

Remote Work across Jobs, Companies, and Space

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Introduction

COVID-19 initiated an enormous shift in remote and hybrid work

This shift has a permanent component, e.g. SWAA (Barrero et. al. 2021) suggests 25% of workdays away from the office after pandemic recedes

Majority of evidence comes from surveys but with:

- Limited sample sizes
- Little pre-pandemic coverage
- High cost to run at scale, at high frequency, and across countries

Job Posting Data

Our project uses the universe of online job postings provided by **Lightcast** (formerly Burning Glass)

First contribution is to use a large language model (LLM) fit to human labels to build a classifier for remote and hybrid work

- Highlight trade-off between accuracy and complexity
- Importance of training sample size

Second contribution is to document granular heterogeneity in remote work adoption across occupations, locations, and firms

Outputs available on www.wfhmap.com

Plan of Talk

1. Data
2. Measurement approach
3. Results

Data Structure

Each job posting contains:

1. Structured metadata on occupation, location, firm, posting date
2. Unstructured text data describing relevant aspects of position

Sample begins in 2014, updated monthly

English-speaking countries: USA, UK, Canada, A/NZ

5% random sample from each country taken through 2018

Table: Counts of Vacancy Postings, Employers, and Cities, January 2014 to January 2023

(1)	(2)	(3)	(4)
Country	Vacancies	Employers	Cities
New Zealand	1,700,523	36,201	67
Australia	8,607,160	197,870	59
Canada	11,711,357	712,577	3,691
United Kingdom	74,576,747	876,103	2,268
United States	161,872,915	3,485,630	31,635
Total	258,468,702	5,308,381	37,720

Note: Reported counts pertain to the universe of online postings from January 2019 onwards and a 5% random sample from 2014 to 2018, after we drop about 6% of the postings in the data-cleaning steps described in Appendix A. We rely on Lightcast’s proprietary algorithm to identify employers and cities.

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Dictionary Method

Much of the text-as-data literature in economics has been based on keyword search, aka dictionary methods

Adrian et. al. (2021) uses this approach to measure remote work adoption with cross-country Indeed.com data

Draca et. al. (2022) uses it on our same UK Lightcast data sample

Software Developer

Pearson ★★★★★ 2,739 reviews

Australia

Remote

Full-time

You must create an Indeed account before continuing to the company website to apply

Apply on company site



Our purpose: At Pearson we ‘add life to a lifetime of learning’ so everyone can realise the life they imagine. We do this by creating vibrant and enriching learning experiences designed for real-life impact.

Our company: Pearson was founded in 1844 and has been built on our ability to grow with and adapt to a constantly evolving market. Our 20,000+ employees are dedicated to creating the high-quality, digital-first, accessible and sustainable resources for lifelong learning.

Flexible working: Pearson is committed to hybrid working practices. When you are not working from home, you’ll be based in our Nunawading office that has free parking and is walking distance to 2 train station. This is a great location for those that are not a fan of the city commute.

The Role : As a Software Engineer, you will be joining one of our cross-functional scrum teams and will play a key role in the development of our online assessment platform. Reporting to our Engineering Manager, you will work from home and collaborate via telecommuniting platforms.

What you will do:

Expense Processor (Remote U.S.A.)

Plus Relocation ★★★★★ 17 reviews

Minneapolis, MN 55426 • Remote

Full-time

You must create an Indeed account before continuing to the company website to apply

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Job details

Job Type:

Full-time

Work From Home:

Allowed

Location:

Anywhere

Full Job Description

Plus Relocation is looking for a numbers driven, detail

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Deputy Home Care Manager

Habitation Care Ltd

Brighton BN1

£21,246 - £26,289 a year - Full-time, Part-time, Temporary contract, Fixed term contract, Temp to perm

[Apply now](#)



We are looking for a Deputy Home Manager with domiciliary care experience to join our company. You will work from home care facilities with a strong track record of quality service.

The person we are looking for must have a positive, and a can-do work attitude at all time.

The person we are looking for must have at least 1 years working experience in a domiciliary care or care home managers role.

The role is for 38 hours per week plus on call duties, and sometimes cover of care calls would be required.

The person will be preparing supporting the Registered manager to carryout daily tasks.

Job Types: Full-time, Part-time, Fixed term, Temp to perm

Contract length: 36 months

Part-time hours: 38 per week

General Builder (Bricklayer Based)

Birkby Construction Limited

Maidstone

£14.50 an hour - Full-time, Permanent

[Apply now](#)



General Builder (bricklayer based) required for Small Works Department of Birkby Construction Limited on a PAYE basis. Company vehicle provided. Applicant must be self-motivated and confident. Willing to remote work sites.

Job Types: Full-time, Permanent

Work from Home: Not Available

Salary: £14.50 per hour

Benefits:

- Company car

Schedule:

- Monday to Friday

Licence/Certification:

- CSCS (preferred)

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Obtaining Human Labels

We select 10,000 sequences of job posting text with mix of:

- Dictionary terms from existing literature
- Negated dictionary terms
- Generic keywords (home, remote, etc.)
- Random sample

Each passage is labeled by three workers on Amazon Mechanical Turk, which yields **30,000 human-based classifications**

Workers asked to identify if sequence is consistent with job offering **remote work at least one day per week**

Agreement rate is above 90%

Algorithm Zoo

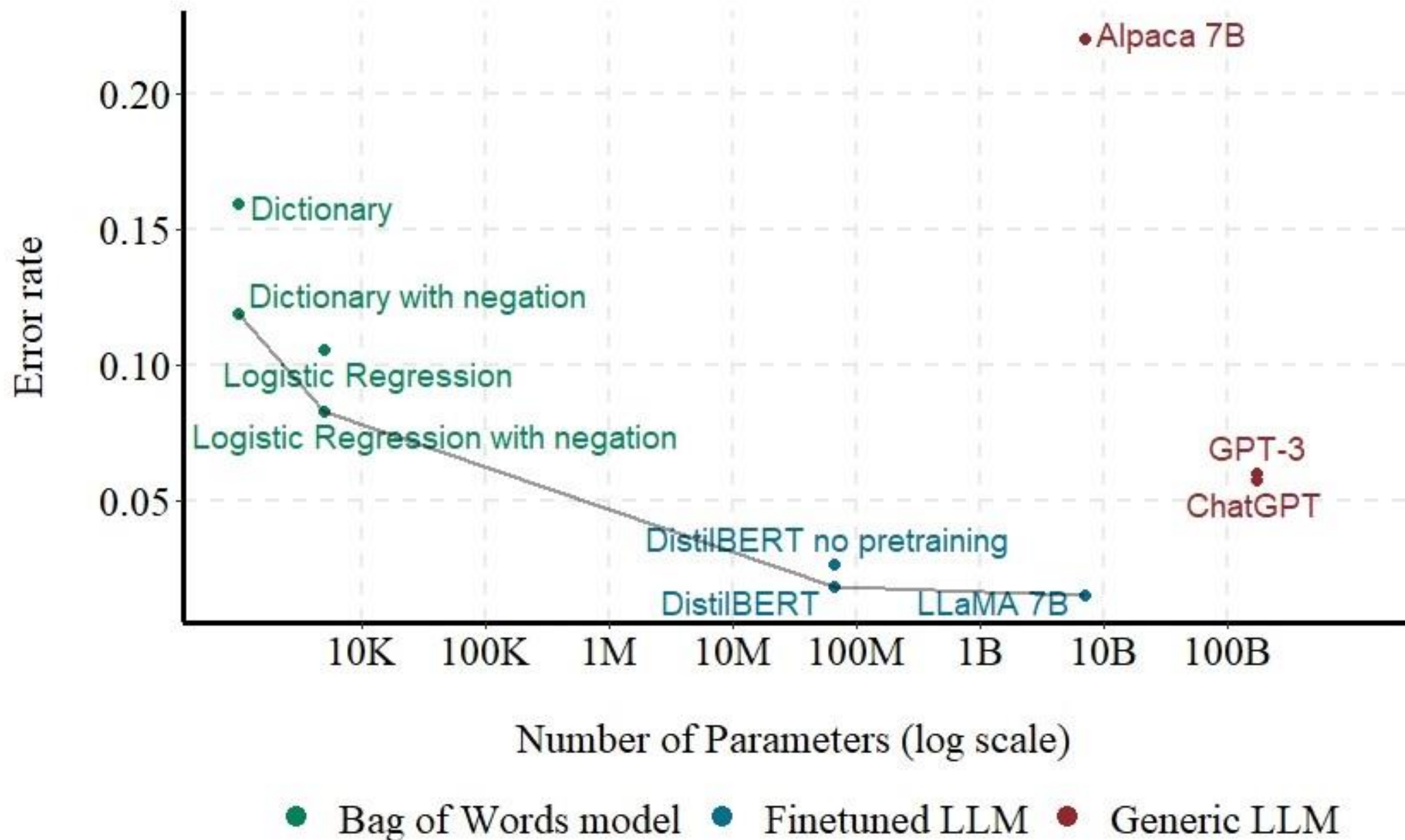
We evaluate three broad classes of algorithm to predict human labels

