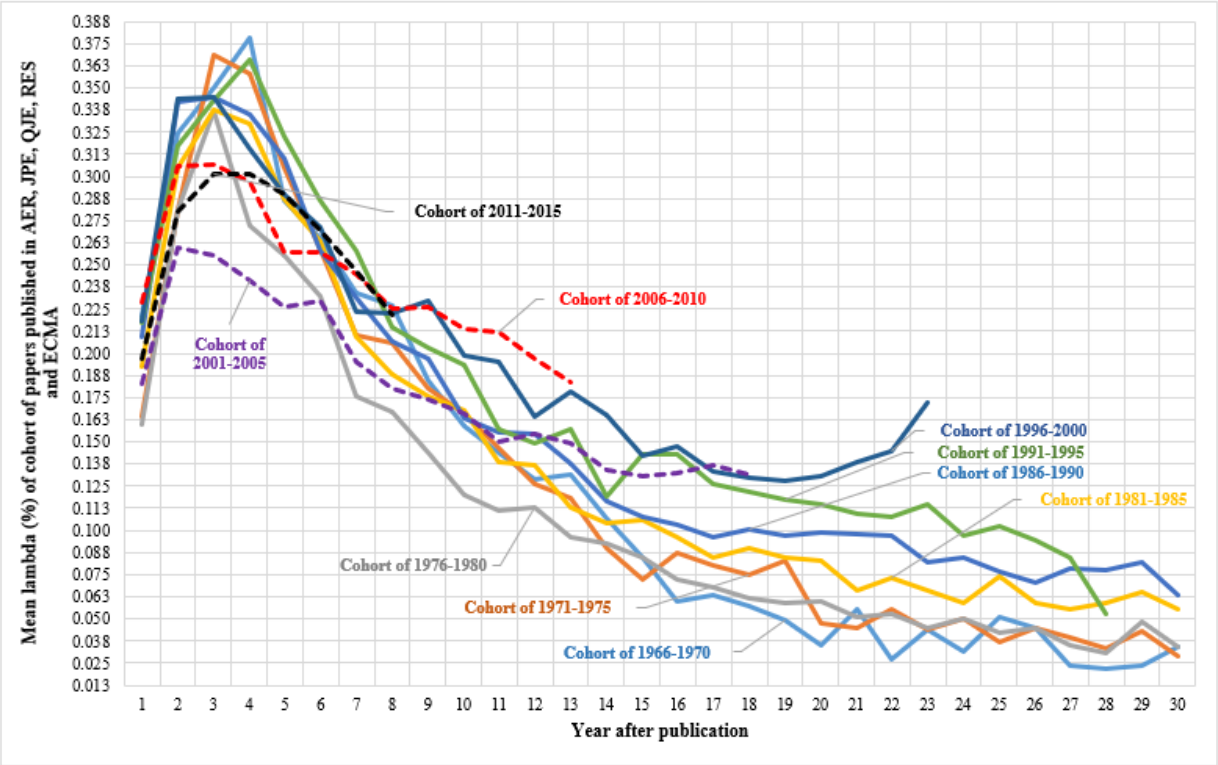
Description : This figure is a graphical illustration of the results presented in Table 10.
Interpretation : Even upon expanding the sample of finance journals, the results are the same. For papers published in more recent cohort groups (post 2000 cohorts), the decline in scientific impact still occurs in the expanded sample, and the decline in lambda is steeper in later cohorts than in earlier cohorts.

Figure 9
Duration of Scientific Impact of Cohorts of Papers Following their Publication in JB, JBF and JCF, Five-Year Cohorts Starting in 1966



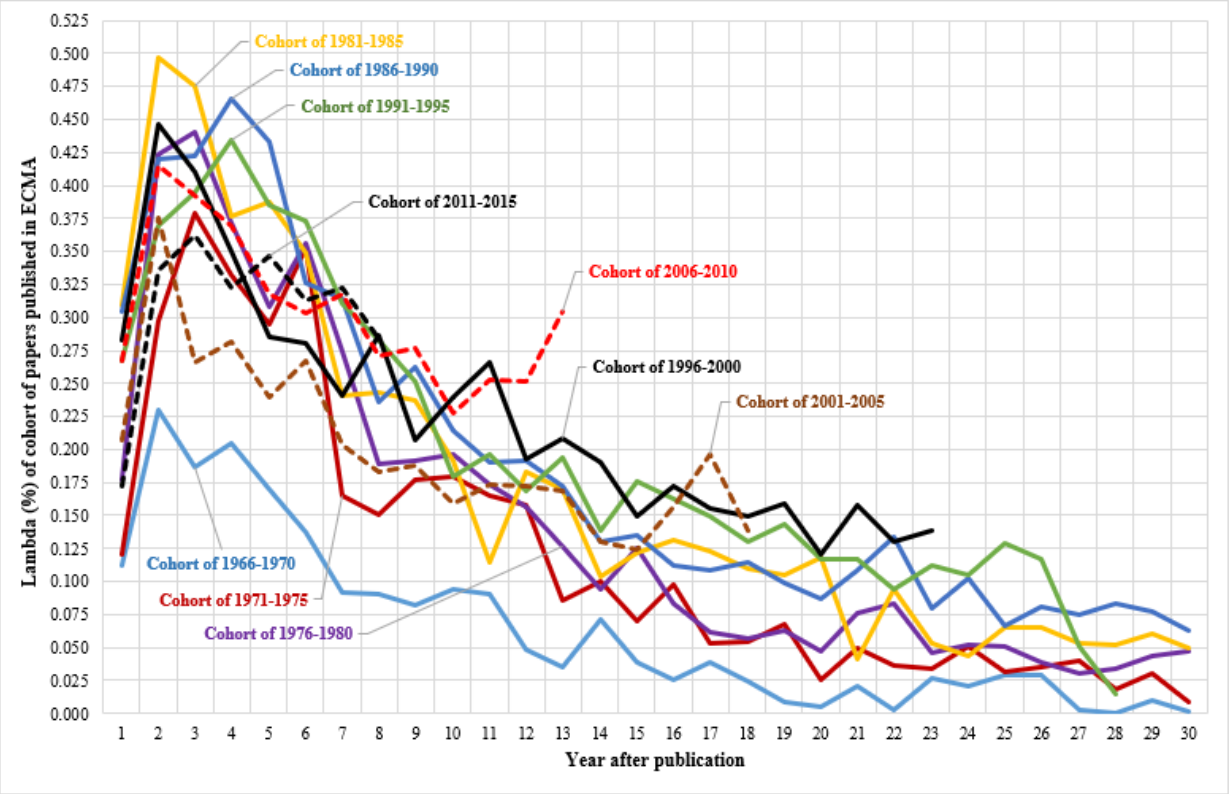
Description : This figure is a graphical illustration of the results presented in Table 11.
Interpretation : We observe in this figure a collapse in scientific impact for non-leading journals' post 2000 cohorts, with all pre-2000 cohorts exhibiting greater relative scientific impact than the post-2000 cohorts. The impact of the 2011-2015 cohort seven years post-publication is lower than any cohort through seven years, including the 2006-2010 cohort. Additional grim discoveries, the mean lambda for the 2006-2010 cohort twelve years after publication has the equivalent impact as the average paper published in the 1981-1985 and 1991-1995 issues of JB, JBF, and JCF thirty years after publication. This is an unsettling display of declining scientific impact at reputable journals outside the top four journals.

