Does Working From Home Work? A Natural Experiment From Lockdowns

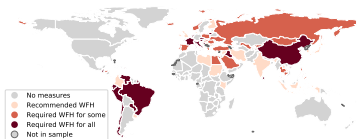
Lucas Shen
December 2022

Covid-19 disrupted work from office

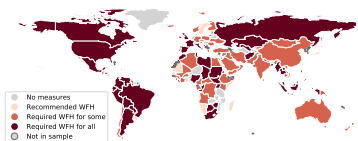
- Covid-19 started around Jan 2020
- Affected economies at different timings
- Governments enforced closures at different timings
- Workers work from home
- Natural experiment

Early response (by 15 Feb 2020)

Intermediate response (by 17 Mar)



Late response (by 30 Apr)



Covid-19 disrupted work from office

Sections The Washington Post Democracy Dies in Darkness Subscribe Sign

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Technology

Big Tech was first to send workers home. Now it's in no rush to bring them back.

Tech giants aren't looking to politicians to set timetables to reopen their offices, telling most staff to work from home at least until next year.

Google and Facebook have told most employees to keep working from home for the rest of 2020 as part of a response by the tech giants to the deadly coronavirus pandemic. (Kimihiro Hoshino/AFP/Getty Images)

By Rachel Lerman and Jay Greene

May 18, 2020

Tech's titans set the agenda for U.S. employers in early March, sending staff to work from home as the coronavirus started to spread near their West Coast headquarters.

Musk tells Twitter staff remote working will end

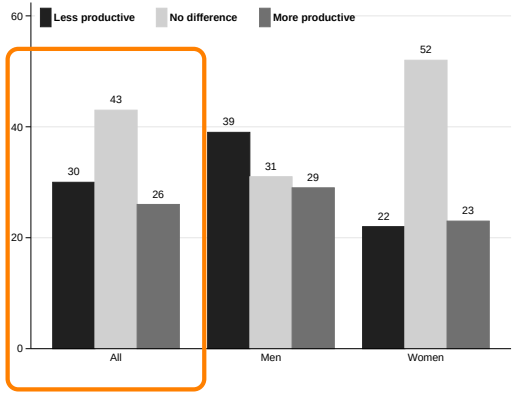
10 November · Comments

By Michael Race
Business reporter, BBC News

Musk: “all the Covid stay-at-home stuff has tricked people into thinking that you don’t actually need to work hard”

Early survey: Minimal impact on individual productivity

- YouGov (2020) survey
- 19–21 May 2020
- 1,000 US adult citizens
- Survey item: **Generally speaking, how has working from home affected your productivity?**
- “No difference” response dominates (43%)



This study

- **Question:** Does working from home (WFH) affect individual output?

- **Data & Methodology:**
  - Open-source software/projects (tracked changes) - GitHub
  - Geocode - OSM
  - Region-date WFH - OxCGRT (Petherick et al. 2020)
  - Event study/DiD

- **Findings:**
  - Tracked changes approximate regular work cadences
  - Minimal impact on individual-level output (tracked changes)
  - Minimal impact even after accounting for low compliance

- **Related literature:**
  - Bloom et al. (2015), RCT in a routine work context
  - Bloom et al.'s (surveys), Choudhury et al. (2020), McDermott and Hansen (2021), Wang et al. (2020)

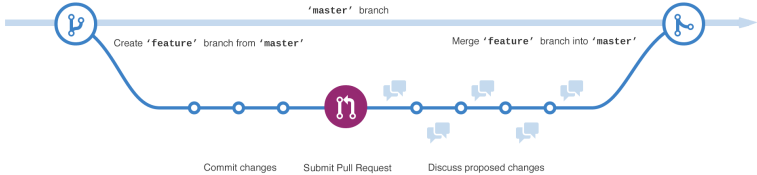
Approaching productivity

- Ideally... productivity = $\frac{\text{units of output}}{\text{units of input}}$