1. **Bag-of-words models:** dictionary, logistic regression (+ negation)
2. **Generic large language models:** GPT3, ChatGPT, Alpaca
3. **Fine-tuned large language models:** DistilBERT, LLaMA

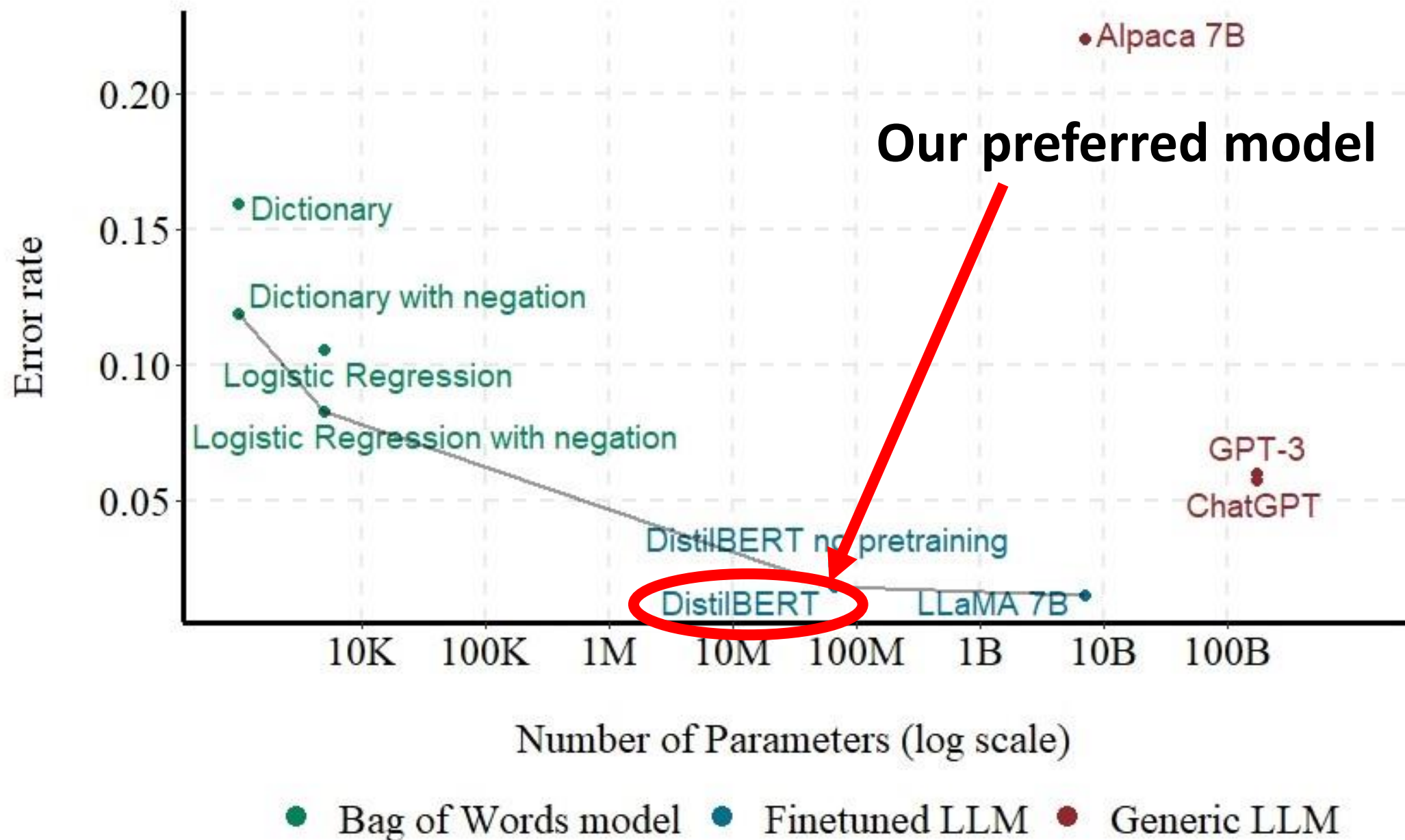
Trainable models are fit on 17,850 human labels.

All models evaluated with test-set error rate computed on 4,050 sequences (majority rule generates true label).