Figure 10
Duration of Scientific Impact of Cohorts of Papers Following their Publication in Five Leading Economics Journals, Five-Year Cohorts Starting in 1966



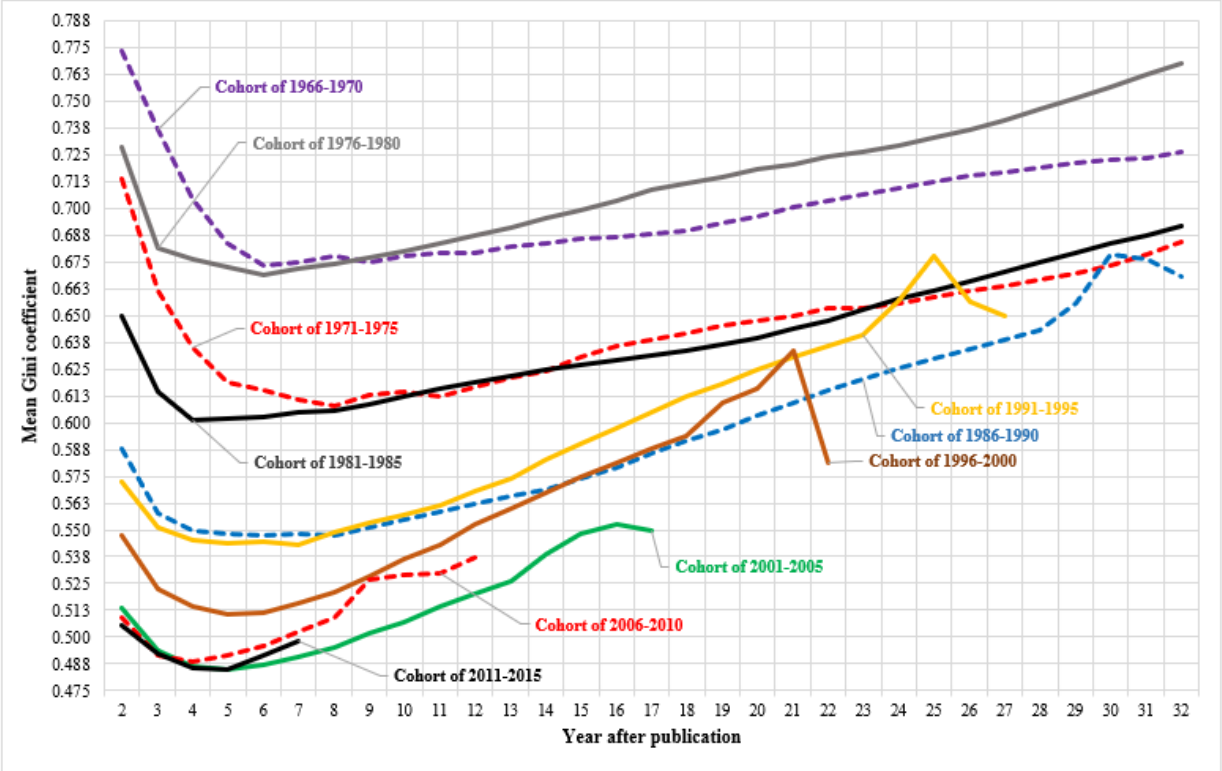
Description : This figure is a graphical illustration of the results presented in Table 12. It provide an analysis of the scientific impact of papers published in the five leading economics journals and its duration.
Interpretation : We observe that all cohorts have a similar pattern of lambdas over time (i.e., all of the lines corresponding to five year cohorts are bunched together, indicating that the cohort lambdas for recent cohorts are not substantially different than they are for older cohorts). Mean lambdas have not declined; cohorts in 2006-2010 and 2011-2015 exhibit less difference in decay than in prior periods. The incidence of citing new economics research in the leading journals does not decline moving forward in time for newer cohorts. This suggests that any recent declining relative scientific impact is not as severe in economics as it is in finance.

Figure 11
Duration of Scientific Impact of Cohorts of Papers Following their Publication in *Econometrica* (ECMA), Five-Year Cohorts Starting in 1966



Description : This figure is a graphical illustration of the results presented in Table 13. It provide an analysis of the scientific impact of papers published in Econometrica and its duration.
Interpretation : There is robust innovation in methodology development published in ECMA; relatively new cohorts appear to continue to have an impact in terms of citations by journals in the top 4 economics journals, and for some recent cohorts, there is even a resurgence of citations in the years following publication. Thus, it is not likely that the old papers being cited are the established methods papers.

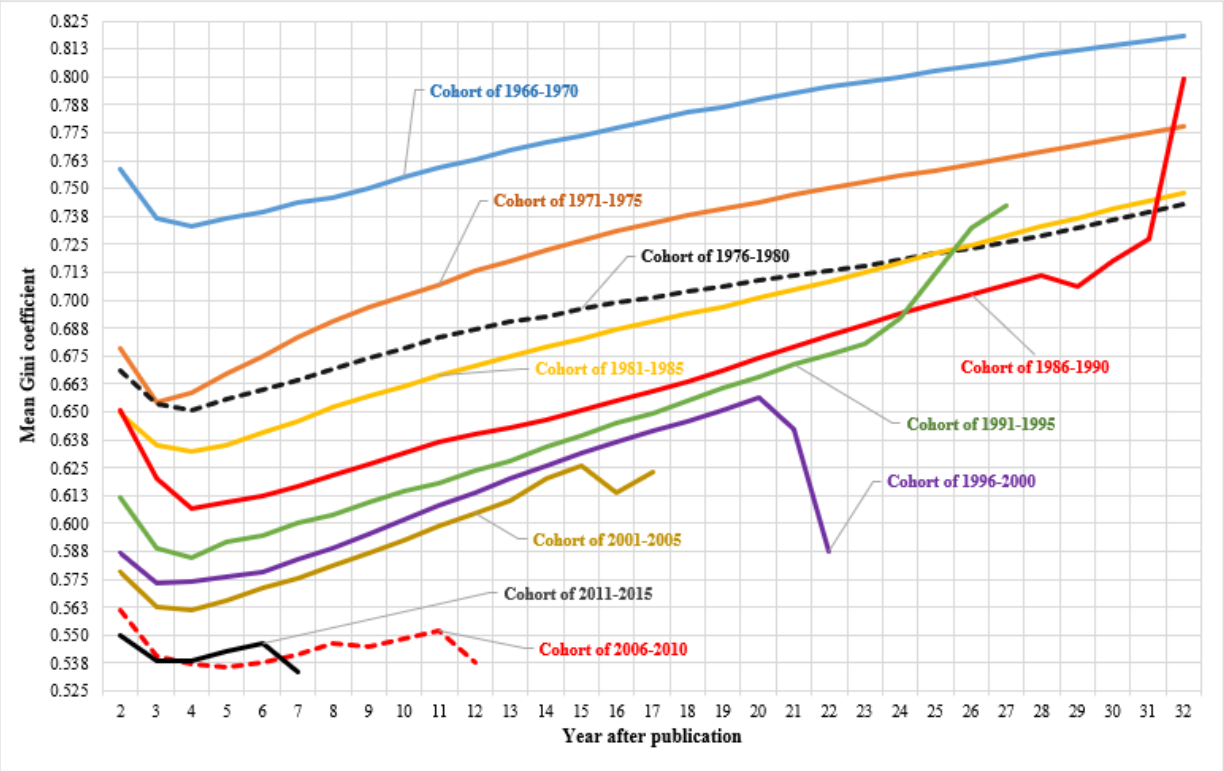
Figure 12
Mean Gini Coefficient of Citations to Five-Year Cohorts of Papers Published in Four Leading Finance Journals, by Age of Papers



Description : This figure is a graphical illustration of the results presented in Table 14. It presents the Gini coefficients of the citations to the leading finance research papers.

Interpretation : The mean Gini coefficients of citations for the recent five-year cohorts start at lower values. Evidently, there are fewer papers in recent years that every paper feels they should cite. We also observe the persistently lower level of the Gini coefficients of newer cohorts even years after publication. These additional results complement the earlier findings to reveal a comprehensive and robust empirical evidence on innovation and knowledge progression in the academic field of finance. Regrettably, during the past two decades, finance knowledge progression has declined sharply, and we find lack of highly innovative papers despite the concurrent increase in research activity and international collaborations.

Figure 13
Mean Gini Coefficient of Citations to Five-Year Cohorts of Papers Published in Five Leading Economics Journals, by Age of Papers



Description : This figure is a graphical illustration of the results presented in Table 15. It shows the Gini coefficients of the citations to the leading economics research papers.

Interpretation : The mean Gini coefficients of citations for the recent five-year cohorts start at lower values. Evidently, there are fewer papers in recent years that every paper feels they should cite. We also observe the persistently lower level of the Gini coefficients of newer cohorts even years after publication. However, despite showing no "home-run" papers in recent years, the economics field while being much older than the finance field continues to progress at about the same rate as in recent decades (or just a little slower) due to the collective contributions of its new research as we find earlier.

Figure 14: **Relative Scientific Impact of New Articles Published in Thirty-Six Business and Non-Business Research Categories (2003-2019)**

Description : The figures above present the at-large relative scientific impact (RSI_t) of new research published during the period 2003-2019 in thirty-six different research categories as defined by InCites Journal Citation Reports, Clarivate Analytics (https://jcr.clarivate.com). The description of these categories is provided in the Appendix. The thirty-six research categories include: All six categories in business found in the database, ten categories from the social sciences, ten categories from the natural / life sciences, and ten categories from engineering. These research categories include many of the traditional academic disciplines that exist at universities. They also include or match to the extent possible the categories listed in the study of Fanelli (2010). For example, the study of Fanelli (2010) combines the research categories "Plant and Animal Sciences" into one. It also includes "Space Science" and "Clinical Medicine" for which we find no similar categories in InCites Journal Citation Reports. Since there are no data available pertaining to the cumulative stock of articles published in each category, we estimate the RSI_t of new articles by considering different scenarios for the ratio of stock of articles published ten years ago or longer to current cumulative total stock for the research category. The ratio of stock of articles published ten years ago or longer (X_{t-10}) to current cumulative total stock of articles (X_t) of a research category in a particular year t is equal to (1 + g)-10 where g = the annual compounded growth rate of the number of articles over the ten year period. Assuming g constant is a reasonable estimation since it is the geometric mean for the annual growth rates for a ten-year period. For illustration, the graphs below are based on a ratio of stock of old articles to current cumulative total stock of 80%. Using a different ratio changes the scale of the vertical axis but neither the shape of the curves nor the percent change in the at-large RSI_t of new research over the period 2003 – 2019. The range of the vertical axes below is always 10.0 for ease of comparison (not necessarily starting at zero).

