

# Career Concerns As Public Good

## The Role of Signaling for Open Source Software Development

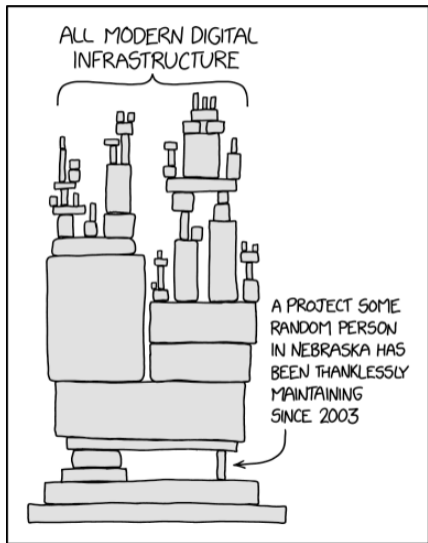
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# Motivation



- open source software (OSS) is a valuable public good
  - 96% of software codebases contain OSS (Synopsys, 2023)
  - equiv. 7.2% of software investment (USD37bn/yr) (Korkmaz et al., 2024)
- decentralized community of volunteer developers
- motivation to contribute hard to rationalize
- ▶ **Are OSS developers motivated by labor market signaling incentives?**

Source: CC-BY-NC 2.5 [xkcd.com/2347](https://xkcd.com/2347)

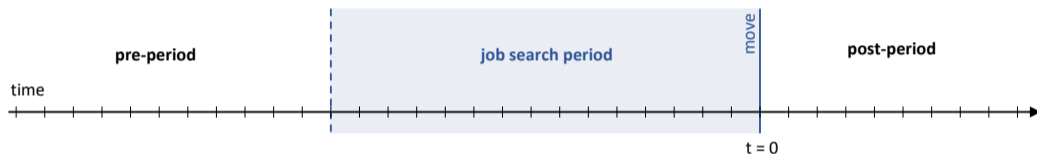
## Related literature

- Lerner and Tirole (2002) already theorized signaling could be a motivation of OSS contributors
  - subsequent literature almost exclusively relies on surveys (i.e., stated preferences approach)
    - e.g., von Krogh et al. (2012); Krishnamurthy (2006); Hars and Ou (2002); Hertel et al. (2003); Stewart and Gosain (2006); Lakhani and Wolf (2003); Hann et al. (2004); Gerosa et al. (2021)
  - in a theory model, Leppämäki and Mustonen (2009) highlight the role of signaling for positive externalities through public good generation
- ▶ **So far, no causal evidence of signaling channel in OSS software production.**
- Notably, Xu et al. (2020) show career concerns/labor market signaling drives a significant portion of reputation-generating activity on an online Q&A forum.

# Empirical approach

## Difference-in-differences

- look at **job changers** and their activity in the **job search period**
- compare **job movers** versus **other movers**



## Event study specification

$$y_{it} = \beta_1 + \sum_{j=\underline{T}}^{\bar{T}} \left[ \beta_j (t_j \times \text{JobChanger}_i) \right] + \delta_i + \delta_{s(t)} + \delta_{a(i)t} + e_{it}$$

$y_{i,t}$  number of user  $i$ 's commits in month  $t$  (IHS)

$\delta_i$  user fixed effects

$\delta_{s(t)}$  month fixed effects

$\delta_{a(i)t}$  user experience fixed effects

$e_{it}$  error term

## Data: sample

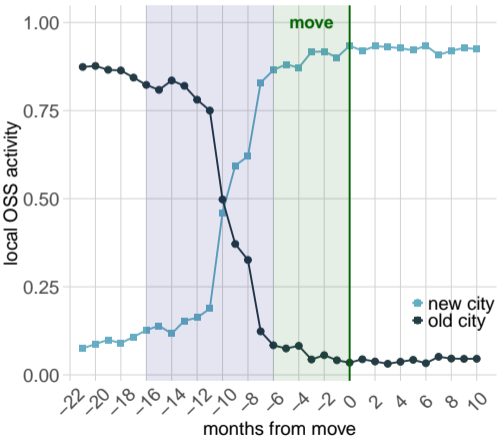
- use data from the **largest online coding platform** GitHub
  - GHTorrent data captures public activity of 44.1M users globally from 2015-2021
  - **user profiles**: location, affiliation
  - **activity stream**: commits, project characteristics
  - **community metrics**: stars, forks
- 22,896 movers, thereof 7,211 (32%) job changers
- **comprehensive** set of users, not only most active (Vidoni, 2022)