Trade-off in model choice



Trade-off in model choice



Training Sample Size

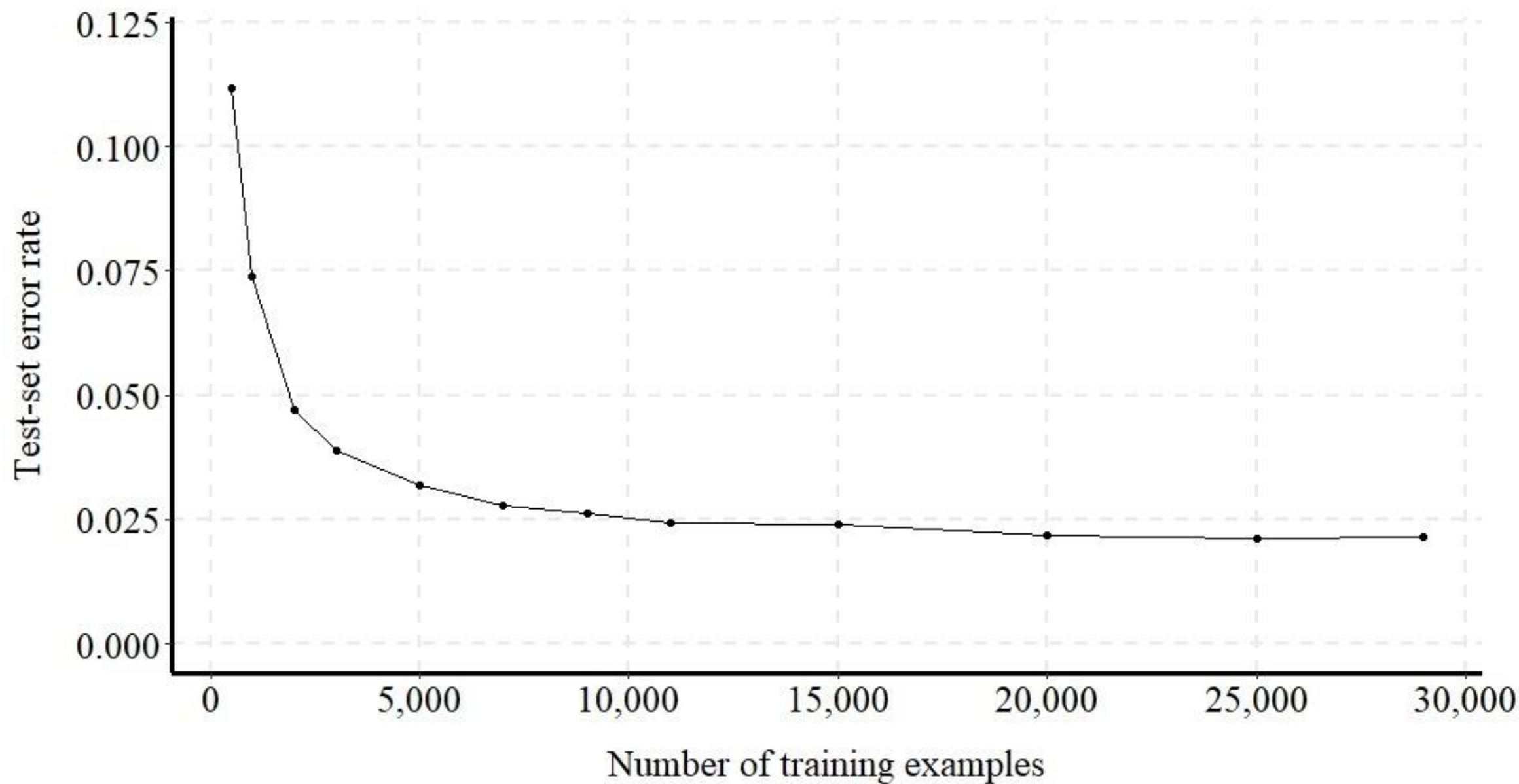
Shapiro et. al. (2022) finds limited gains to BERT beyond negated dictionaries for predicting the sentiment of news articles

However, the sentiment training sample is smaller than 1,000

How big a training sample does DistilBERT require to achieve good performance?

We repeat test-set error evaluation for random draws of varying sizes from our training data

Evolution of test-set error rate in training sample size



How do Large Language Models Work?

Imagine guessing the masked word in the following sentences:

As a leading firm in the [MASK] sector, we hire highly skilled software engineers

As a leading firm in the [MASK] sector, we hire highly skilled petroleum engineers

Humans naturally use appropriate context to make guesses

How do Large Language Models Work?

Imagine guessing the masked word in the following sentences:

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Humans naturally use appropriate context to make guesses

How to incorporate context into a language model?

Attention Operation

In a language model, [MASK] is represented by an *embedding* vector ρ passed to a multinomial logistic regression to make a word prediction.

Let $n = 1, \dots, N$ index a sequence of words and let ρ_n^0 be an initial vector representation of word n .

In models with attention, the embedding for [MASK] is formed as

$$\rho = \sum_n \alpha_n \rho_n^0 \text{ where } \sum_n \alpha_n = 1$$

The weights α_n are adjusted to correctly predict the masked word.

In fine-tuning, one replaces generic language prediction tasks with more tailored tasks, e.g. predicting human labels.

Overall Classification Approach

Segment each job posting into sequences of roughly uniform size

Classify each sequence a 0 or 1 using fine-tuned DistilBERT

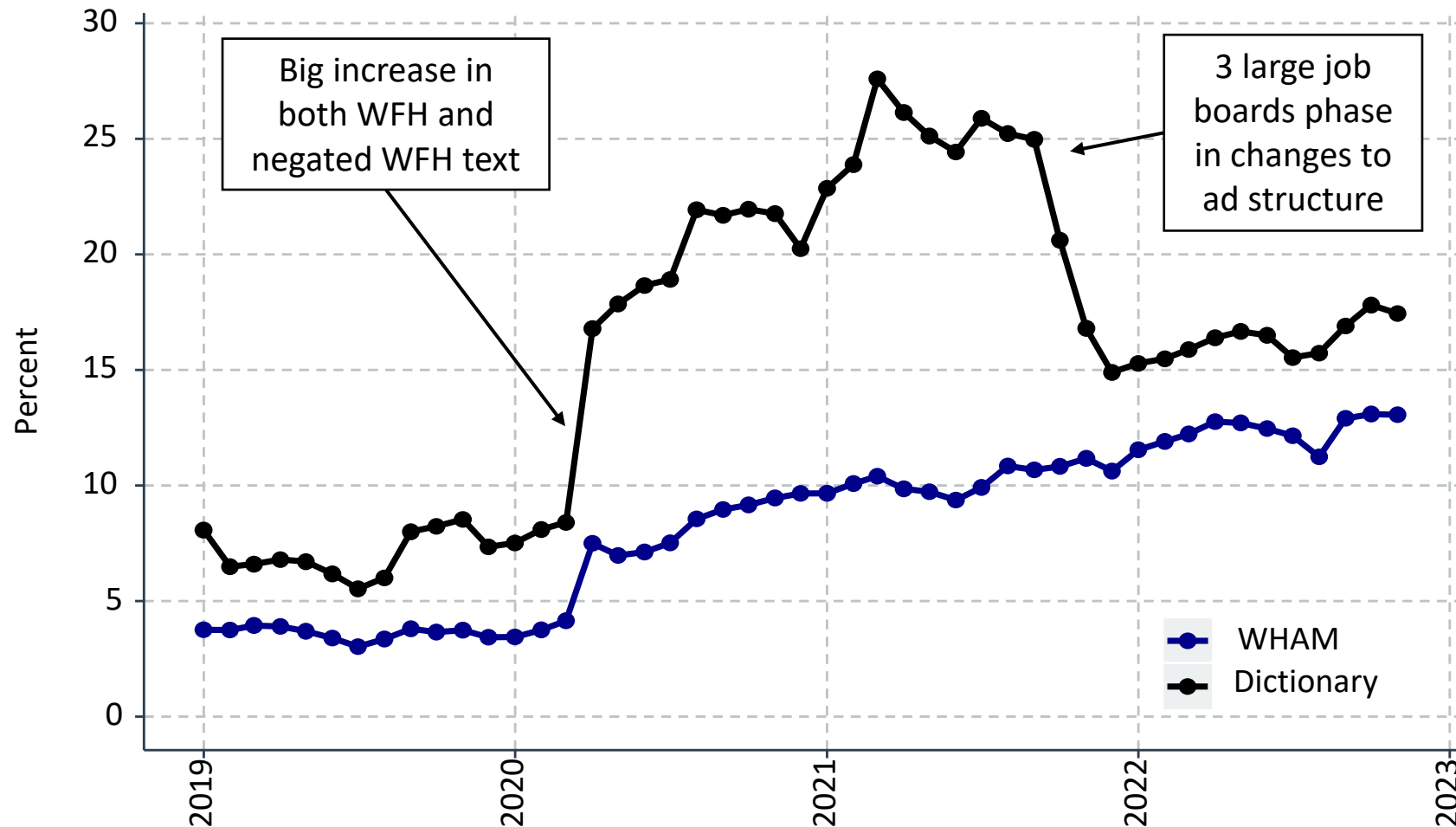
Classify overall posting according to maximum classification

