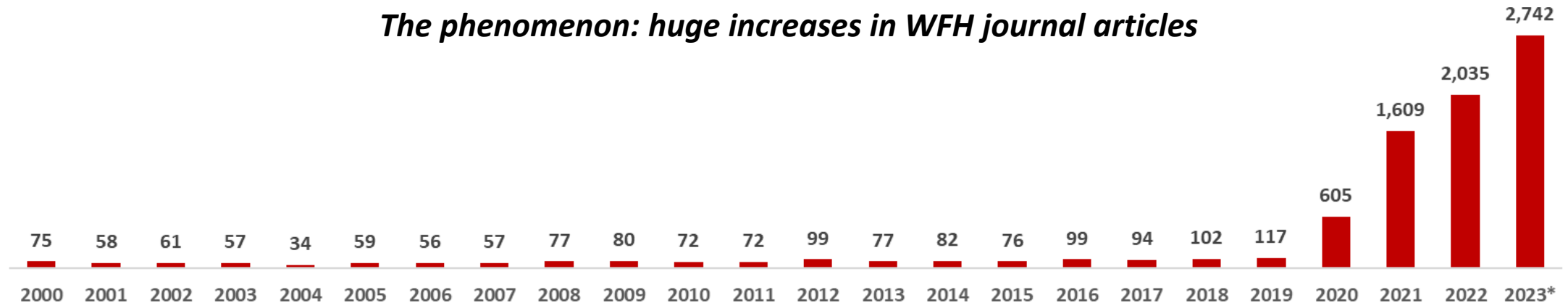


WFH Research Following the COVID-19 Pandemic: a Discontinuous Jump in Scientific Papers on Niche Topic

The phenomenon: huge increases in WFH journal articles

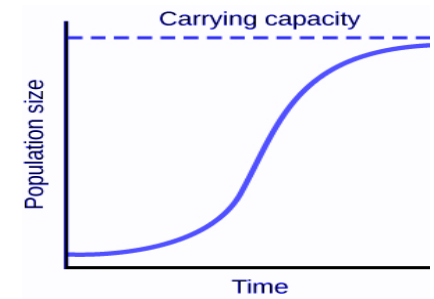


- I. The Increase in WFH Articles in the Context of Logistic Curve Jumps
- II. What Leads Researchers to Jump into “Hot Topic”
- III. Scopus Bibliometric Data on Journal Articles & Conference Papers and Stanford Remote Work Conference
- IV. Role of Conferences
- V. Conclusions and Next steps

*Qingnan Xie, Harvard Center for Labor and Economic Justice
NBER Work-from Home Conference Nov 3rd, 2023*



I. Growth Bursts in Scientific Publications



Exponential growth fits many socio-economic variables but in many others, growth begins modestly, accelerates and then declines to some peak/saturation point (after which it may decline). In science the number of papers on coronaviruses increased hugely after discovery of the COVID-19 virus, producing what Science called in May 2020 a GIANT FLOOD of papers “doubling every 20 days” since January 2020, but with the growth rate declining by 2022 through 2023.

The logistic curve is common way to model growth spurts of almost any population, with a S-shaped curve that can be written as the Population $P(t) = \frac{M}{1+e^{-k(t-t_0)}}$, where M is the maximum value of P , t is time, t_0 is the initial time, and k is the logistic growth parameter that determines its steepness: a big k gives the curve slow growth at the beginning, sharp growth in the middle, and slow growth at the end – mimicking a discontinuous jump. Equivalently, the curve can be represented as differential equation based on the basic demographic birth-death equation, in which $\frac{dP}{dt} = kP(1 - \frac{P}{M})$, which grows at k when P is small, barely changes when P is near M and has biggest growth when $P = 1/2 M$.