Interpretation : The results indicate that the steadily and sharply declining RSI_t of new research in finance is not a systematic phenomenon across other business or non-business research categories during the period 2003-2019. In fact, there were seven patterns in the non-business categories we examined, with various frequency of occurrence, and the categories of Operations Research Management Science and Computer Science, Information Systems exhibited two additional patterns. These results indicate that it does not have to be this way in finance. Also, many disciplines that experienced declining RSI_t of new research had a reversal.

Figure 14 continued
Relative Scientific Impact of New Articles Published in Thirty-Six Business and Non-Business Research Categories

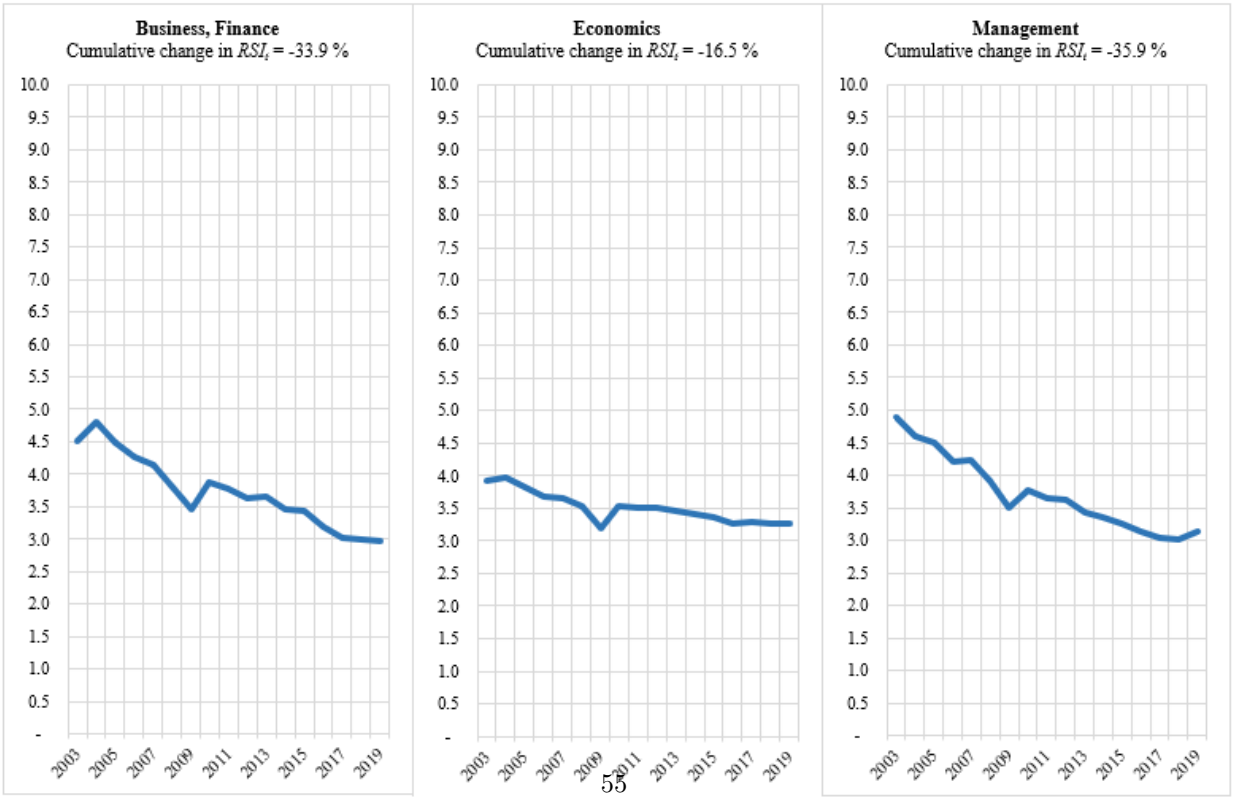


Figure 14 continued
Relative Scientific Impact of New Articles Published in Thirty-Six Business and Non-Business Research Categories

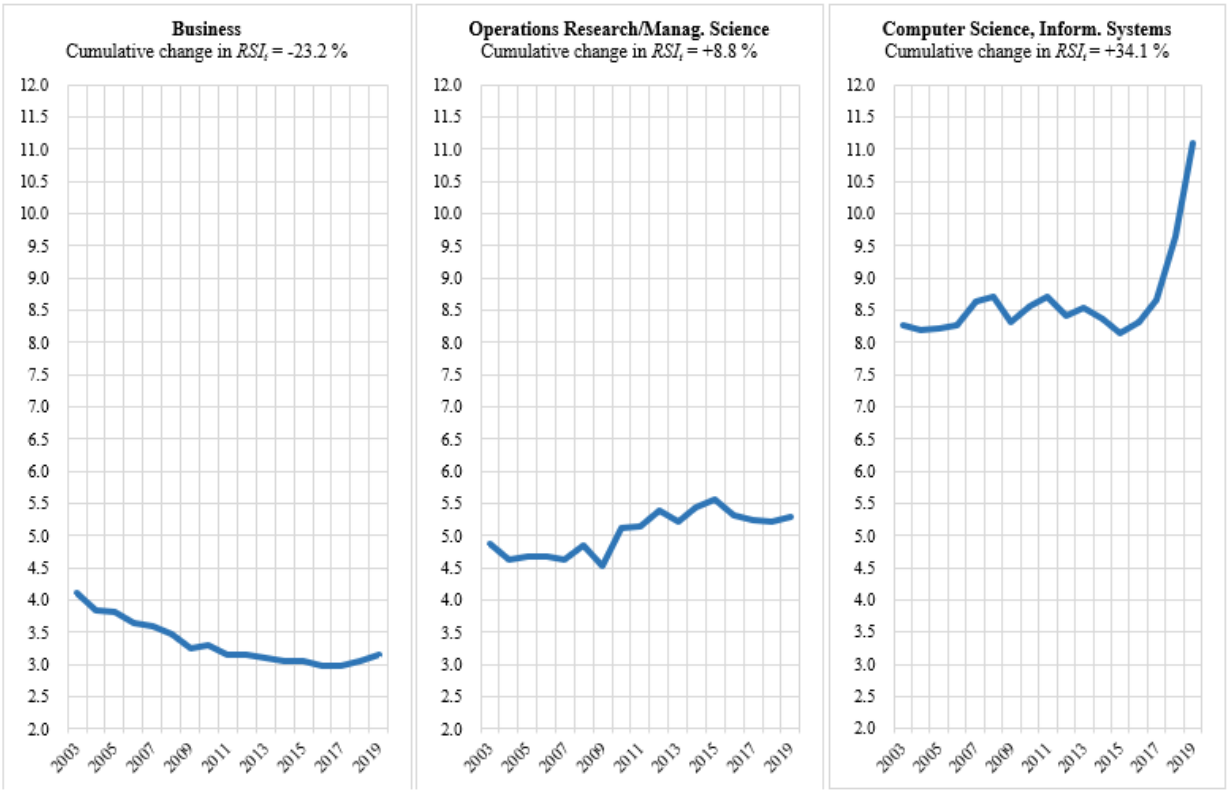
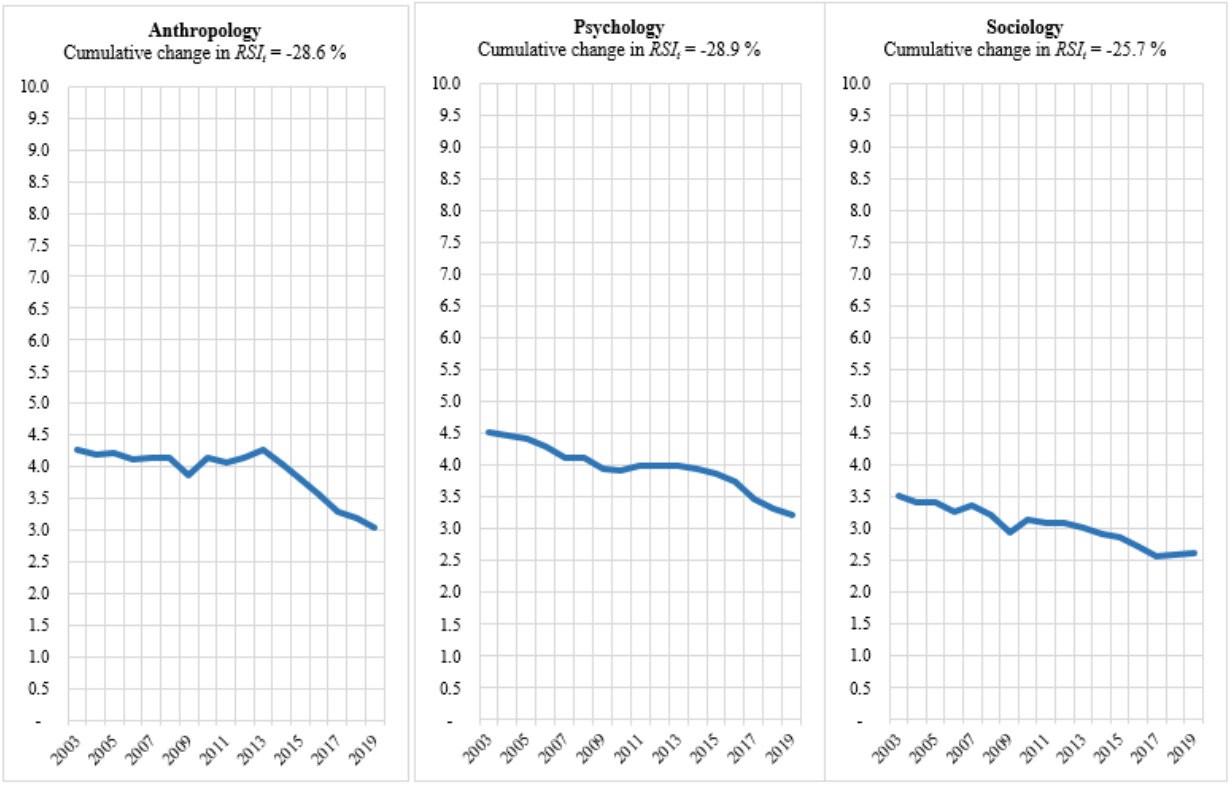