Demo at <https://huggingface.co/spaces/yabramuvdi/wfh-app-v2>

Result is a **flow** measure that captures firms' **willingness to commit** to remote work, which can differ from stock of remote workers

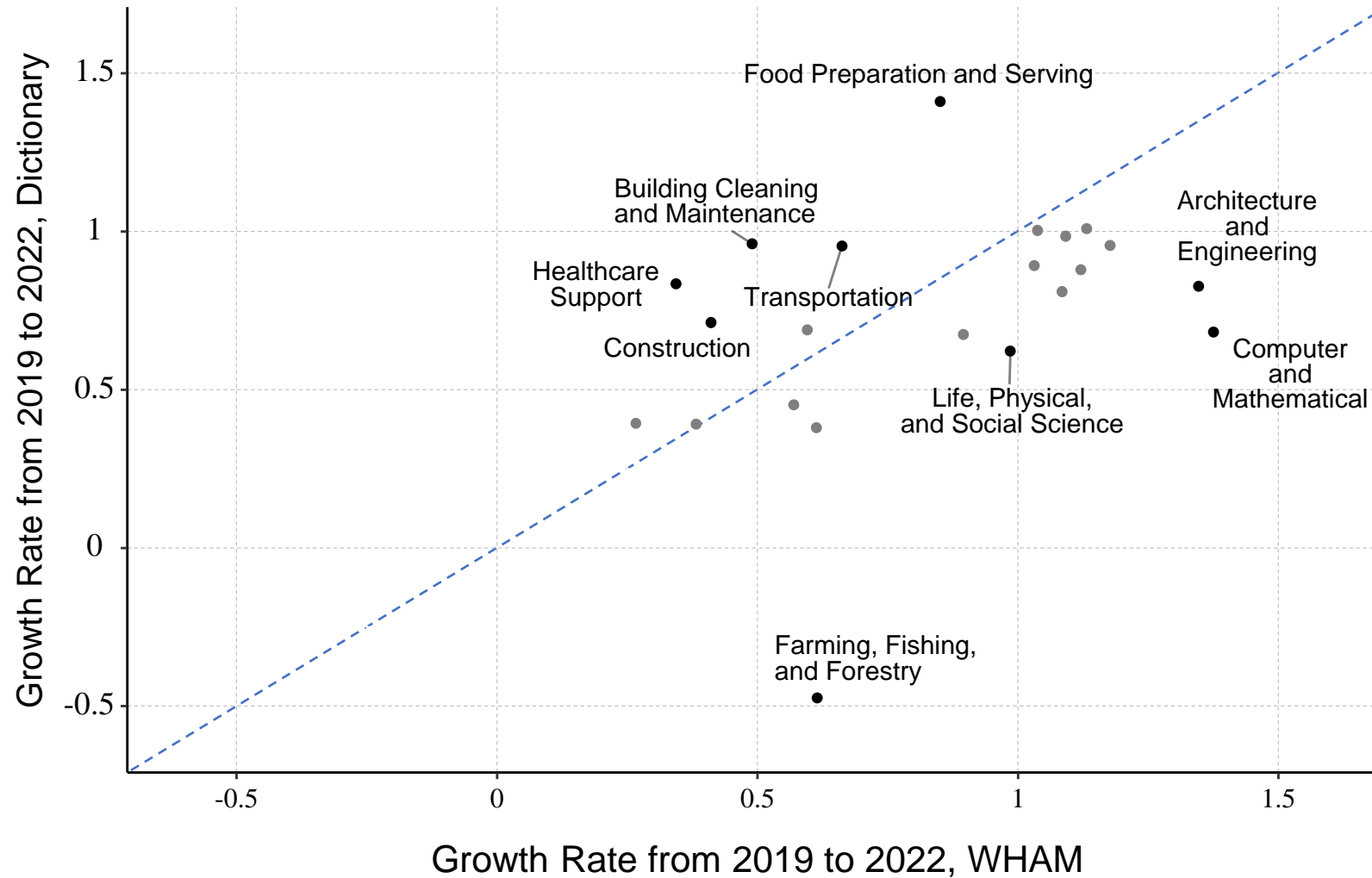
Figure: WHAM and Dictionary Methods Applied to U.S. Vacancy Postings

Postings Classified as Job Allows Hybrid or Fully Remote Work



Note: This figure shows the percent of postings that say the job allows one or more remote workdays per week, as classified by WHAM (blue) and a dictionary-based approach (black) using the keywords in Adrjan et al. (2021). For both methods, we reweight the data to match the U.S. occupational distribution of vacancies in 2019 at the six-digit SOC level.

Figure: Share of U.S. Postings that Allow Some Remote Work, Growth Rate by Two-Digit Occupations, WHAM Compared to Dictionary Method