- The seminal study on WFH productivity is Bloom et al. (2015):
  - RCT in Ctrip (travel agency)
  - Call center representatives
  - Clock in hours, take calls, make hotel/airline orders
  - productivity = $\frac{\text{calls completed}}{\text{work minutes}}$

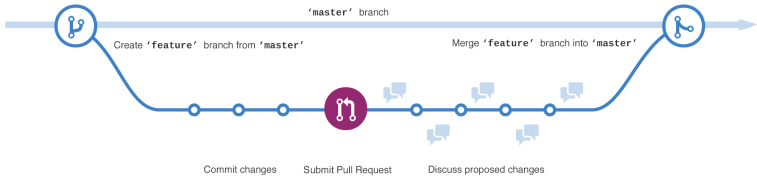
- My study
  - Natural experiment
  - Uses tracked changes to open-source code & projects on GitHub
  - No observation on time spent per change
  - ↑ tracked changes ↑ output

Approaching productivity using GitHub (1/3)



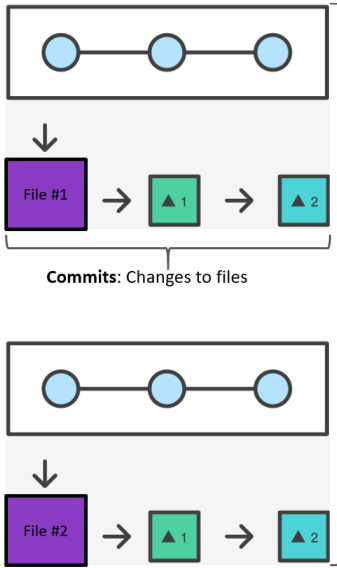
- GitHub = Open-source platform
- “where the world builds software”
  - $>$ 56m users
  - $>$ 100m repositories (projects)
  - $>$ 3m organisations
- (Git) version control + collaboration on open-source projects
- Tracked changes

Approaching productivity using GitHub (2/3)



- Key milestones (in Git version control workflow)
  - Commits (changes to files committed to tracking)
  - Pull requests (Commit(s) submitted to main pipeline)

Approaching productivity using GitHub (3/3)



Pull requests: Notification to team members that a collection of changes/improvements are ready to be pulled into the main pipeline

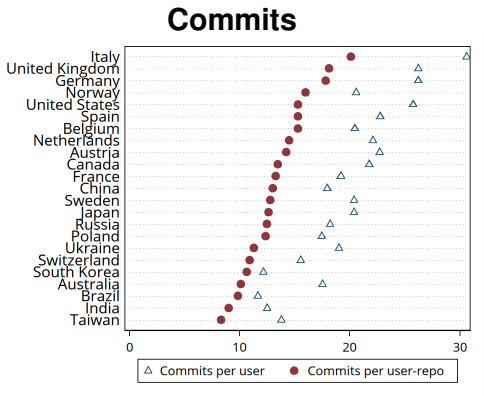
Commits

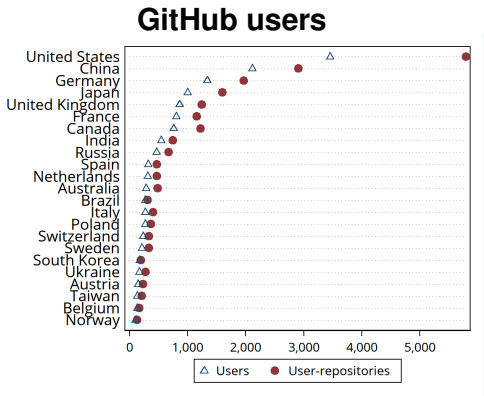
- Changes to files (e.g. data file, word doc, code file)
- Tracked changes (saves, snapshots)

Pull requests (or pulls)

- Collaborative workflow
- Submissions of (a collection) of commit(s)
- Team members review, comment, discuss
- Approval: changes “pulled” into main pipeline