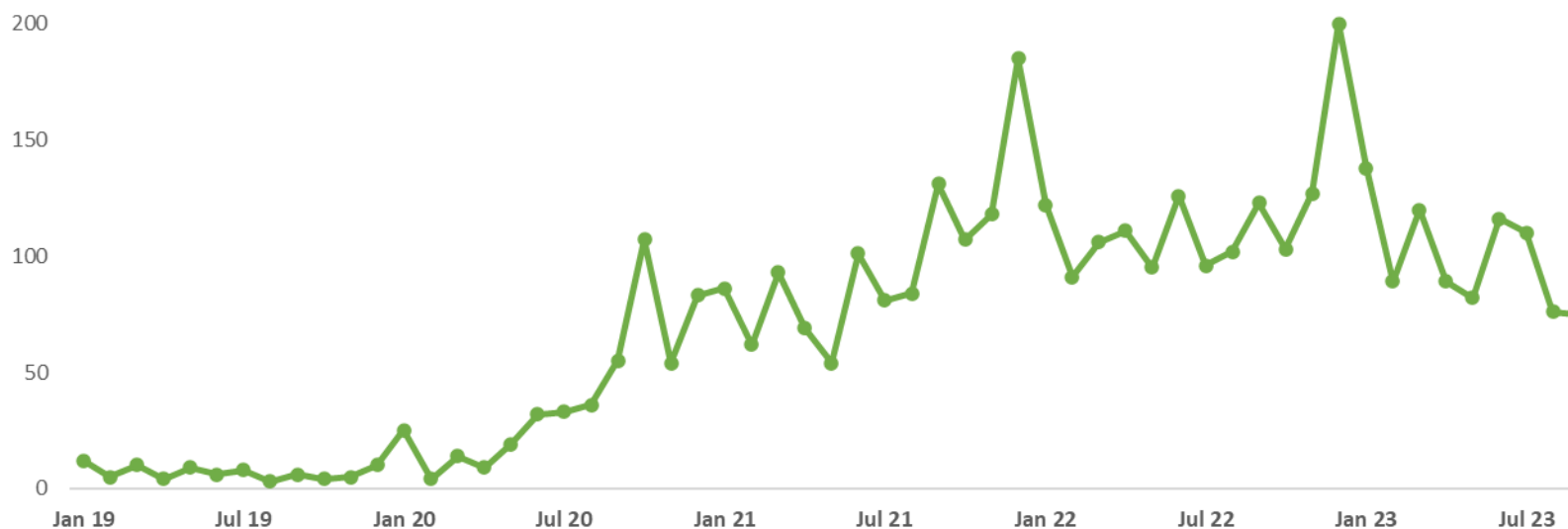
With papers on a scientific topic, it is natural to scale the number relative to all papers, turning $P(t)$ to shares with values between 0 and 1. As logistic growth fits a field/topic, which can expand even if the aggregate does not, the starting point of analysis of the growth of WFH papers is whether the number or share of papers fits the logistic.

The Increase of Numbers of WFH Articles post COVID-19 Pandemic

Prior to the 2020 COVID-19 pandemic, relatively few US workers worked from home (WFH) for pay, with 40%-50% of those reporting WFH being self-employed and thus with no other potential workplace (Census). As a modest labor market phenomenon for wage and salary employees, WFH attracted limited research.

Identifying the number of WFH journal articles in the Scopus data base as those that have at least one of the seven terms (*work* from home; telework*; remote work*; telecommut*; home-based work*; digital nomad; mobile work**) in either the title, abstract, or keywords, the March-April 2020 burst in WFH induced by the pandemic in the US (with similar timing in many other countries) produced a fivefold increase in the number of papers in 2020-23 compared to the number in the previous twenty years – a 23-fold increase in publications per year in slide 1, which raised the WFH share of all scientific papers from <0.01% to 0.06%.

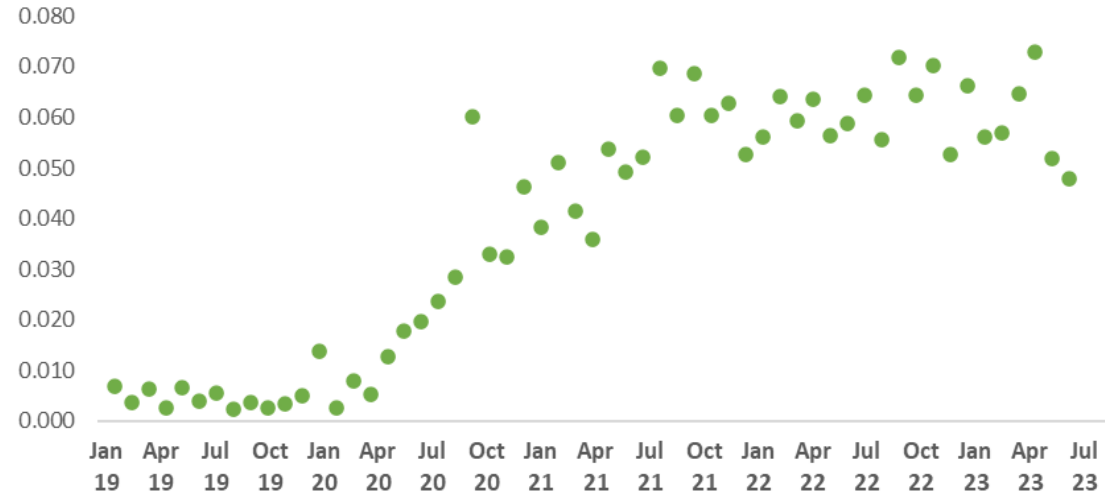
Monthly Numbers of WFH Journal Articles, 2019-23