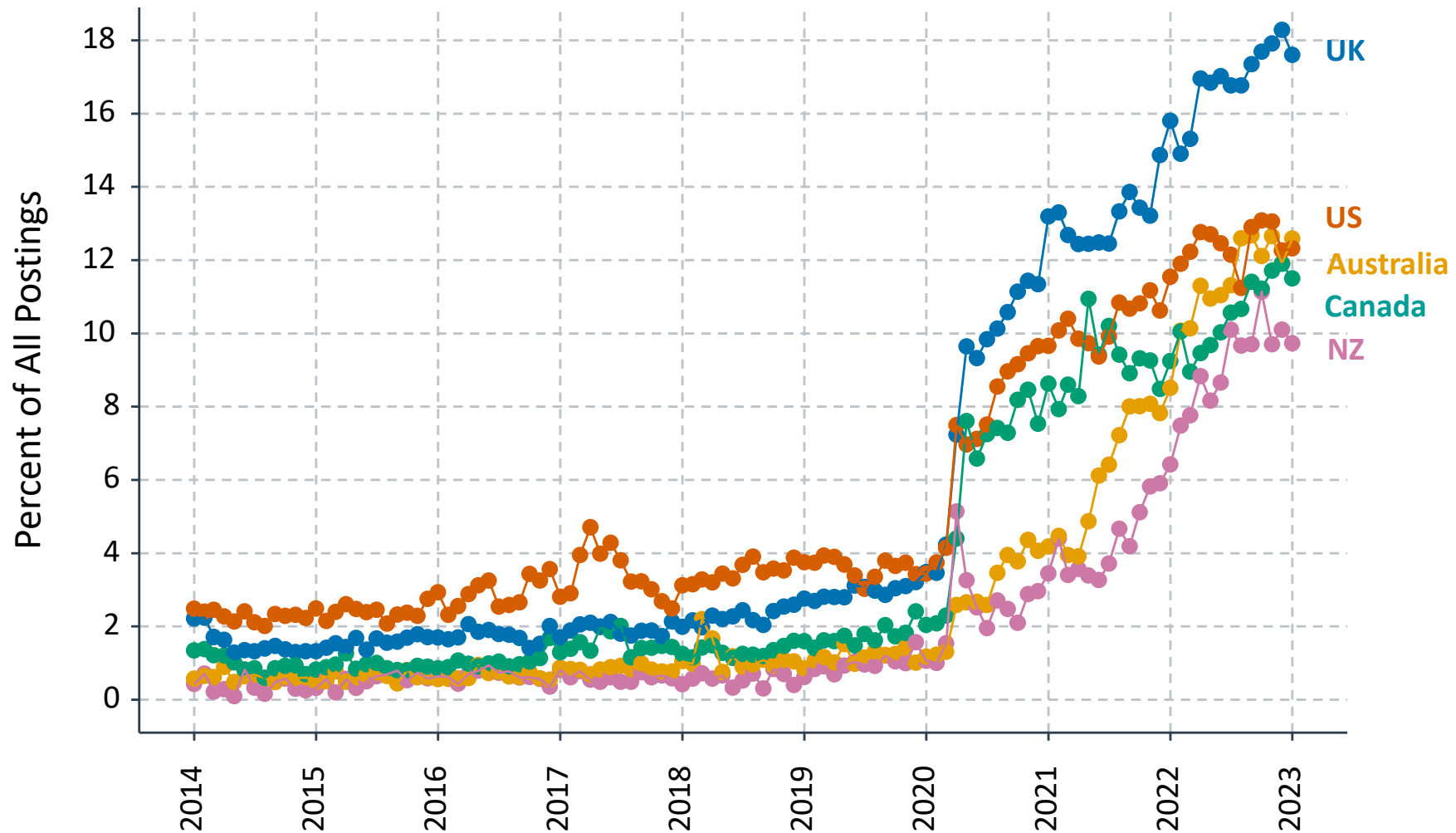


Note: We sort postings into Standard Occupational Classifications (SOC) at the two-digit level and calculate the share of postings that say the job allows for one or more days per week of remote work in 2019 and 2022. We then calculate the DHS growth rate from 2019 to 2022 as $(X_{2022} - X_{2019}) / 0.5 * (X_{2019} + X_{2022})$. For the dictionary method, we use the keywords in Adrjan et al. (2021). The blue-dashed line shows a 45 degree line.

Plan of Talk

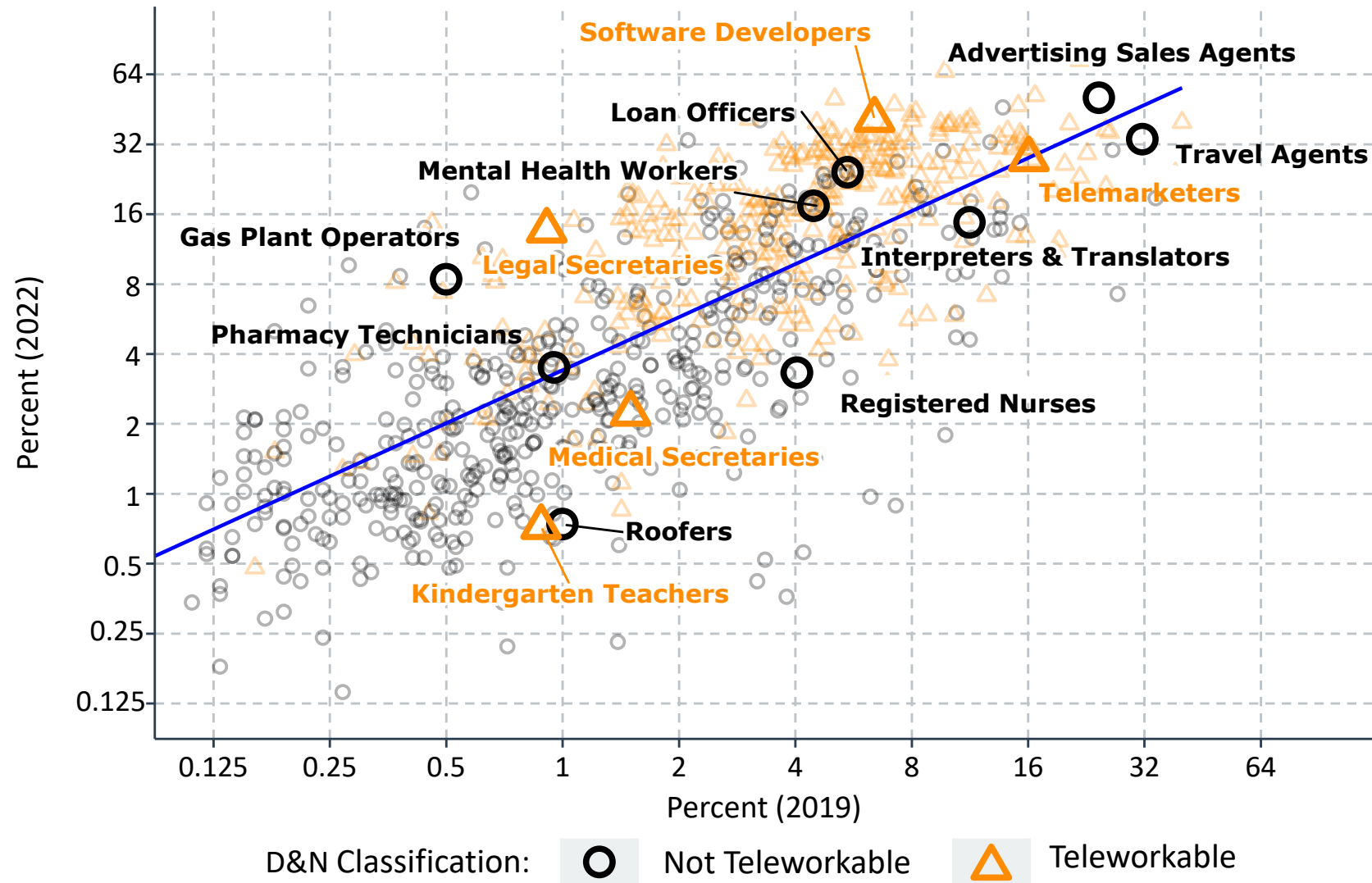
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Figure: Vacancy Postings that Explicitly Offer Hybrid or Fully Remote Work Rose Sharply in All Five Countries from 2020