Figure 14 continued
Relative Scientific Impact of New Articles Published in Thirty-Six Business and Non-Business Research Categories



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Relative Scientific Impact of New Articles Published in Thirty-Six Business and Non-Business Research Categories

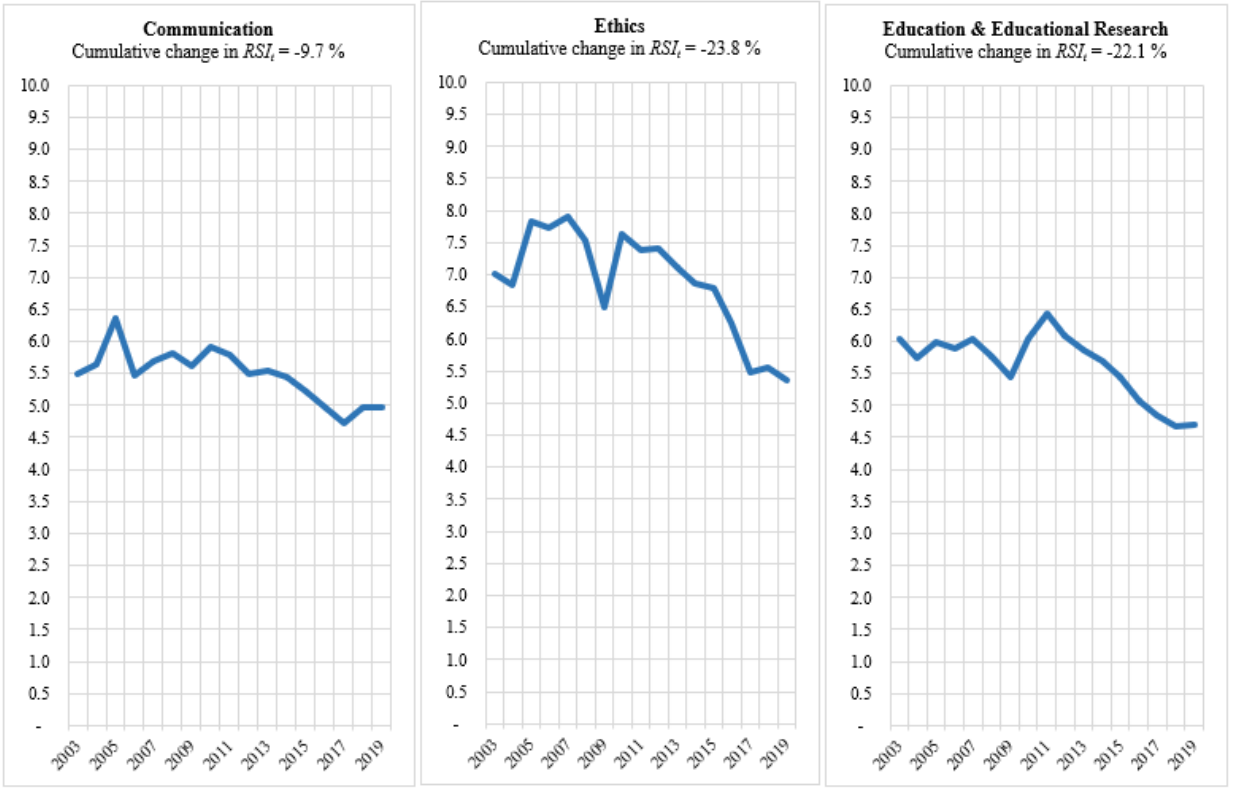

Figure 14 continued
Relative Scientific Impact of New Articles Published in Thirty-Six Business and Non-Business Research Categories