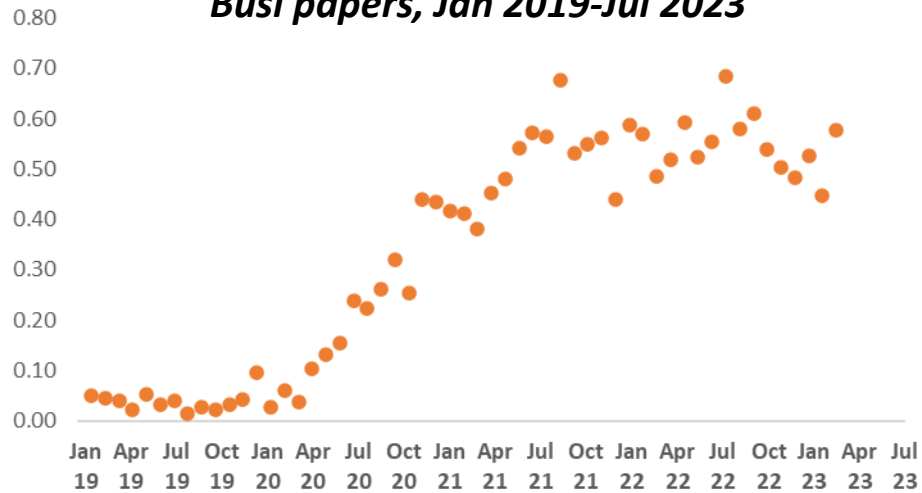
Note: Data are collected at July - October 2023

Finding 1: Logistic pattern in WFH shares of papers in all research fields and papers in specific fields defined by journals, with some potential for drop in Medicine papers.

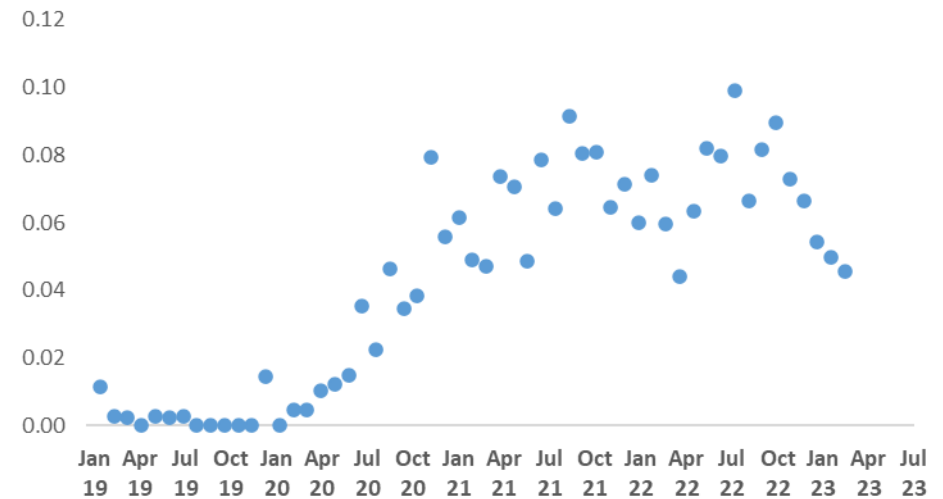
#All WFH papers/#all papers, Jan 2019-Jul 2023



#WFH Soci & Econ & Busi papers/#all Soci & Econ & Busi papers, Jan 2019-Jul 2023



#WFH Medi papers/#all Medi papers, Jan 2019-Jul 2023



II. Decisions that Underly Logistic-type Jump in Papers

The explosion of WFH papers required a flow of new researchers to the topics, a willingness of journal editors and conference organizers to shift their views toward WFH topic from niche to important – all underpinned by new funding sources and ultimately social interest as millions of wage and salary workers began working from home.

Researcher Decisions to work on “new” topic, such as WFH. Depend on opportunity to obtain new findings and publish results, with greater attention from research community (wider citations or higher impact factor of journals) than working on older topics.

1. Treating WFH as dependent variable: COVID-19 pandemic raised interest on WFH → more papers from existing specialists who have written on WFH and those in nearby fields; methodologists in surveys, experiments, econometrics, or big data shift to WFH as place to try out their approaches. Space for game theorists or bargaining to analyze conditions more or less favorable to workers and firm in moving to WFH.

2. Treating WFH as exogenous shock: Researchers in other areas who view WFH as exogenous shock impacting their topics: effect of WFH on pollution, delivery services; neck sprains due to shift in workplaces; ergonomic design of chairs in the home-based offices; specific topics say job postings or HR practices or union drives on what WFH does postings, practices or organizing drives.

3. WFH as policy issue for improved intervention: firm policy/public health issue for decision-making, so can study effects of decisions about closure of workplaces, public health rules, and possible ways to make better decisions.

Non-researcher decisions that influence researchers and role of imitation

1. Decisions based on assessment of importance: Journal editors, reviewers, and conf organizers: if topic has sudden social interest, likely to get more downloads/references to papers on the new topic. Faster publications of relevant papers; Interview of editors etc.

Funders (govt, foundations, firms) to provide special support/quick review of proposals connected the crisis;

Survey firms, data providers to provide new data and of researchers to seek out new forms of data.

2. Imitation: Both researchers and non-researchers could be following some form of **imitative** behavior, that plays big role in booms and busts in finance. Imitation could involve following entrepreneurial research leaders – if some researchers got lots of attention for her work on WFH, that looks like great area for work – or following senior professors who encourage work on new topic. Possibly test the citations patterns.