## Data: summary statistics

Medians	job	other	$\Delta$	$\% \Delta$
<b>Activity</b>				
Commits	163	188	-25	13.3%
<i>commits single projects</i>	72	76	-4	5.3%
<i>commits team projects</i>	59	80	-21	26.3%
Experience	37	42	-5	11.9%
<b>Collaboration</b>				
Projects	14	16	-2	12.5%
<i>single projects</i>	9	9	0	0.0%
<i>team projects</i>	5	6	-1	16.7%
Project members	2.21	2.82	-0.61	21.6%
<b>Quality</b>				
Followers	5	5	0	0.0%
Stars	1.10	1.88	-0.78	41.5%
Forks	0.62	1.11	-0.49	44.1%

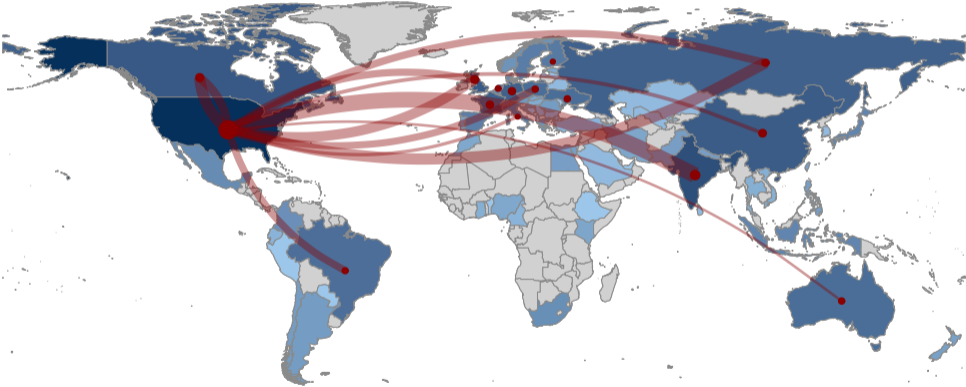
# Data: move dynamics

- users gradually start collaborating with destination city



# Data: movers

- domestic (blue, 71%) and international (red) movers





# Results: signaling activity



## Results: difference-in-differences

IHS(single commits)	(1)	(2)	(3)
Job mover $\times$ job search	0.2595*** (0.0088)	0.2230*** (0.0093)	0.1177*** (0.0091)
Job mover $\times$ post move	-0.2154*** (0.0120)	-0.1738*** (0.0131)	-0.0813*** (0.0123)
User FE	$\times$	$\times$	$\times$
Month FE		$\times$	$\times$
Experience FE			$\times$
Adjusted R <sup>2</sup>	0.139	0.154	0.217
Observations	1,717,200	1,717,200	1,717,200
Users	22,896	22,896	22,896

► back-of-the-envelope calculation  $\rightarrow \approx$  **4.9% of overall OSS production**

# Results: community use-value

- signaling projects focus less on (direct) community use-value (stars, forks)



## Results: labor market orientation

- signaling activity concentrates on **labor market value** and **external visibility**
  - **higher-valued** programming languages (StackOverflow Top Paying Technologies)
  - in **web development** and **data engineering**, not routing or low-level programming
  - keywords for **coding** and **(personal) website**, not education/coursework
- users' signaling activity
  - higher for **international/-continental** movers
  - higher when moving to **academia**
  - lower when moving to **big tech**

- career concerns have **positive externalities** on OSS, a valuable public good
- **direction of OSS development** driven by signaling is different
  - focused more on labor market value and
  - less on direct community use-value
- results suggest signaling through OSS is higher for developers
  - with weaker credentials (international movers) and
  - close to communities that value openness (academia)

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# Thanks,

what are your questions?



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