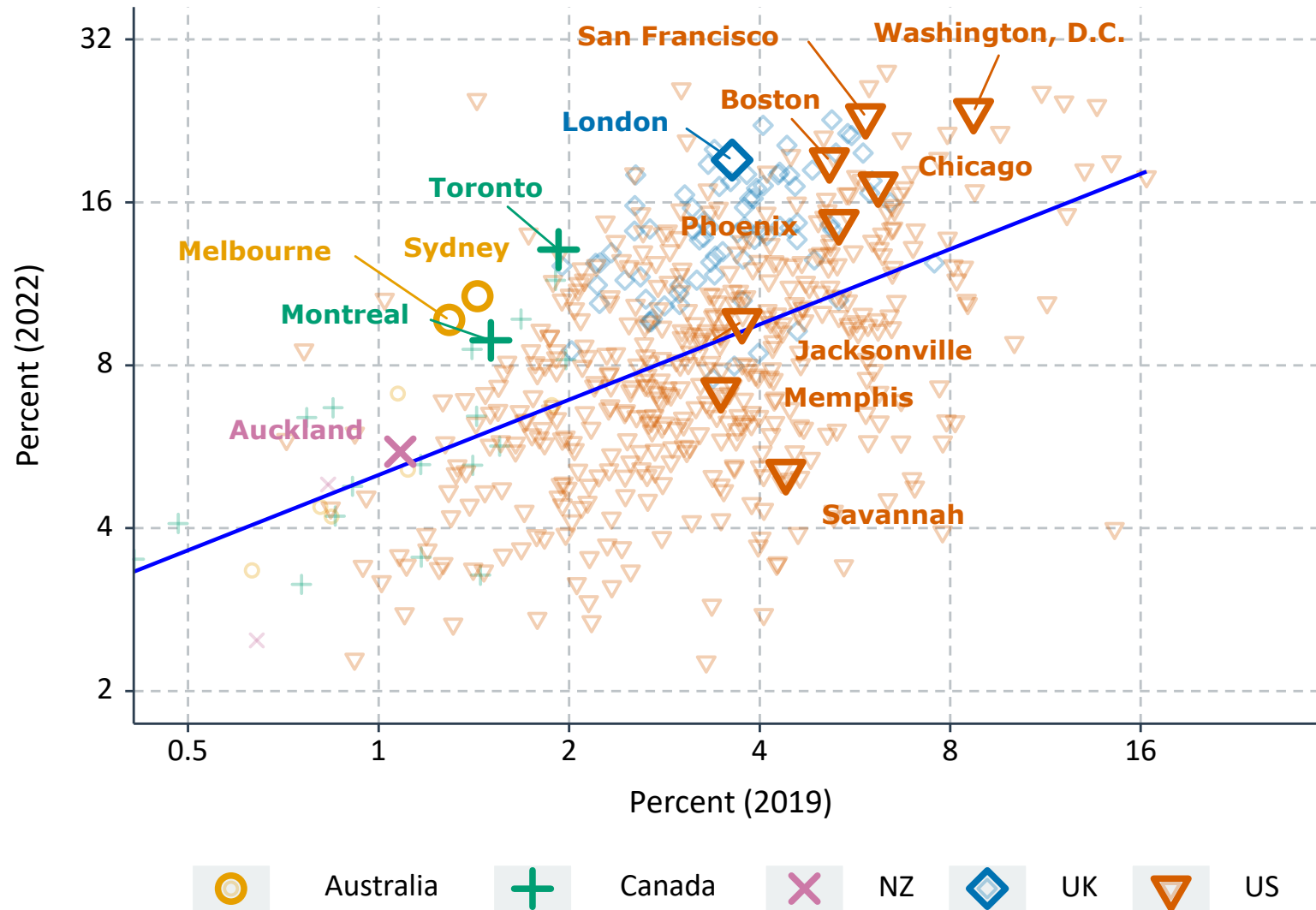
Note: This figure shows the percent of vacancy postings that say the job allows one or more remote workdays per week, encompassing both hybrid and fully-remote working arrangements). We compute these monthly, country-level shares as the weighted mean of the own-country occupation-level shares, with weights given by the U.S. vacancy distribution in 2019. Our occupation-level granularity is roughly equivalent to six-digit SOC codes. See Appendix B for the corresponding raw series and series based on alternative weighting schemes.

Figure: The Share of Vacancy Postings that Explicitly Offer Hybrid or Fully Remote Work Rose in Almost Every Occupation, U.S. Data



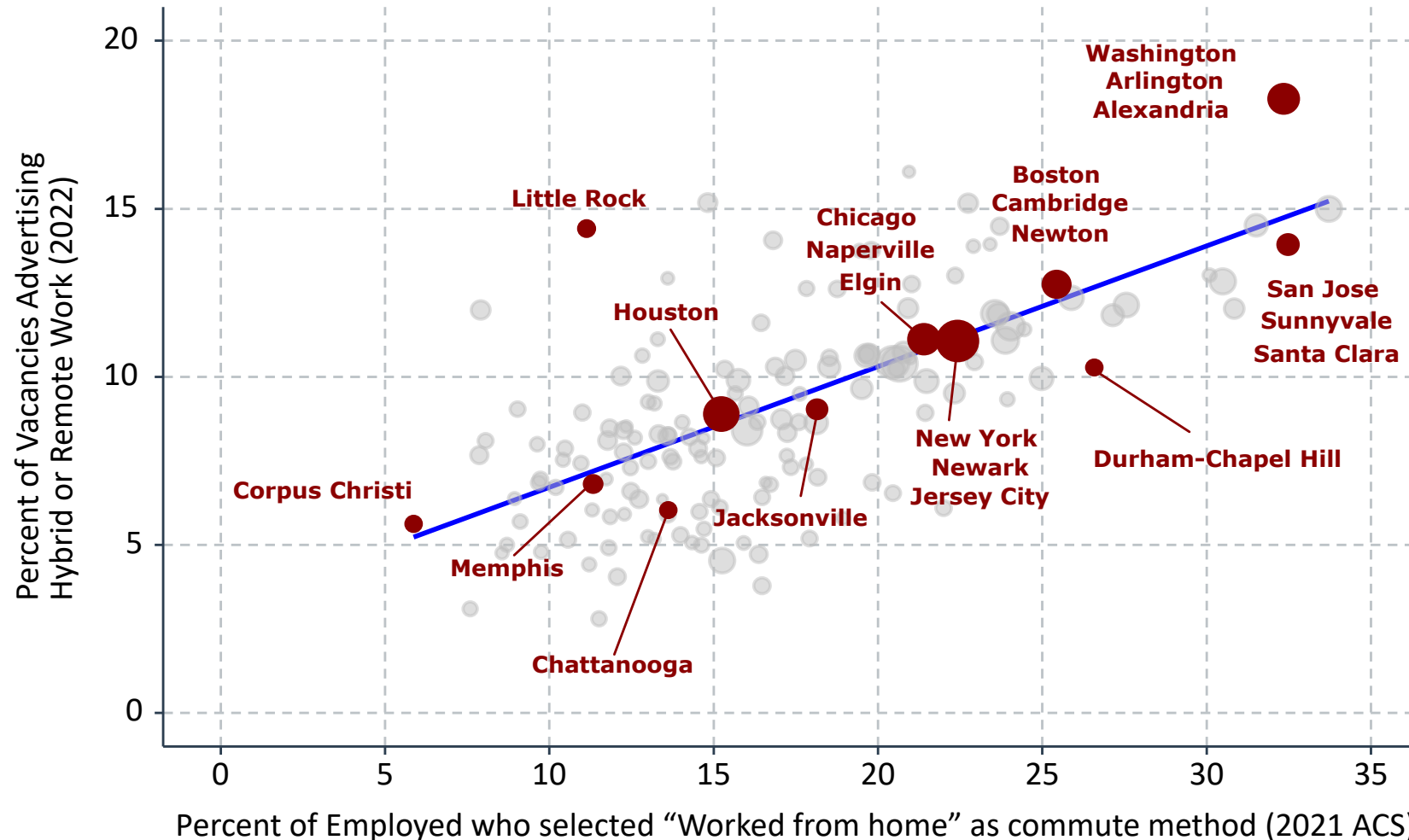
Note: This figure plots the percent of postings that say the job allows one or more remote workdays per week for 875 occupations in 2019 and 2022. We define occupations by ONET codes, dropping those with fewer than 250 posting in 2019. The line shows the unweighted OLS fit: $\log(y) = 1.22 + 0.76 \log(x)$, which has an R^2 value of 0.63. The color and shape denote whether Dingle & Neiman (2020) classify the occupation as feasible for fully remote working.