3. Phrase imitation: Using WFH in title/keyword/abstract as “background”/gimmick for getting attentions: Add Covid-19/WFH to your title/keyword (eg. “*Enhanced Analysis Approach to Detect Phishing Attacks during COVID-19 Crisis*” with work-from-home in the abstract)

Underlying burst in WFH and for additional research is public concern for the issue, which could be measured by news reports, sentiments etc.

III. Scopus Bibliometric Data on Journal Articles & Conference Papers and Presentations in Stanford Remote Work Conferences

Bibliometric data from Scopus:

This presentation uses journal article and conference proceeding data to examine the sudden “discontinuous” jump in WFH research, identifying papers by whether papers having at least one of the seven terms noted on slide 1 in either their *titles*, *keywords*, or *abstracts*. Titles and abstracts are pulled out directly from papers (given by authors), and keywords are provided by Scopus which are standardized to distinguish synonyms, various spellings, and plurals.

27 field tags are assigned to journals by Scopus in-house experts based on the aims, scope, and content of journals. This analysis distinguishes the fields of papers using the field tags of journals that published the papers. Some journals have more than one field tag and are calculated at the whole count basis.

The *author-level publication data* are collected using the author IDs provided by the Scopus for each paper. Scopus author ID disambiguates authors with the same names by algorithms accounting for their affiliation, field, ORCID, etc. I randomly sampled 100 WFH papers post COVID-19 and pulled out 525 unique author IDs from those papers.

2022 Stanford Remote Work Conference:

Since Scopus only indexes published works and the Computer Science and Engineering fields have the convention of conference proceeding publications, so more than 80% of the ~1000 WFH conference papers in Scopus are in CS and Engineering fields that study the technologies for WFH.

To gain a better understanding of WFH papers in the Social Science field, I use presentations given in the 2022 Stanford Remote Work Conference to examine how many WFH conference presentations are later on published in journals.

Finding 2: Share of Broad Social Science Tags Falls and Medicine Tag Rises

The supply of WFH journal articles post pandemic came from wider fields with increased share of papers from medicine journals, focused on such topics as health care access, telemedicine, and the effects of WFH on people’s mental health, psychological well-being, and physical health. WFH papers in social science fields also increasingly were concerned with health issues – burnout and stress and health policy. This suggests that authors writing the WFH articles came from a wide disciplinary background who published in their own disciplinary journals.

Share of field tags pre and post Pandemic (2000-19 vs 2020-23)

	% Field Tags		
	2000-19	2020-23	Changes
<i>Broad Social Science</i>	53	42	-12
Social Sciences (SOCL)	25	22	-2.8
Business, Management and Accounting (BUSO)	20	12	-7.8
Economics, Econometrics and Finance (ECON)	5	6	0.8
Decision Sciences (DECI)	4	2	-2.0
<i>Non-Social Science</i>	47	58	12
Medicine (MEDI)	5	15	10.5
Engineering (ENGI)	12	6	-5.4
Computer Science (COMP)	9	7	-2.0
Psychology (PSYC)	6	7	0.9
Environmental Science (ENVI)	4	7	2.9
Arts and Humanities (ARTS)	3	3	-0.6
Other field tags	8	13	6

Note: Field tags are assigned to articles based on the field tags of the publication journals. We count each field tag once for articles on journals with more than one field tags. Using the fractional count method wouldn't affect the results.

Journals publishing the most WFH articles shows the same shift from social science journals to the medicine journals

Top 10 Journals in **All Fields** that Published WFH Articles pre & post COVID-19 Pandemic

Pre-Pandemic: 2000-2019			Post-Pandemic: 2020-2023		
Journal title	#WFH articles	%WFH articles	Journal title	#WFH articles	%WFH articles
New Technology Work And Employment	45	2.9	International Journal Of Environmental Research And Public Health	226	3.8
Transportation Research Record	38	2.5	Sustainability Switzerland	171	2.9
Olhydraulik Und Pneumatik	20	1.3	Frontiers In Psychology	117	2.0
Transportation Research Part A Policy & Practice	19	1.2	Plos One	74	1.3
Facilities	14	0.9	Journal Of Occupational And Environmental Medicine	47	0.8
Environment And Planning A	13	0.8	Work	45	0.8
Transportation	13	0.8	BMC Public Health	37	0.6
Work	11	0.7	Transportation Research Part A Policy And Practice	36	0.6
Human Relations	10	0.6	International Journal Of Manpower	34	0.6
International Journal Of Human Resource Management	10	0.6	BMJ Open	27	0.5

Top 10 Journals in **Social Science, Econ, or Business** fields that Published WFH Articles pre & post COVID-19 Pandemic