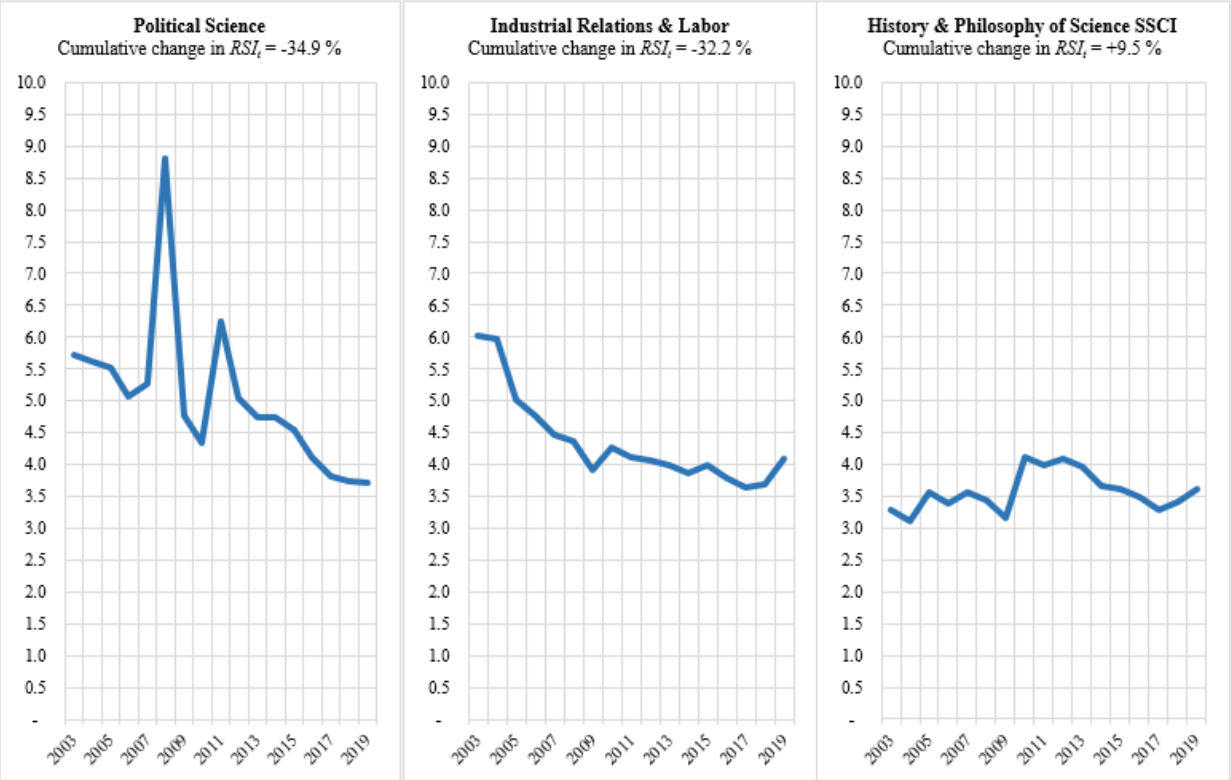

Figure 14 continued
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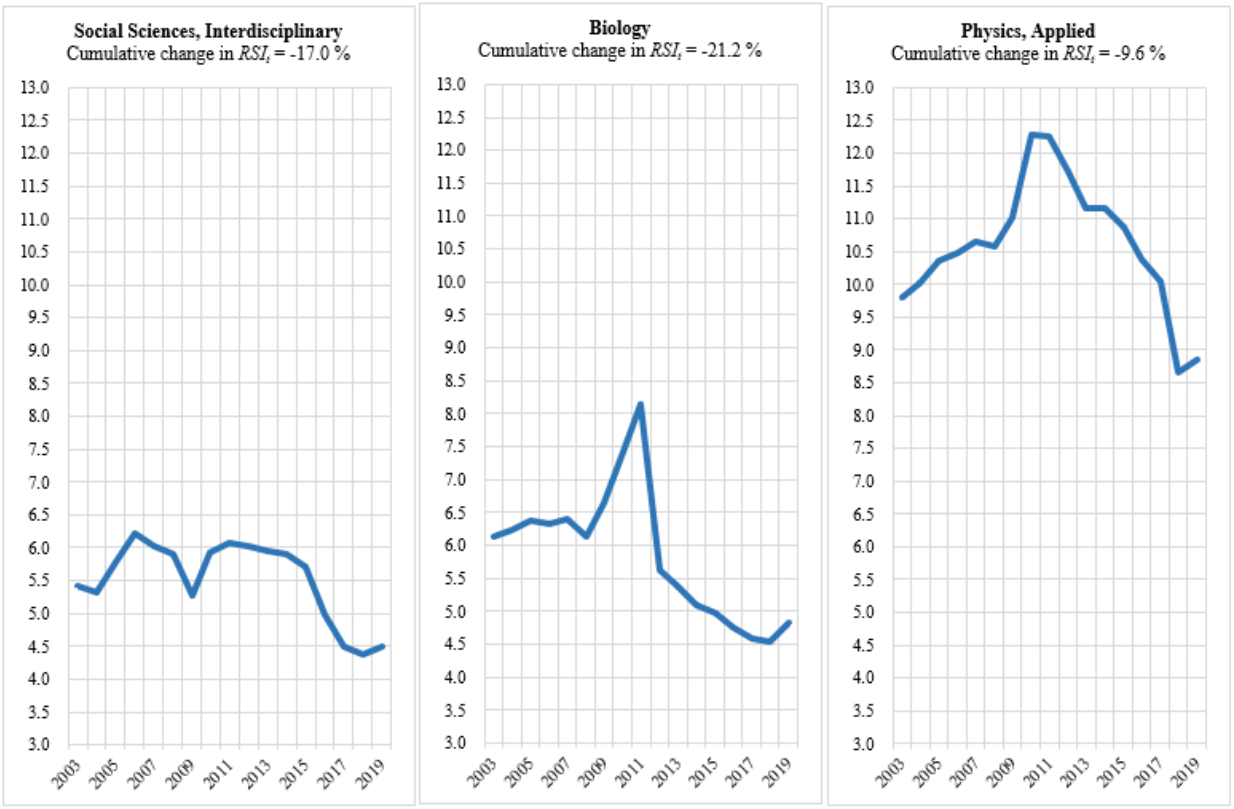

Figure 14 continued
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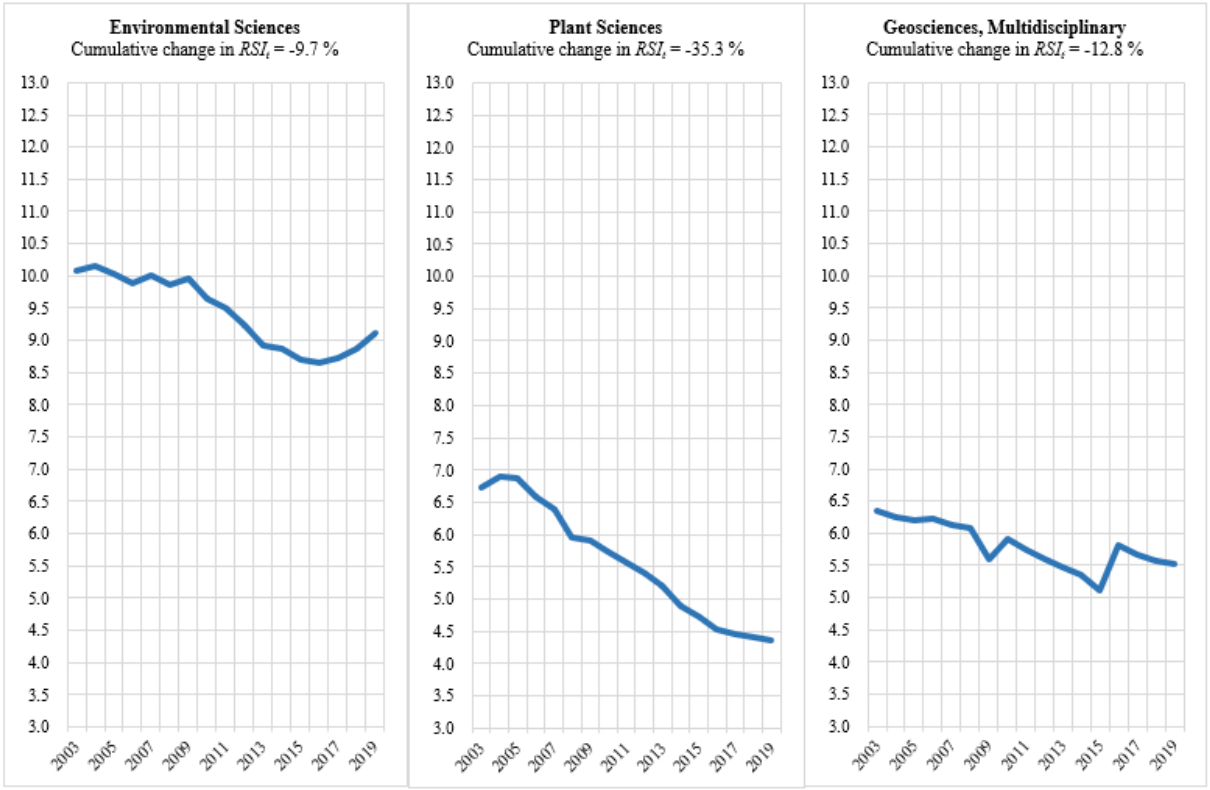

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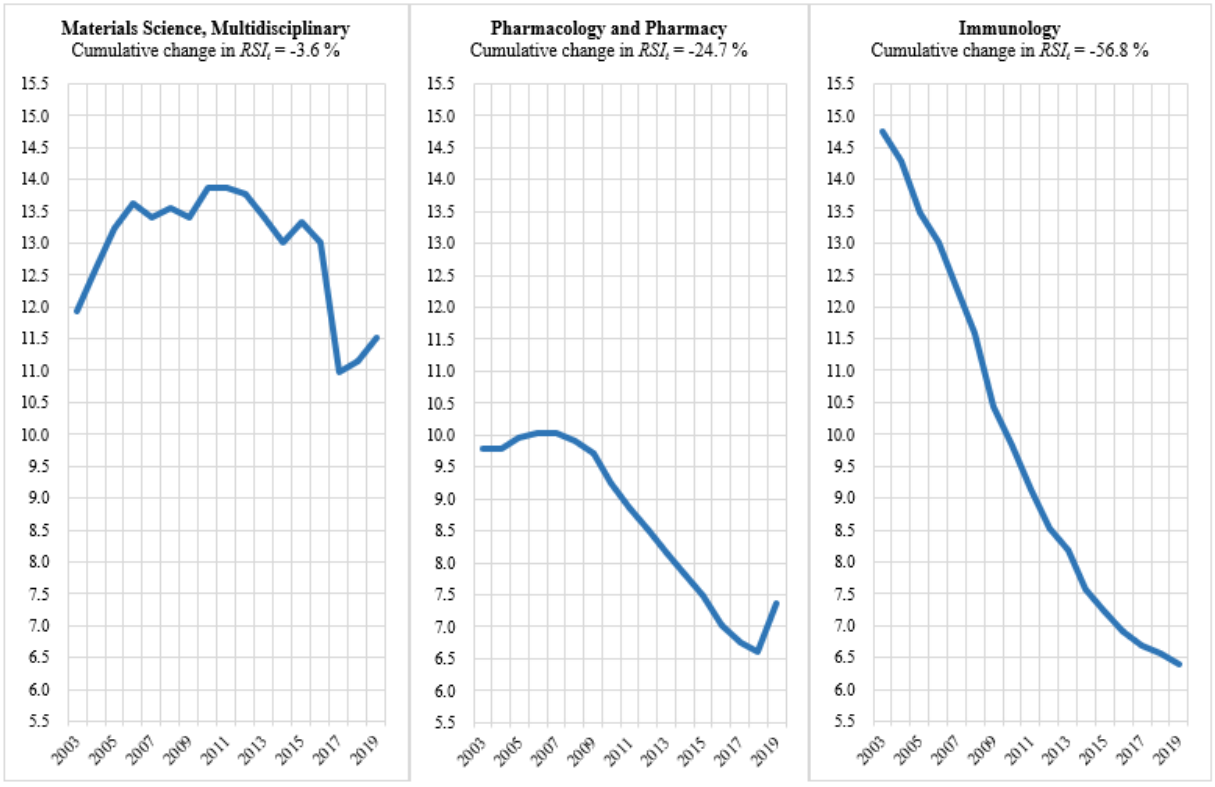