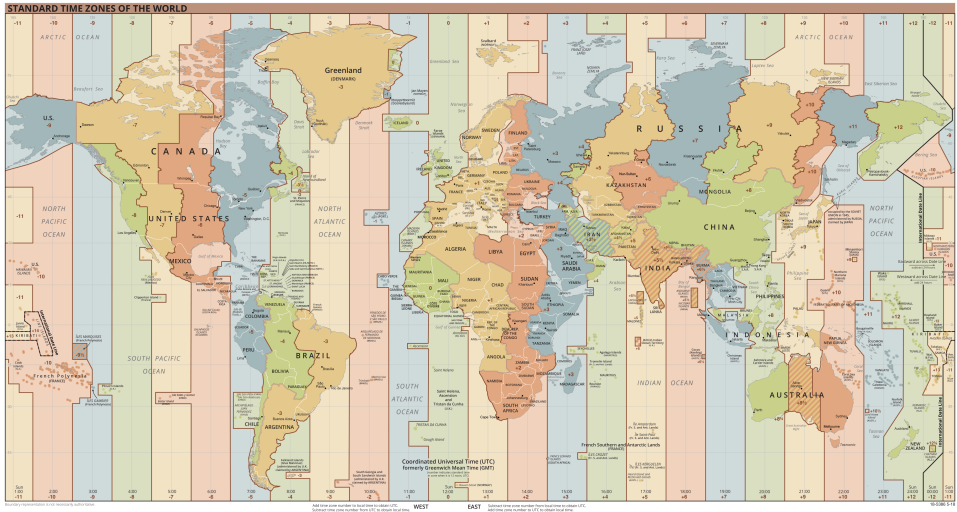
GitHub activity captures major regions





Retrieving GitHub user location

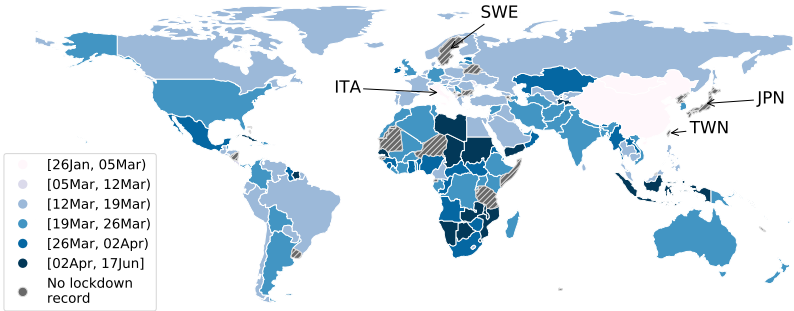
- Geocode user self-reported location to region/state
- *OpenStreetMap (Nominatim) API*
- Self-reported location $\longrightarrow$ region
  - E.g., “Salzburg, Austria” $\longrightarrow$ Austria
  - E.g., “Borlänge” $\longrightarrow$ Sweden
  - E.g., “武汉, CN” $\longrightarrow$ China
  - E.g., “Santa Rosa, CA, USA” $\longrightarrow$ US
  - E.g., “Non Euclidean Hellscape” $\longrightarrow$?
  - E.g., “Edinburgh/Berlin” $\longrightarrow$?
- 42k (89%) unique location strings can be geocoded
- Most users (98%) are successfully geocoded



- self-reported location ⟶ lat-long ⟶ timezone
- e.g.: Atlanta, Georgia ⟶ (33.748992,-84.390264) ⟶ America/New York (GMT -5)

OxCGRT: Region-date specific workplace closures

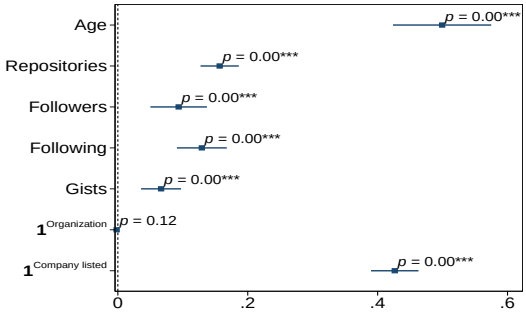
OxCGRT WFH indicator	Type	Description from Oxford's Blavatnik School of Government (Petherick et al. 2020)
0	Non-binding	No measures
1	Non-binding	Recommended closing (or recommended work from home)
2	Binding	Required closing (or work from home) for some sectors or categories of workers
3	Binding	Required closing (or work from home) for all-but-essential workplaces (e.g. grocery stores, doctors)