Pre-Pandemic: 2000-2019			Post-Pandemic: 2020-2023		
Journal title	#WFH articles	%WFH articles	Journal title	#WFH articles	%WFH articles
New Technology Work And Employment	45	4.4	Sustainability Switzerland	172	5.2
Transportation Research Part A Policy And Practice	19	1.8	Transportation Research Part A Policy And Practice	36	1.1
Facilities	14	1.4	International Journal Of Manpower	34	1.0
Environment And Planning A	13	1.3	Transport Policy	26	0.8
Transportation	13	1.3	Information Technology And People	25	0.8
Human Relations	10	1.0	Gender Work And Organization	23	0.7
International Journal Of Human Resource Management	10	1.0	Journal Of Business Research	21	0.6
Human Resource Management International Digest	9	0.9	Proceedings Of The ACM On Human Computer Interaction	20	0.6
Journal Of Managerial Psychology	9	0.9	Social Sciences	18	0.5
International Journal Of Manpower	8	0.8	Transportation Research Interdisciplinary Perspectives	17	0.5

ONLY 2 WFH articles published in top 10 Econ journals before the pandemic

1	Valuing alternative work arrangements <i>开放获取</i>	Mas, A., Pallais, A.	2017	American Economic Review 107(12), pp. 3722-3759	208
2	Does working from home work? Evidence from a chinese experiment <i>开放获取</i>	Bloom, N., Liang, J., Roberts, J., Ying, Z.J.	2015	Quarterly Journal of Economics 130(1), pp. 165-218	591

Finding 3a: WFH keywords in social science field contains more words on COVID-19 relevant issues

I use the Chat-GPT + manual correction to group the most used 160 keywords pre and post pandemic into the following group. Given the huge increases in # of articles, the absolute changes in # of keywords all increased

COVID-19 brought the public health challenges to the world, pandemic and public health relevant keywords appeared on a big proportion of 2020-23 WFH articles with SOCI tag. Large scale quarantine made people had to stay at home, more negative mental health keywords (stress, burnout) merged compared with positive keywords (satisfaction; flexibility) pre pandemic. Here, keywords changed to words close to the exogenous shock.

Keyword Group	% Keywords weighted by #papers having the keyword		Representative Vocabulary	
	Pre-pandemic 2015-19	Post-pandemic 2020-23	Pre-pandemic 2015-19	Post-pandemic 2020-23
<i>Work and Labor</i>	28.0	13.0	Workplace; Turnover; Flexibility	Working Conditions; Work-life Balance; Unemployment; Productivity
<i>Transportation and Mobility</i>	17.9	7.7	Travel Behavior; Mobility; Transportation	Travel Demand; Transportation Policy
<i>Demographic</i>	13.3	10.3	-	-
<i>Geographic</i>	9.3	5.5	-	-
<i>Technology</i>	7.4	2.6	Internet; User Interfaces	Digitalization; Digital Transformation
<i>Research Method</i>	7.4	4.3	-	-
<i>Environmental</i>	4.9	0.2	Environmental impact; Air quality	Climate Change
<i>New group</i>				
<i>COVID-19 Pandemic</i>	-	31.5	-	COVID-19; Pandemic; Coronavirus
<i>Public Health and Healthcare</i>	-	9.0	-	Health Policy; Occupational Health
<i>Mental Health and Well-being</i>	-	5.6	-	Mental Health; Stress; Burnout
<i>Education</i>	-	3.2	-	Higher Education; Online Learning/E-learning
<i>Others</i>	11.9	7.0	-	-

Note: Keywords are Scopus indexed keywords which consists of refined author keywords and words from title & abstract. We pull the top 160 most used keywords from Scopus, then we use the Chat-GPT + manual correction to group those keywords into suitable groups. Given the huge increases in # of articles, the absolute changes in # of keywords all increased

Finding 3b: WFH Keywords in medicine field show more concerns

The COVID-19 outbreak caused a serious shortage in medical resource and health service, thus some new branches of research studying the access to health care merged.

Since a lot of doctors and nurses needed to WFH during the pandemic, tele-medicine keywords stood out.

The Psychology relevant keywords was absorbed by the Mental health relevant keywords with more negative vocabulary

Keyword Group	% Keywords weighted by #papers having the keyword		Representative Vocabulary	
	Pre-pandemic 2015-19	Post-pandemic 2020-23	Pre-pandemic 2015-19	Post-pandemic 2020-23
<i>Demographic</i>	26.2	28.1	-	-
<i>Health and Healthcare</i>	19.8	8.0	Health Care Delivery; Obesity; Occupational Health	Health Care Personnel; Health Care Access; Vaccination
<i>Data and Method</i>	13.7	15.1	-	-
<i>Work and labor</i>	13.4	9.1	Workplace; Job Satisfaction; Work Environment	Job Satisfaction; Job Stress; Working Time; Workload
<i>Transportation</i>	5.8	0.1	Traffic And Transport; Cycling; Car Accidents	Urban Mobility Plans; Transport Policy
<i>Psychology</i>	5.8	-	Communication; Self-leadership; Motivational Process	-
<i>Technology</i>	5.6	1.6	Internet; Smartphone; Videoconferencing	Telemedicine; Telehealth
<i>New group</i>				
<i>COVID-19 Pandemic</i>	-	25.6	-	COVID-19; Pandemic; Coronavirus
<i>Mental Health and Well-being</i>	-	8.8	-	Anxiety; Depression; Psychological Well-being; Distress Syndrome
<i>Others</i>				
	9.6	3.5	-	-

Finding 4: Half WFH articles analysis WFH as dependent variable and half as independent variable

Information contained in keywords is limited, the combination and context are critical, “WFH arrangement after COVID-19” and “COVID-19 pandemic after WFH” are very different in what they study. To gain a better understanding of how WFH research topics expanded/changed, we randomly sampled 100 papers and hand labelled them into three categories based on their use of WFH as dependent or independent variables.

