

What Makes Geeks Tick? A Study of Stack Overflow Careers

Lei Xu¹ Tingting Nian² Luis Cabral³

¹TSE

²UC Irvine

²NYU Stern

Online Platforms & Voluntary Contribution



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Research Question

- **What motivates private contributions to a public good?**
 - Altruism
 - Ego gratification: peer recognition
 - **Career concerns: job offers, access to venture capital**
- Result: achieving goal (new job) implies 24% drop in online activity, 16% of which related to career concerns

Why Care?

- Economists: Altruism?
- Platforms: How to motivate user participation?
 - Many fail due to insufficient user participation
 - Motivations not well understood, esp with voluntary contribution
 - Career incentives can help
- Job Market Signaling: online activity
 - Asymmetric Information
 - New Signaling Channel
 - High Quality Signals

Literature

Theory

Career Concerns: Holmstrom (1982), followed by large literature

Career Concerns + OSS: Lerner and Tirole (2001,2002,2005), von Krogh & von Hippel (2006), von Krogh et al. (2012), Roberts et al. (2006), Blatter & Niedermayer (2008), Spiegel (2009), Mehra et al. (2011)

Empirics

Career Concerns: Chevalier & Ellison (1999)

Online Voluntary Contribution: OSS

Bitzera & Geishecker (2010), Lakhani & von Hippel (2003), Bitzer & Geishecker (2010), Marlow & Dabbish (2013), Hann, Roberts & Slaughter (2013)

Online Voluntary Contribution: Others

Zhang & Zhu (2011) on Wikipedia, Paul, Hong & Chi (2012) on Quora

- 1 Introduction & Motivation
- 2 Literature
- 3 Screenshot Tour of Stack Overflow (SO) and Stack Overflow Careers (SOC)
- 4 Theoretical Model
- 5 Data & Empirical Results
- 6 Robustness Checks: Common-Trend Assumption
 - Integer Constraints
 - Skills Mismatch
 - Dynamic Selection Effects (Ashenfelter's Dip (AD))
- 7 More Results
- 8 Implications & Concluding Remarks

Stack Overflow (SO)

- Largest Q&A website for programmers
- Founded in 2008
- 4m users; 8m visits/day; 8k questions/day;
9m cumulative questions, 15m Answers
- Main Activities: Questions, Answers, Votes, Edits
- Reputation System

5

votes

3

answers

437

views

5

votes

3

answers

11k views

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votes

5

answers

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5

votes

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answers

1k views

RegEx for distance in metric system

I want a RegEx to match distance values in metric system. This regex should match 12m, 100cm,1km ignoring white space

[regex](#) [distance](#)

asked Sep 27 '09 at 10:25


Raytheon

87 • 4

5

votes

How to calculate Euclidean length of a matrix without loops?

It seems like the answer to this should be simple, but I am stumped. I have a matrix of Nx3 matrix where there 1st 2nd and 3rd columns are the X Y and Z coordinates of the nth item. I want to ...

[matlab](#) [distance](#) [norm](#) [euclidean-distance](#) [vectorization](#)

asked Mar 17 '11 at 16:56


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Python - how to speed up calculation of distances between cities

I have 55249 cities in my database. Every single one has got latitude longitude values. For every city I want to calculate distances to every other city and store those that are no further than 30km. ...

[python](#) [django](#) [algorithm](#) [distance](#)

asked Dec 18 '13 at 10:00


pythonishvili

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votes

Efficient way to calculate distance matrix given latitude and longitude data in Python

I have data for latitude and longitude, and I need to calculate distance matrix between two arrays containing locations. I used this [This](#) to get distance between two locations given latitude and ...

[python](#) [numpy](#) [scipy](#) [distance](#)

asked Oct 16 '13 at 20:31


Akavall

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edited Sep 27 '09 at 17:06



SilentGhost

91.8k ● 22 ● 175 ● 217

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3 Answers

active

oldest

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And to extend Paul's answer to include decimal place values...

7

`(\d+).?(\d*)\s*(m|cm|km)`

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answered Sep 27 '09 at 10:35



Nick Larsen ♦

10.6k ● 4 ● 29 ● 69

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Paul Dixon Sep 27 '09 at 10:39

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▼ 2 edited body

source link



inline



side-by-side



side-by-side markdown

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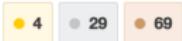
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c#	●	SCORE 145	POSTS 99	javascript	●	SCORE 67	POSTS 25	linq	●	SCORE 60	POSTS 27

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Stack Overflow Careers (SOC)

- Matching programmers on SO with jobs
- Programmers join by invitation only and create profiles
- Employers pay fee, search by location, skills, etc

Keywords

Location

 Job Title, Keyword, or Company City, Country or Zip CodeSearch

1283 jobs

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Norcross, GA, United States

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March 2009 - December 2010

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Computer Science - Databases and Knowledge Systems, Georgia State

University

2001 - 2008

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🌟 [LINQ union with optional null second parameter](#)