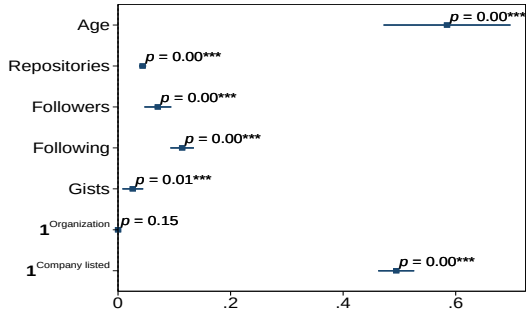
Data summary

- GitHub (Google BigQuery + GitHub APIs)
  - Census of (public) timestamped commits Jan–Jun 2020 from BigQuery archive
  - Metadata: timestamp, user, repository
  - Search API + User API + Repository API (snapshots)
  - User: self-reported location, account creation date, #followers, #repositories, etc.
  - Repository: creation date, #stars, #contributors, etc.
- *OpenStreetMap (Nominatim) API*
  - self-reported location $\longrightarrow$ country (E.g., Borlänge $\longrightarrow$ Sweden)
  - $\sim$42k of 47k (89%) unique locations strings
- OxCGRT (Petherick et al. 2020)
  - Region-date records of WFH enforcement
- Data
  - Jan–Jun 2020
  - $\sim$350k commits
  - $\sim$290k pull requests
  - $\sim$340k user-repositories

Geocoded users are more prominent

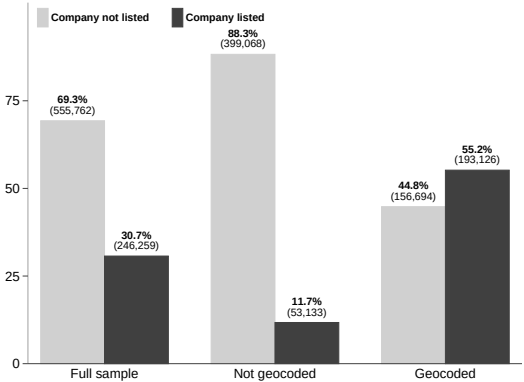


(a) Commits sample



(b) Pulls sample

Major Tech Companies are captured (commits)



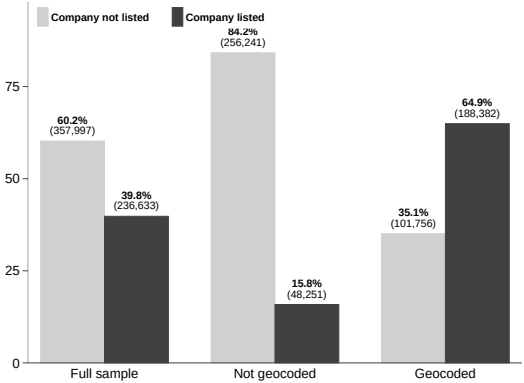
(a) Users self-reported company

	Company	Count		Company	Count
0	google	182	15	freelancer	13
1	microsoft	81	16	jetbrains	13
2	red hat	78	17	stanford university	13
3	alibaba	53	18	elastic	13
4	tencent	43	19	yandex	12
5	baidu	29	20	alipay	11
6	freelance	28	21	netease	11
7	bytedance	28	22	amazon	11
8	ibm	23	23	pingcap	11
9	facebook	20	24	shopify	10
10	automattic	18	25	esri	10
11	github	15	26	redhat	10
12	wso2	15	27	intel	10
13	thoughtworks	14	28	mercari	9
14	vmware	13	29	mit	9

(b) Most frequent companies

Commits sample

Major Tech Companies are captured (pulls)