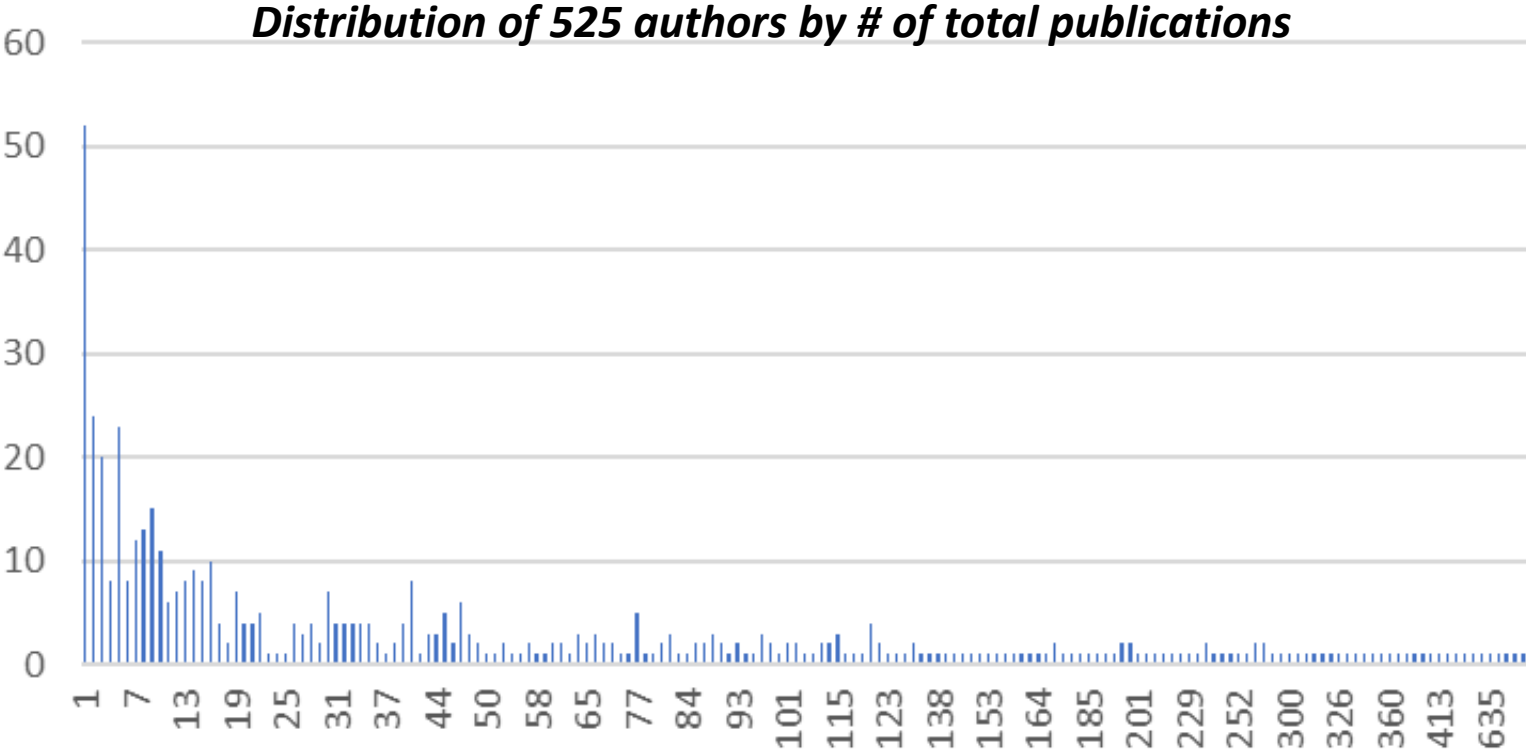
Category3	% Papers	Example
<p>1. Conventional WFH in Econ & Business context WFH as the focal object in the research [WFH = f(x)]</p>	<p>44</p>	<ul style="list-style-type: none"> • <i>Adapting to the new normal: The impact of remote work on firm performance in Jordan and Morocco</i> • <i>Managing Remote Projects Effectively with an Action Dashboard</i>
<p>2. WFH as exogenous shock to other outcomes Y =f(WFH)</p>	<p>46</p>	<ul style="list-style-type: none"> • <i>A Cross-Sectional Study of the Association Between Telecommuting Environments and Shoulder Pain Among Japanese Telecommuting Workers</i> • <i>COVID-19 turbulence and positive shifts in online purchasing by consumers: modeling the enablers using ISM- MICMAC analysis</i> [Several significant categories of enablers like health, trust, convenience, work from home, referral buying, panic purchase and overstocking possess a strong influence on the shift to online purchasing due to the pandemic.] • <i>Labeling local brand to increase coffee shop visits during the COVID-19 pandemic</i> [The COVID-19 pandemic period has become a distraction and a challenge for the café business due to physical restrictions and large numbers of employees working from home. This research aims to describe how local labeling brands can increase coffee shop visits during the COVID-19 pandemic in Indonesia.] • <i>High frequency of digital eye strain and dry eye disease in teleworkers during the coronavirus disease pandemic</i> [This study aimed to evaluate visual display terminal (VDT)-related digital eye strain (ES) and dry eye disease (DED) symptoms in subjects whose work was changed to teleworking during the coronavirus pandemic. Methods. A digital self-reported survey including demographics, medical history, VDT time and ES-related symptoms before and during the pandemic]
<p>3. WFH is mentioned as a general background</p>	<p>10</p>	<ul style="list-style-type: none"> • <i>Enhanced Analysis Approach to Detect Phishing Attacks during COVID-19 Crisis</i> [Employees have been encouraged to work from home where possible to slow down the viral infection. The massive increase in the volume of online has posed a new context for cybercrime, with the increase in the number of emails and phishing websites. This paper presents a novel approach for detecting phishing Uniform Resource Locators (URLs) applying the Gated Recurrent Unit (GRU).] • <i>The online technology acceptance model of generation-Z people in Thailand during COVID-19 crisis</i> [During COVID-19 pandemic, Thai people must quarantine themselves at home or work from home to prevent the outbreak of this disease and must comply with the laws of the Thai government. This research aims to study the acceptance of the online technology of Thai people in Generation-Z during COVID-19.]