Figure: The Share of Vacancy Postings that Explicitly Offer Hybrid or Fully Remote Work Grew at Different Rates across Cities since the Pandemic



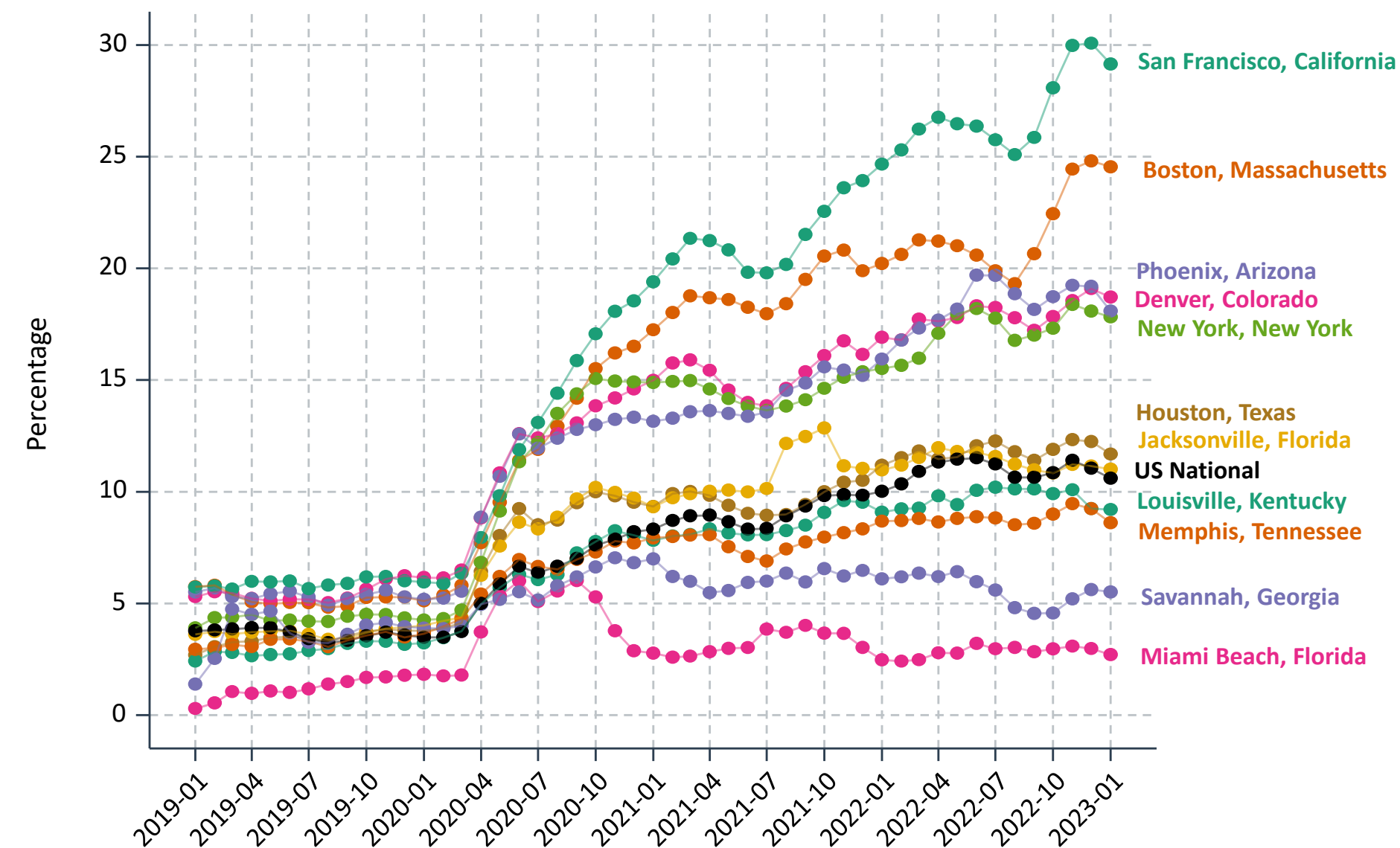
Note: This figure plots the city-level percent of postings that say the job allows one or more remote workdays per week in 2019 and 2022. “City” refers to the location of the establishment or firm that is hiring. The line shows the unweighted OLS fit: $\log(y) = 1.61 + 0.46 \log(x)$, which has an R^2 value of 0.28.

Figure: Share of Vacancy Postings Offering Hybrid or Fully Remote Work Compared to Share of Employed that Designate “Worked from home” as commute method, U.S. Metropolitan Statistical Areas



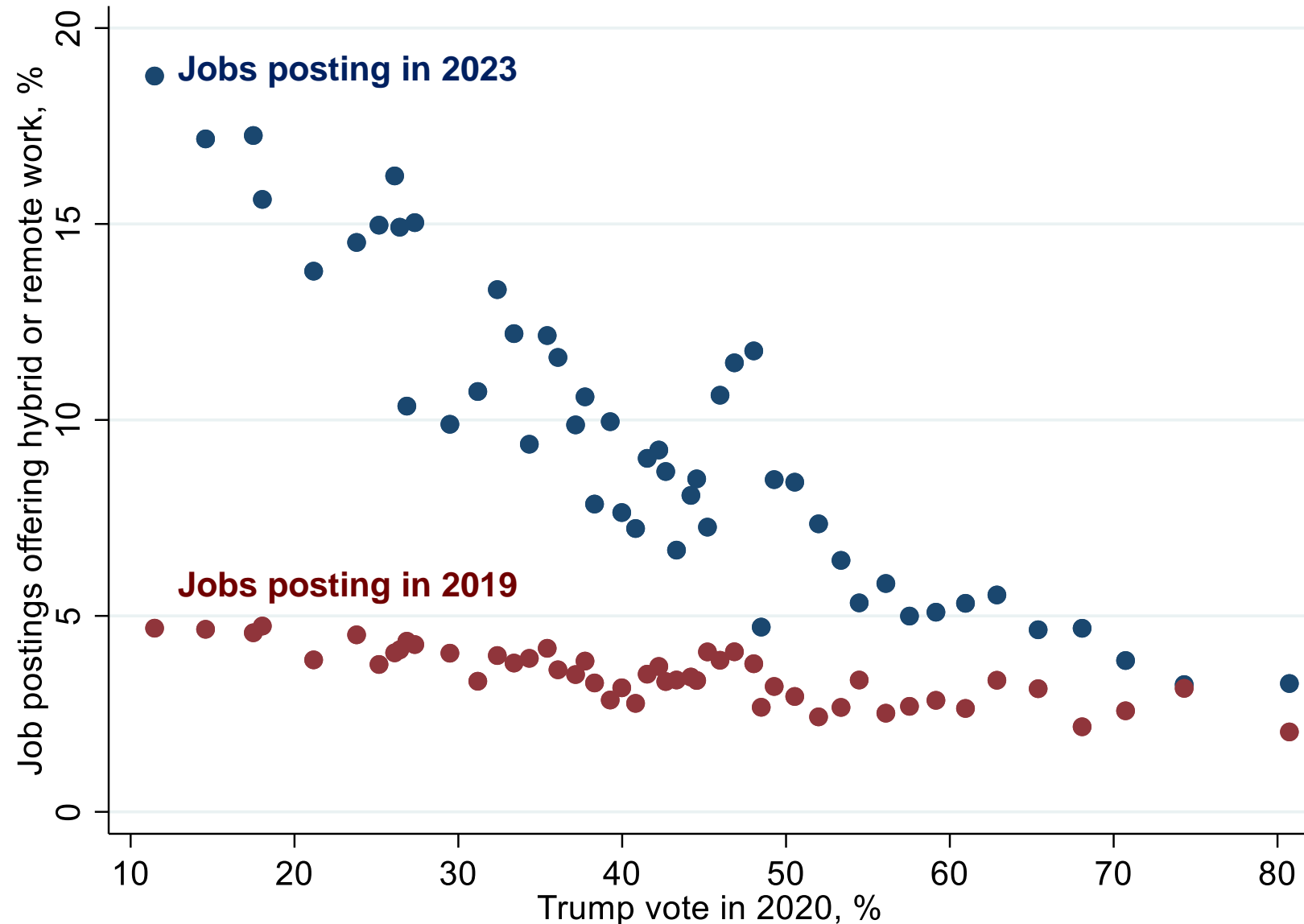
Note: The vertical scale is the percent of postings in 2022 that say the job allows one or more remote workdays per week (i.e. both hybrid and fully-remote). The horizontal scale is the percent of employees who select “Worked from home” as their commute method in 2021 in the American Communities Survey (ACS). ACS respondents are instructed to “Mark (X) ONE box for the method of transportation used for most of the distance,” which suggests that only those who work in a fully-remote capacity should select this box. (Persons with 1+ days of commute per week have more mileage from that commute mode.) The line shows the unweighted OLS fit: $\log(y) = 3.12 + 0.36 \log(x)$, which has an R^2 value of 0.55. The regression includes one observation that is outside the plotted axes.