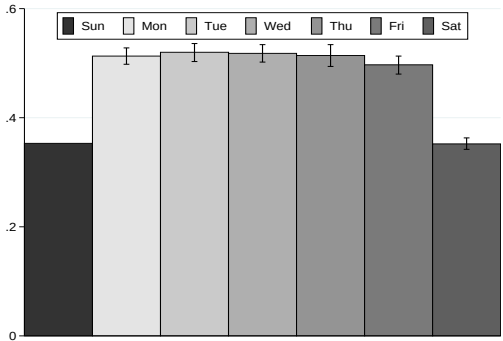
(a) Users self-reported company

	Company	Count		Company	Count
0	google	949	15	linkedin	61
1	red hat	573	16	netflix	58
2	microsoft	500	17	automattic	57
3	ibm	157	18	thoughtworks	54
4	facebook	115	19	adobe	53
5	freelance	103	20	intel	50
6	vmware	98	21	amazon web services	50
7	mozilla	98	22	datadog	50
8	shopify	94	23	uber	49
9	github	91	24	alibaba	48
10	freelancer	84	25	aws	48
11	suse	74	26	elastic	47
12	tencent	63	27	salesforce	47
13	spotify	61	28	nvidia	45
14	hashicorp	61	29	yandex	45

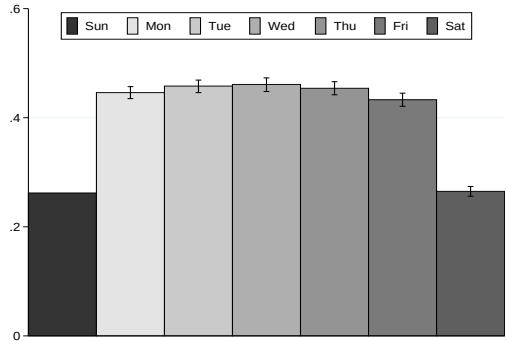
(b) Most frequent companies

Pull request sample

Tracked changes approximate day-of-week cadence

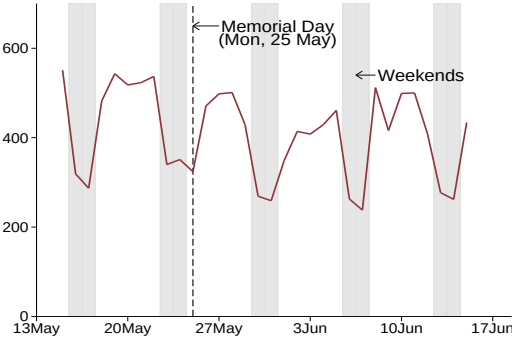


(a) DoW differences, geocoded sample

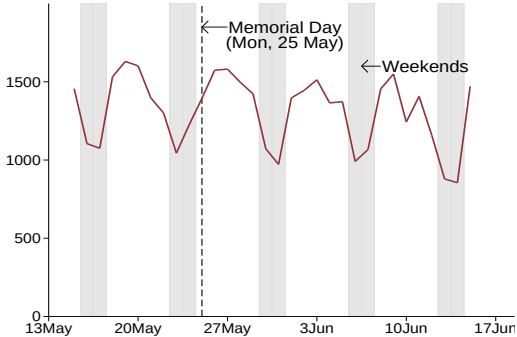


(b) Dow differences, out-of-geocoded sample

Tracked changes capture lulls during holidays (1/3)

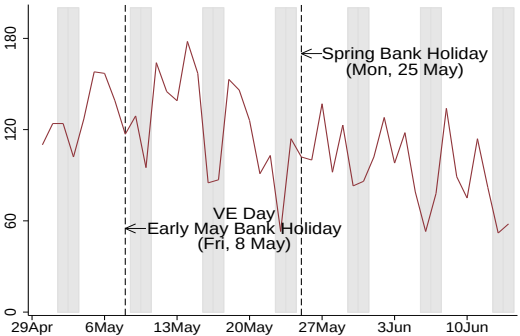


(a) Memorial Day, US sample

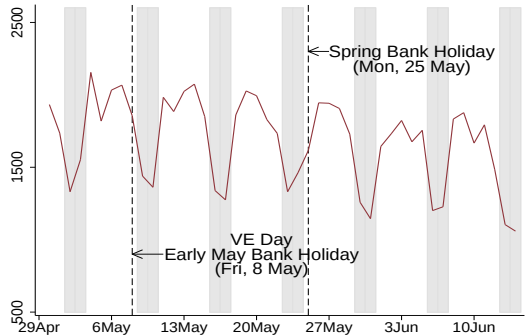


(b) Memorial Day, Rest-of-world

Tracked changes capture lulls during holidays (2/3)