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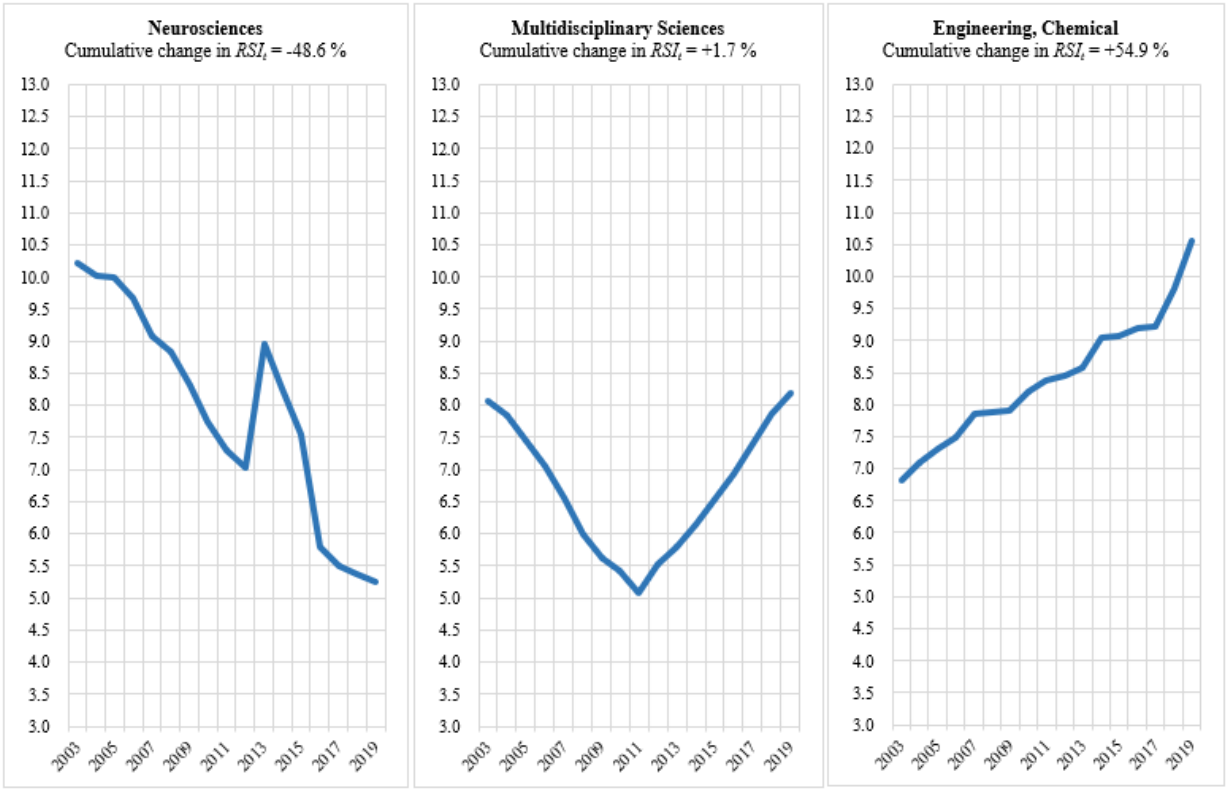

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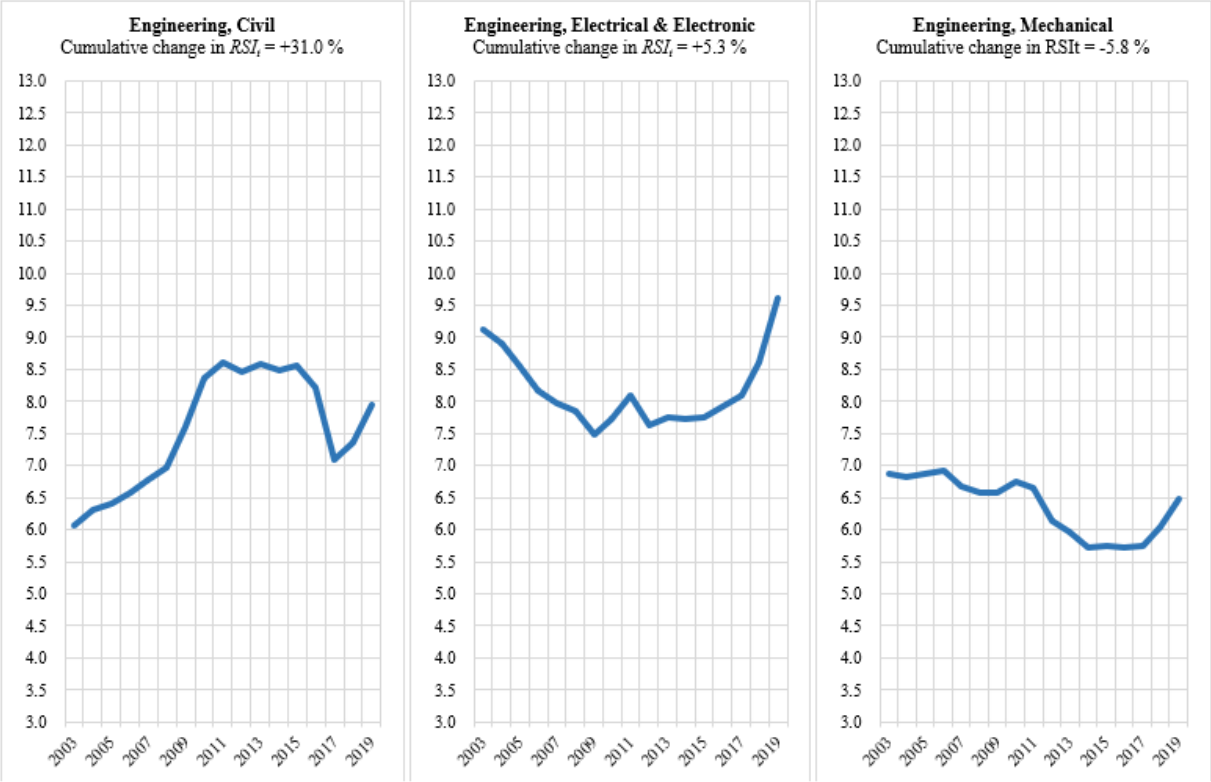