Finding 5: Most authors new to the area

There are 525 authors on the randomly sampled 100 WFH articles, 135 (26%) of them have zero publications before the pandemic.

Among the 390 authors with earlier publications, only 8 (2%) authors have at least one pre-pandemic WFH paper; 145 (37%) authors ever published on journals with *five* or more WFH papers in 2015-19; 212 (54%) authors ever published on journals with *three* or more WFH papers in 2015-19; 252(65%) authors ever published on journals with *two* or more WFH papers in 2015-19.

4% of type 1 papers in the contend analysis have at least one authors with earlier WFH papers, while 0.6% of type 2 papers have at least one authors with earlier WFH papers, and none of the type 3 paper have an author with earlier WFH papers

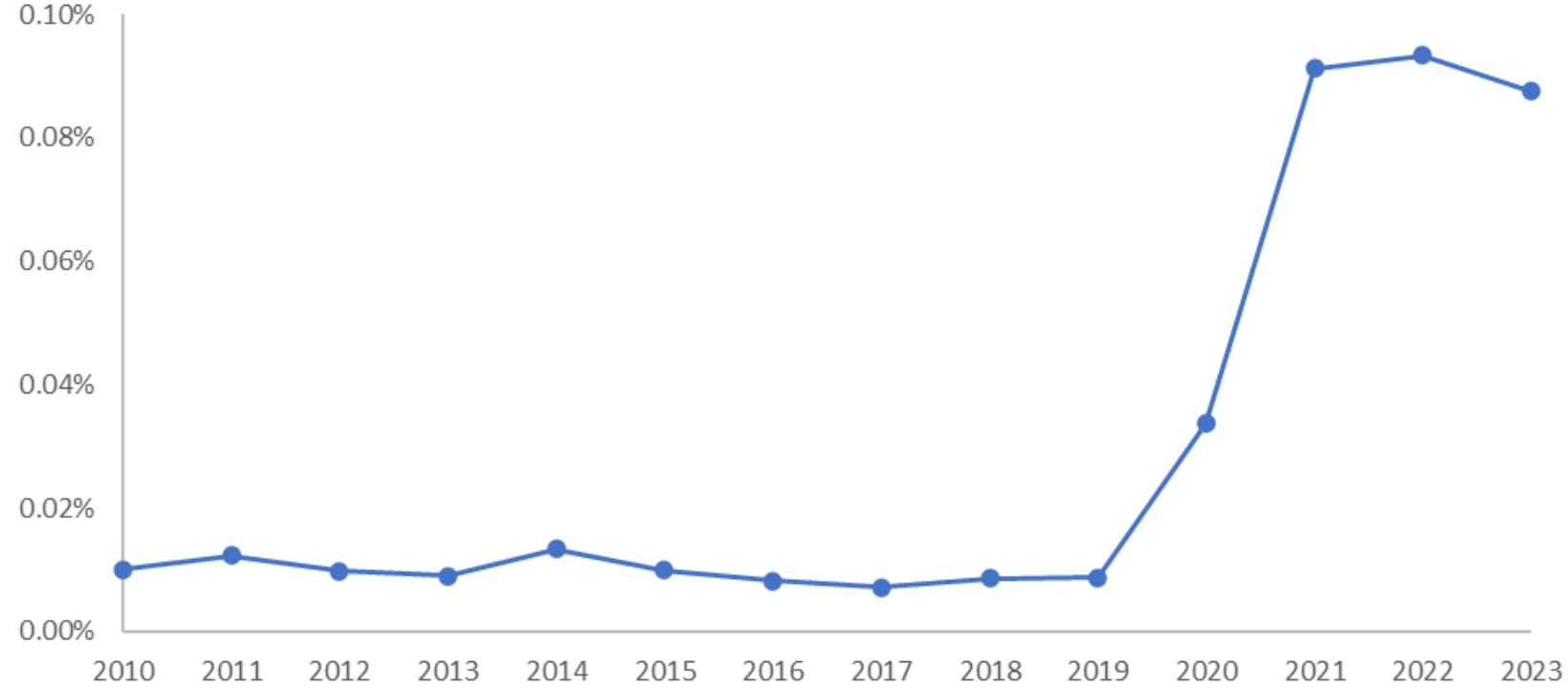


IV. Conferences papers

Scopus Conferences Papers: Averagely, 80% of the WFH conferences papers from Scopus are in the computer science & engineering fields for each year before and after the pandemic. Conference paper publishing practice is very different in computer science & engineering fields compared with social science. In social science, most of presentations given at conferences will later published on the special edition of journals or journals chosen by the authors.

Even the level is pretty low, but the WFH share of all CS and ENGI conference papers still shows the burst after the pandemic, and most of those papers are about some technologies/designs that could be used for WFH.

WFH share of all computer science and engineering conference papers, 2010-2023



Finding 6: Time gap between conference presentations and publications

21 presentations given at the 2022 Stanford Remote Work Conference: only one of the presentations is published in a journal, eighteen of them are working papers, and two of them are in progress. This suggest a more than one year time gap between the research presented at conferences and the publications.

Need further analysis on preprints and working papers.

Title of Presentation	Paper status in Oct 2023
Who is doing the chores and childcare in dual-earner couples during the COVID-19 era of working from home?	Review of Economics of the Household
How Many Americans Work Remotely?	NBER working paper
Remote Work across Jobs, Companies, and Space	NBER working paper
The Effect of Working from Home on the Agglomeration Economies of Cities: Evidence from Advertised Wages	SSRN preprint
The Impact of Remote Work on Local Employment	BLS working paper
Housing Demand and Remote Work	NBER working paper
Disrupting science: How remote collaboration impacts innovation	The Oxford Martin Working Paper