Figure: Share of Postings Offering Hybrid or Fully Remote Work vary across US cities



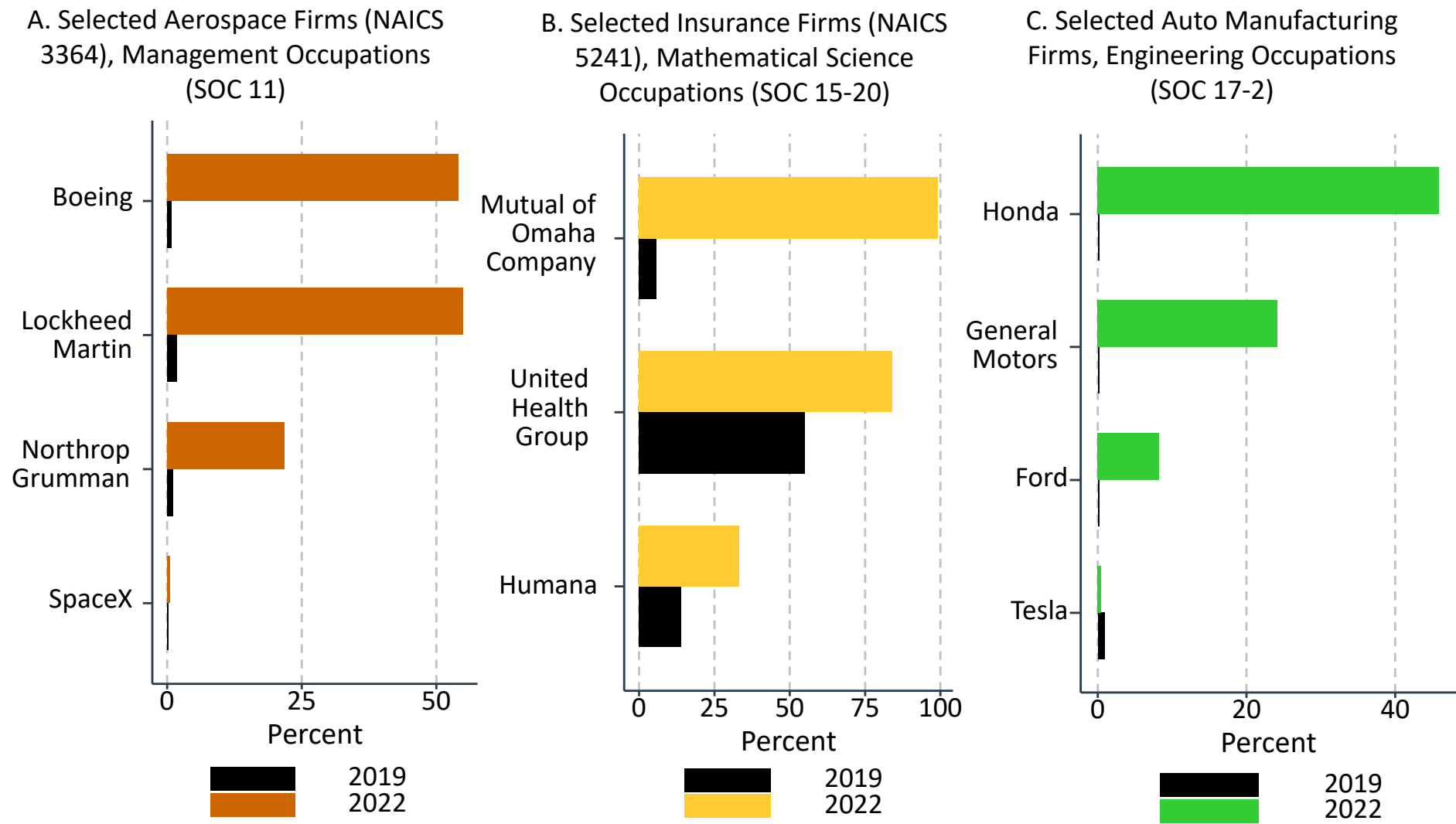
Note: We calculate the monthly share of all new job vacancy postings which explicitly advertise remote working arrangements (i.e. both hybrid and fully-remote), by selected cities. Prior to aggregation at the monthly level, we employ a jackknife filter to remove a small number of outlier days (see Appendix A: Data for further details). This figure shows the 3-month moving average. Cities chosen above are selected examples to illustrate the wide cross-city spread.

WFH grew most post-pandemic in non-Trump voting parts of the US



Notes: US county level binscatter of share of vacancy postings offering a job that allows 1+ days remote working per week vs Trump 2020 Presidential Vote Share. Weighting by county size. 50 bins. Source www.wfhmap.com

Figure: The Prevalence of Postings that Allow Hybrid or Fully-Remote Work Varies Greatly, even among Same-Industry Firms Recruiting in the Same Occupational Category



Note: For each firm, year and indicated occupation, we report the percent of U.S. postings that say the job allows one or more remote workdays per week.

Conclusion

We use an enormous corpus of job postings from Lightcast to measure remote work adoption in great detail

We evaluate the performance of a variety of language models for measuring remote work adoption from job posting text

We choose LLM that strikes balance between accuracy and complexity

Size of training data important to obtain accurate model

Initial stylized facts with much more work to be done on drivers of firm-level adoption choices

Data

We **encourage other researchers** and interested parties to explore our dataset, and utilise it in their own work.

Please **cite our working paper** when using these data: ***“Remote Work across Jobs, Companies, and Space” (Hansen, Lambert, Bloom, Davis, Sadun & Taska, 2023).***

Data Categories

Category A: **Readily Available!**

- Monthly country-level statistics for United States, United Kingdom, Australia, Canada, and New Zealand
- Monthly occupation-level statistics (2-digit US SOC) for the United States

Download here

Category B: **Readily Available (with sign-up)**

- Monthly Industry-level statistics (NAICS 2-digit sector) for the United States
- Monthly occupation-level statistics (2-digit US SOC) for the United States
- **NEW!** Monthly city-level statistics (for **150+** cities) for the United States
- **NEW!** Monthly city-level statistics (for **40+** cities) for the United Kingdom

Sign-up to access these data.