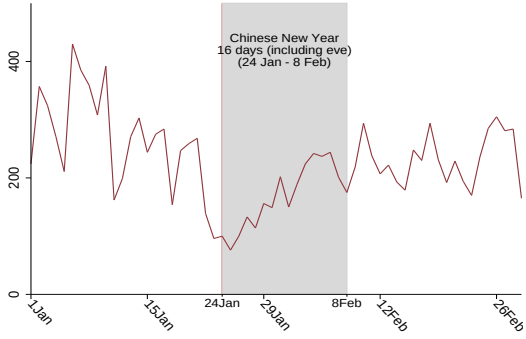


(a) May Bank Holiday, UK sample

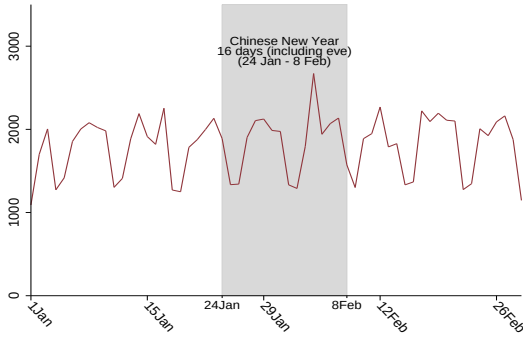


(b) May Bank Holiday, Rest-of-world

Tracked changes capture lulls during holidays (3/3)