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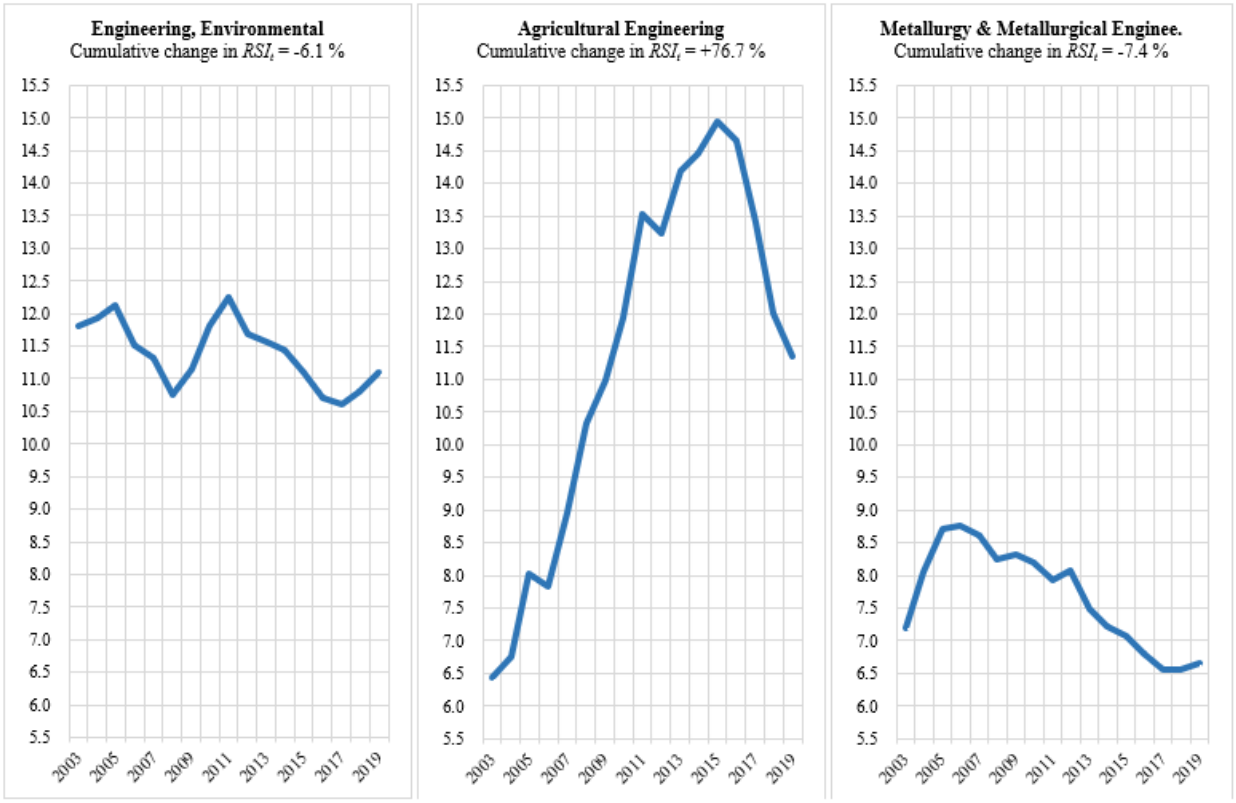

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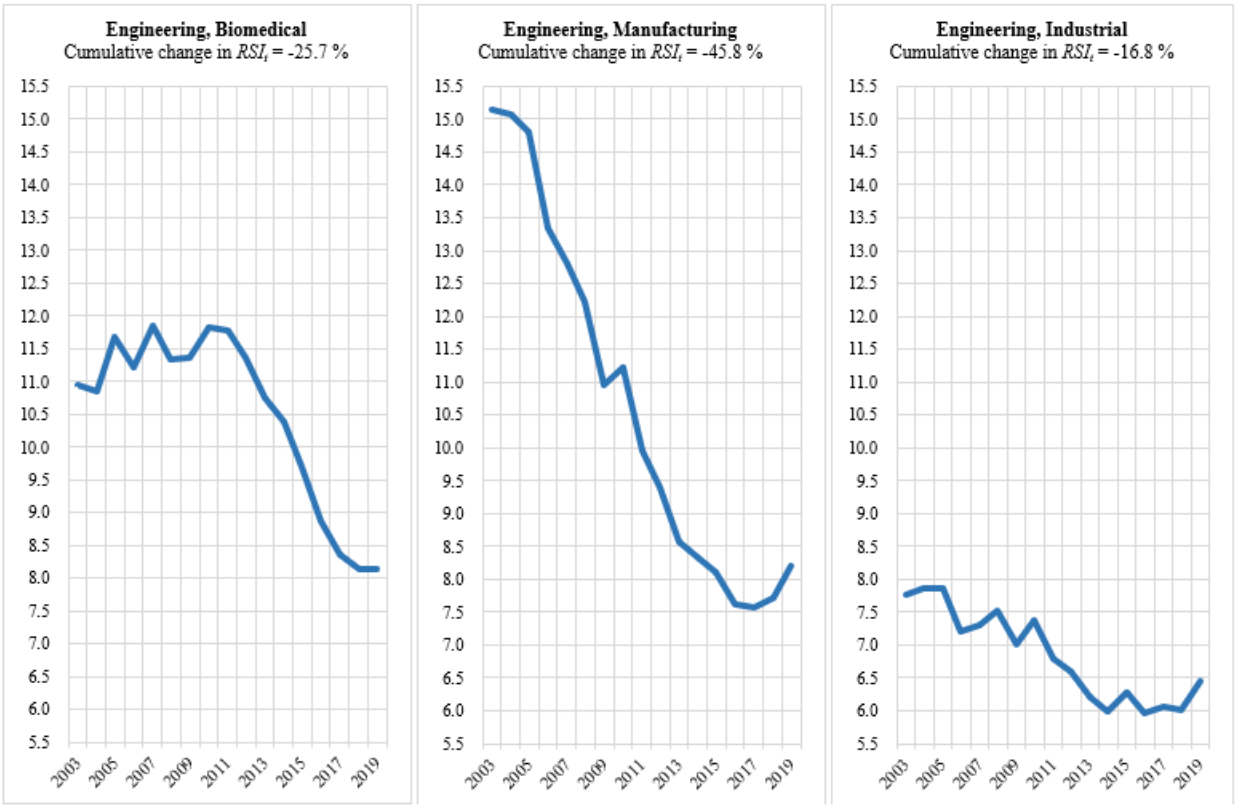

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12 Appendix : Profile of Research Categories

The profile of the following categories are downloaded from InCites Journal Citation Reports, Clarivate Analytics (https://jcr.clarivate.com) on June 28th, 2019, May 27th, 2020, and February 16th, 2021 (as we added more categories in our analysis). The notes on the categories "Business, Finance", "Economics", and "Business" are added by the authors for clarification. A journal may appear under more than one category as shown below in the notes. The categories shown below include all the business research categories in the database, ten categories in the social sciences, ten categories in the natural / life sciences, and ten categories in engineering. These categories include / match to the extent possible the categories listed in the study of Fanelli (2010). For example, the study of Fanelli (2010) combines the research categories "Plant and Animal Sciences" into one. It also includes "Space Science" for which we find no similar category in InCites Journal Citation Reports.

Business Management and Economics Research Categories

- **Business, Finance :** covers resources primarily concerned with financial and economic correlations, accounting, financial management, investment strategies, the international monetary system, insurance, taxation, and banking. Note: In addition to Journal of Finance, Journal of Financial Economics, Review of Financial Studies, and Journal of Financial and Quantitative Analysis, this category includes Journal of Accounting Research, Accounting Review, and Journal of Accounting Economics. It does not include American Economic Review, Quarterly Journal of Economics, Journal of Political Economy, or Review of Economic Studies.

- **Economics :** covers resources on all aspects, both theoretical and applied, of the production, distribution, and consumption of goods and services. These include generalist as well as specialist resources, such as political economy, agricultural economics, macroeconomics, microeconomics, econometrics, trade, and planning. Note: In addition to American Economic Review, Quarterly Journal of Economics, Journal of Political Economy, and Review of Economic Studies, this category includes Journal of Accounting Economics, Journal of Finance, Journal of Financial Economics, Review of Financial Studies, and Journal of Financial and Quantitative Analysis. It does not include Journal of Accounting Research or Accounting Review.

- **Management :**covers resources on management science, organization studies, strategic planning and decision-making methods, leadership studies, and total quality management.

- **Business :**This category covers resources concerned with all aspects of business and the business world. These may include marketing and advertising, forecasting, planning, administration, organizational studies, compensation, strategy, retailing, consumer research, and management. Also covered are resources relating to business history and business ethics.Note: The category "Business" in the database includes the leading "Management" category journals, the leading journals in the marketing discipline, and many other fields, including interdisciplinary (e.g., Journal of International Business Studies) and practitioners' journals (e.g., Harvard Business Review). It does not include the journals in the disciplines of economics, finance, or accounting. It does not proxy for a particular discipline. There is no separate category for the marketing discipline in the database.

- **Operations Research Management Science :**includes resources on the definition, analysis, and solution of complex problems. Relevant topics in this category include mathematical modeling, stochastic modeling, decision theory and systems, optimization theory, logistics, and control theory.

- **Computer Science, Information Systems :**covers resources that focus on the acquisition, processing, storage, management, and dissemination of electronic information that can be read by humans, machines, or both. This category also includes resources for telecommunications systems and discipline-specific subjects such as medical informatics, chemical information processing systems, geographical information systems, and some library science.