The Power of Proximity: Office Interactions Affect Online Feedback and Quits, Especially for Women and Young Workers	Working paper in homepage
Is Hybrid Work the Best of Both Worlds? Evidence from a Field Experiment	HBS WORKING PAPER SERIES
How Hybrid Working From Home Works Out	NBER working paper
Worker Sorting, Work Discipline and Development	NBER working paper
Mismatch in Preferences for Working from Home – Evidence from Discrete Choice Experiments with Workers and Employers	IZA working paper
“Working” Remotely? Selection, Treatment, and The Market for Remote Work	SSRN preprint
COVID-19 AND REMOTE WORK: AN EARLY LOOK AT US DATA	NBER working paper
Spatial Implications of Telecommuting	NCST Working paper
The International Price of Remote Work	NBER working paper
Work From Home and the Office Real Estate Apocalypse	NBER working paper
From in-person to online: the new shape of the VC industry	SSRN preprint
Virtual Water Coolers: A Field Experiment on the Role of Virtual Interactions on Organizational Newcomer Performance	HBS WORKING PAPER SERIES
Speak Up or Stay Silent: Experimental Evidence on the Impact of Remote Work on Worker Voice	No paper found
Measuring the Impact of Remote Work Across the United States	No paper found

V. Conclusion

The analysis shows the high responsiveness of scientific researchers in many fields to a sudden social need for greater information and insight into what may be the lasting effect of the pandemic on the world of work, with researchers drawn not only from nearby fields but from ones that would initially appear far away from working from home, such as medicine and engineering fields.

The next steps

- Bibliometric techniques: a) define papers with only 1 WFH terms vs 2, 3, WFH terms; b) Papers give WFH terms in different places - title, abstract, or keywords; c) Reviews; d) Normal changes/expanding of a field vs the changes under shock; e) Measure closeness index of fields by how many journals/papers/authors have joint field codes.
- Analyze the share of papers on hot topics in journals, by field, by impact...
- Analyze the share of papers on hot topics of authors in the same/similar field – test by #Earlier WFH papers; # earlier papers on WFH journals, # earlier papers on other journals with the same field tag as WFH journals
- Authors from other fields use their skills to study the hot topics
- Authors from other fields uses the hot topic as a background/factor that will affect their own fields
- The shock create new issues/shift the original focus of the field
- Time lag of academic publishing. Extend to other resource: news, report, consulting report,
- Use the closeness of authors to measure the closeness of retrieved papers to typical WFH area