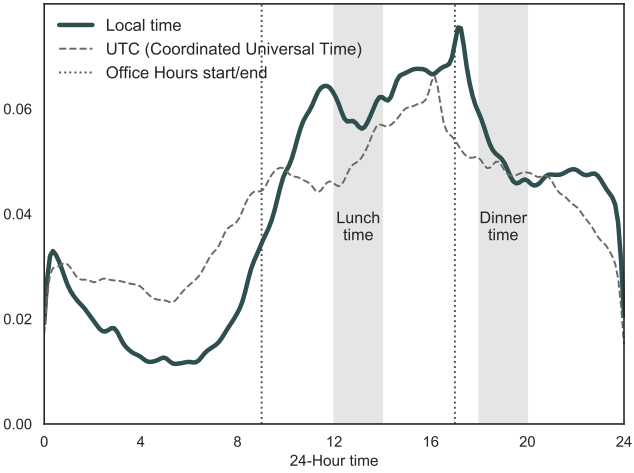


(a) Chinese New Year, Chinese countries sample



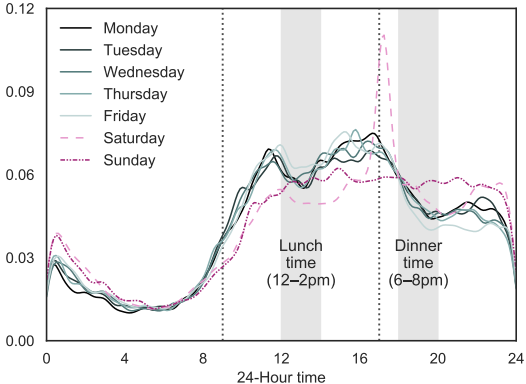
(b) Chinese New Year, Rest-of-world

Tracked changes capture time-of-day cadence

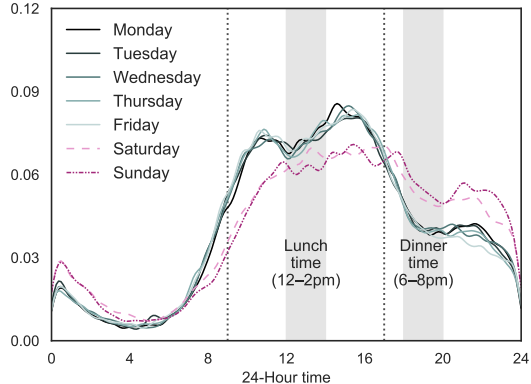


- Convert standard times to local times
- Activity is dense during office hours and at night
- Activity peaks before lunch & end-of-day
- Lowest outside of regular office hours

Time-of-Day x Day-of-Week cadence

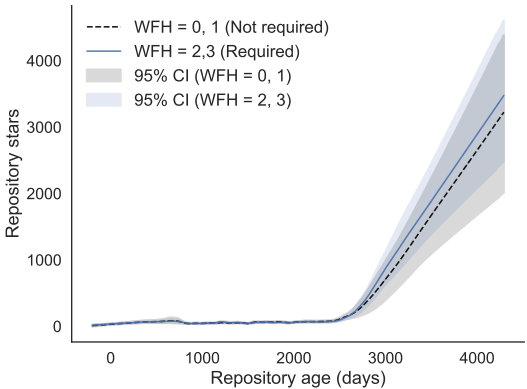


(a) Commits

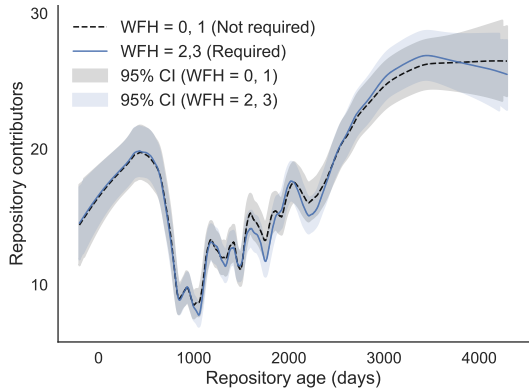


(b) Pull Requests

No difference in active projects before vs after lockdowns



(a) Commits



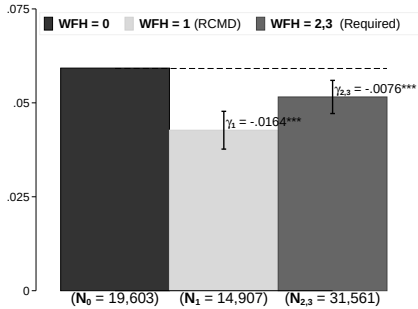
(b) Pull Requests

Estimating changes after lockdown

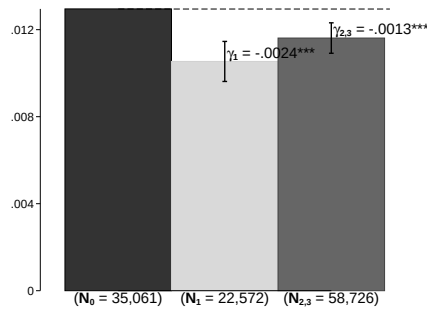
$$\ln(1 + \text{tracked changes})_{ijk} = \alpha_i + \alpha_j + \sum_{k \in \{0,1,(2,3)\}} \gamma_k \mathbb{1}\{\text{WFH} = k\}_i + \varepsilon_{ijk} \quad (1)$$

- i = user
- j = repository
- k = WFH arm
- α's are user and repository fixed effects
- γ_k = ITT effects
- Standard errors clustered by region of user i