Social Sciences Research Categories

- **Psychology :**is concerned with resources on the study of human behavior and mental processes. This category covers the biological and neurological underpinnings of perception, thought, and behavior; psychological development and change over the life span; in addition to emotional and mental disturbances and diseases and their treatment. Resources that report on animal behavior to illuminate human behavior and mental processes are also covered.

- **Sociology :**covers resources that focus on the study of human society, social structures, and social change as well as human behavior as it is shaped by social forces. Areas covered in this category include community studies, socio-ethnic problems, rural sociology, sociobiology, social deviance, gender studies, the sociology of law, the sociology of religion, and comparative sociology.

- **Communication :**covers resources on the study of the verbal and non-verbal exchange of ideas and information. Included here are communication theory, practice and policy, media studies (journalism,

broadcasting, advertising, etc.), mass communication, public opinion, speech, business and technical writing as well as public relations.

- **Ethics :**covers resources on normative ethics, including all aspects of the evaluation of human conduct and social relations, such as business ethics, medical ethics, environmental ethics, etc.
- **Social Sciences, Interdisciplinary :**includes resources with an interdisciplinary approach to the field such as studies on social sciences and computers, time and society, evaluation practice, black studies, information science and society, homosexuality studies, childhood studies, and death studies.
- **Education Educational Research :**covers resources on the full spectrum of education, from theoretical to applied, from nursery school to Ph.D. Included in this category are resources on pedagogy and methodology as well as on the history of education, reading, curriculum studies, education policy, and the sociology and economics of education, as well as the use of computers in the classroom.
- **Political Science :**covers resources concerned with political studies, military studies, the electoral and legislative processes, political theory, history of political science, comparative studies of political systems, and the interaction of politics and other areas of science and social science.
- **Anthropology :**covers resources relating to the scientific study of human beings, especially their origin, distribution, behavior, as well as their physical, social and cultural characteristics and development. This category, by definition, borrows from related resources in history, archaeology, and several other social sciences.
- **Industrial Relations Labor :**covers resources on arbitration, business and labor law, human resources, labor history, labor relations, and the sociology of work relations.
- **History Philosophy of Science (SSCI) :**covers resources on the history of scientific disciplines including medicine and technology, as well as resources on the philosophical and social studies of science.

Natural / Life Sciences Research Categories

- **Biology :**category includes resources having a broad or interdisciplinary approach to biology. In addition, it includes materials that cover a specific area of biology not covered in other categories such as theoretical biology, mathematical biology, thermal biology, cryobiology, and biological rhythm research.

- **Physics, Applied :**covers those resources dealing with the applications of condensed matter, optics, vacuum science, lasers, electronics, cryogenics, magnets and magnetism, acoustical physics, and mechanics. This category also may include resources on physics applications to other sciences, engineering, and industry.

- **Geosciences, Multidisciplinary :**covers resources having a general or interdisciplinary approach to the study of the Earth and other planets. Relevant topics include geology, geochemistry/geophysics, hydrology, paleontology, oceanography, meteorology, mineralogy, geography, and energy and fuels. Resources having a primary focus on geology, or geochemistry geophysics are placed in their own categories.

- **Materials Science, Multidisciplinary :**covers resources having a general or multidisciplinary approach to the study of the nature, behavior, and use of materials. Relevant topics include ceramics, composites, alloys, metals and metallurgy, nanotechnology, nuclear materials, and adhesion and adhesives.

- **Multidisciplinary Sciences :**includes resources of a very broad or general character in the sciences. It covers the spectrum of major scientific disciplines such as Physics, Chemistry, Mathematics, Biology, etc. Nature and Science are the preeminent resources in this category and serve as typical examples. The Web site of the National Science Foundation is a good example of a web resource included in this category. Some specialized resources that have a wide range of applications in the sciences also may fall under this category. The journal Fractals—Complex Geometry Patterns and Scaling in Nature and Society would be an example of such a resource.

- **Pharmacology Pharmacy :**covers resources on the discovery and testing of bioactive substances, including animal research, clinical experience, delivery systems, and dispensing of drugs. This category also includes resources on the biochemistry, metabolism, and toxic or adverse effects of drugs.

- **Immunology :**covers resources dedicated to all aspects of immune response and regulation, at the cellular-molecular level as well as the clinical level. Other topics include studies of the interaction between pathogens and host immunity, as well as clinical immunology, emerging immunotherapies, and the immunologic contribution to disease course.

- **Neurosciences :**covers resources on all areas of basic research on the brain, neural physiology, and function in health and disease. The areas of focus include neurotransmitters, neuropeptides, neurochemistry, neural development, and neural behavior. Coverage also includes resources in neuro-

endocrine and neuro-immune systems, somatosensory system, motor system and sensory motor integration, autonomic system as well as diseases of the nervous system.

- **Environmental Sciences :**covers resources concerning many aspects of the study of the environment, among them environmental contamination and toxicology, environmental health, environmental monitoring, environmental geology, and environmental management. This category also includes soil science and conservation, water resources research and engineering and climate change.

- **Plant Sciences :**covers resources concerning many aspects of the study of plants including systematic, biochemical, agricultural, and pharmaceutical topics. This category includes materials on higher and lower plants, terrestrial and aquatic plants, plant cells, entire plants, and plant assemblages.

Engineering Research Categories

- **Engineering, Chemical :**covers resources that discuss the chemical conversion of raw materials into a variety of products. This category includes resources that deal with the design and operation of efficient and cost-effective plants and equipment for the production of the various end products.

- **Engineering, Civil :**includes resources on the planning, design, construction, and maintenance of fixed structures and ground facilities for industry, occupancy, transportation, use and control of water, and harbor facilities. Resources also may cover the sub-fields of structural engineering, geotechnics, earthquake engineering, ocean engineering, water resources and supply, marine engineering, transportation engineering, and municipal engineering.

- **Engineering, Electrical Electronic :**covers resources that deal with the applications of electricity, generally those involving current flows through conductors, as in motors and generators. This category also includes resources that cover the conduction of electricity through gases or a vacuum as well as through semiconducting and superconducting materials. Other relevant topics in this category include image and signal processing, electromagnetics, electronic components and materials, microwave technology, and microelectronics.

- **Engineering, Mechanical :**includes resources on the generation, transmission, and use of heat and mechanical power, as well as with the production and operation of tools, machinery, and their products. Topics in this category include heat transfer and thermodynamics, fatigue and fracture, wear, tribology, energy conversion, hydraulics, pneumatics, microelectronics, plasticity, strain analysis, and aerosol technology.

- **Engineering, Environmental :**includes resources that discuss the effects of human beings on the environment and the development of controls to minimize environmental degradation. Relevant topics in this category include water and air pollution control, hazardous waste management, land reclamation, pollution prevention, bioremediation, incineration, management of sludge problems, landfill and waste repository design and construction, facility decommissioning, and environmental policy and compliance.

- **Agricultural Engineering :**covers resources concerning many engineering applications in agriculture, including the design of machines, equipment, and buildings; soil and water engineering; irrigation and drainage engineering; crop harvesting, processing, and storage; animal production technology, housing, and equipment; precision agriculture; post-harvest processing and technology; rural development; agricultural mechanization; horticultural engineering; greenhouse structures and engineering, bioenergy and aquacultural engineering.

- **Metallurgy Metallurgical Engineering :**includes resources that cover the numerous chemical and physical processes used to isolate a metallic element from its naturally occurring state, refine it, and convert it into a useful alloy or product. Topics in this category include corrosion prevention and control, hydrometallurgy, pyrometallurgy, electrometallurgy, phase equilibria, iron-making, steel-making, oxidation, plating and finishing, powder metallurgy, and welding.

- **Engineering, Biomedical :**includes resources that cover the numerous chemical and physical processes used to isolate a metallic element from its naturally occurring state, refine it, and convert it into a useful alloy or product. Topics in this category include corrosion prevention and control, hydrometallurgy, pyrometallurgy, electrometallurgy, phase equilibria, iron-making, steel-making, oxidation, plating and finishing, powder metallurgy, and welding.

- **Engineering, Biomedical :**covers resources on the conversion of raw materials into end-use products or processed materials. Topics in this category include computer-integrated manufacturing (CIM), computer-aided design (CAD), and computer-aided manufacturing (CAM); design of products, tools, and machines; quality control; scheduling; production; and inventory control.

- **Engineering, Industrial :**includes resources that focus on engineering systems that integrate people, materials, capital, and equipment to provide products and services. Relevant topics covered in the category include operations research, process engineering, productivity engineering, manufacturing, computer-integrated manufacturing (CIM), industrial economics, and design engineering.