Minimal impact of lockdown on tracked changes



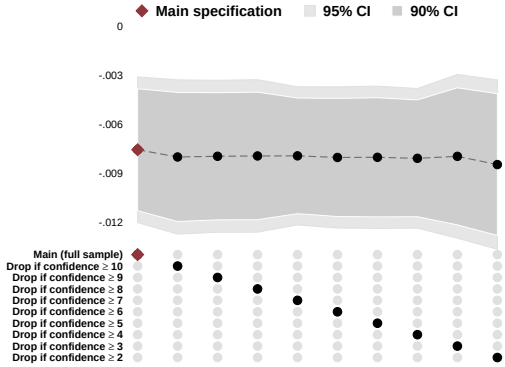
(a) Log commits



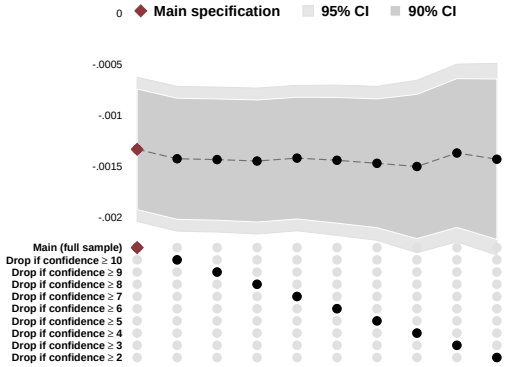
(b) Log pull requests

- Unit of analysis: User-repository
- Collapse to pre- & post-WFH (Bertrand et al. 2004)
- Treatment variable: post-WFH dummies

Estimates not sensitive to geocoding



(a) Commits



(b) Pull requests

- Iteratively dropping users by quality of geocoding

Open-source software (OSS) is more work than hobby

- One concern is that GitHub hosts hobby projects
- Anecdotally, many serious projects (e.g., Google's TensorFlow) are open-sourced
- Many packages I use are open-sourced
- From surveys:
  - Stack Exchange (2022): $<$ 6% code only as hobby
  - Zlotnick (2017), 5.5k GitHub users: 85% contribute to OSS in their day job
  - Zlotnick (2017), 5.5k GitHub users: 94% are end-users of OSS in their professional work
  - Zlotnick (2017), 5.5k GitHub users: 65% contribute back to OSS as part of work duties
- OSS is also the default when choosing software (GitLab 2018; Zlotnick 2017)
  - OSS quality is same or higher than proprietary

Compliance with state-imposed WFH

- Ideally, we observe whether individuals WFH or work in office
- Only observe state-imposed WFH—assignment but not compliance
- Most likely source of non-compliance = Individuals already WFH ("always-takers")
- Based on surveys of software developers
  - Stack Exchange (2015): ∼29% WFH at least partially
  - Stack Exchange (2019): ∼18% WFH at least partially
  - Yang et al. (2022): ∼18% Microsoft employees WFH
- Surveys: $\implies \sim 71\%$ compliance
- Assume only 50% comply $\implies \sim < 1 percent$ (∼-0.9 percent change)

Contextualising: Related studies

- Bloom et al. (2015)
  - RCT in Ctrip, travel agency in China
  - 249 participants — call center representatives
  - Answer calls & take orders for hotel/airline bookings
  - Ensure equal access to IT & internet access
  - WFH increase productivity by 4%
  - Transactional & routine: Well-defined metrics of productivity

- This study
  - Minimal change in output after lockdowns
  - Software developers & researchers
  - Different work context
  - Tasks are seldom repetitive & routine

Limitations

- Productive outout $\neq$ productivity
- Covid shock is global $\longrightarrow$ spillovers can occur which limits a causal interpretation
- ITT only—Only observe assignment but not compliance
- WFH under adverse conditions (Covid) $\neq$ WFH in general times
- Quality of output remains understudied in this and other studies

Recap & Discussion

- Tracked changes in open-source projects
- Open-source projects: Non-transactional & non-routine
- How does WFH affect workers who have to deal with ad-hoc problems and troubleshooting unexpected problems?
- Workers who have to deal with changing project requirements, unrealistic timelines, attending meetings, insufficient resources, etc.
- Minimal negative impact of WFH on output
- Perhaps monitoring is the issue

Musk tells Twitter staff remote working will end

10 November · Comments

By Michael Race
Business reporter, BBC News

Musk: “remote workers are just pretending to work”

Digital presenteeism = red herring?: Workers can’t pretend when working in office??

Thank you!

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