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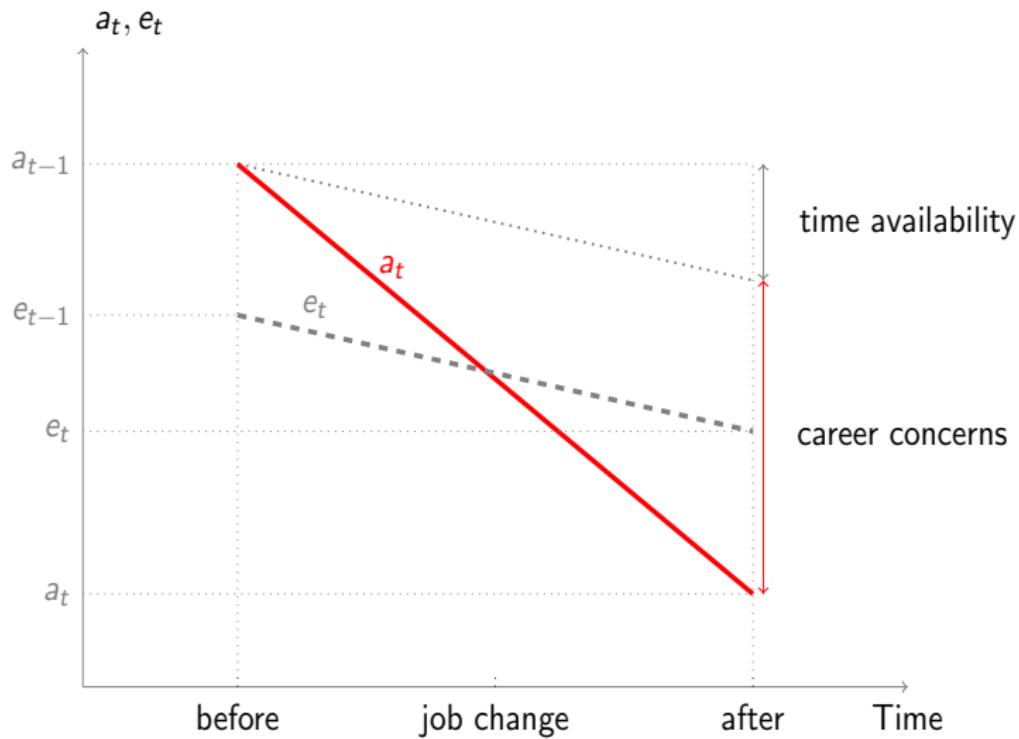
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Identification: Difference-in-Differences

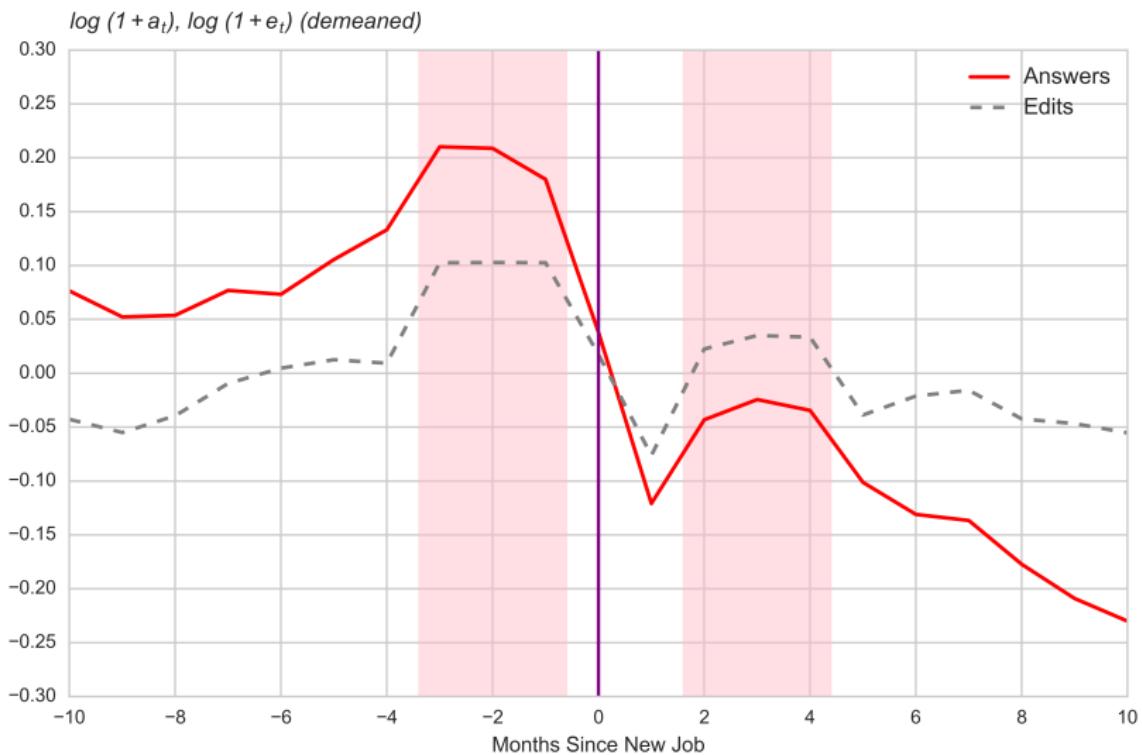


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Data

- Location: US & Canada (50k users)
- Exclude SOC users with no link to SO
- Exclude users who did not switch jobs
- Exclude if two switches within 6 months
- Exclude users with $a_t = 0$ or $e_t = 0$ for all 8-month period around job switch
- Result: about 1301 users with 1520 job switches

Plot of Mean Logged Activity



Diff-in-Diff Specification

$$y_{ijt} = \alpha_{ij} + \beta S_{it} + \gamma J_j S_{it} + \lambda_{jt} + X_{ijt} \theta + \epsilon_{ijt}$$

where:

λ_{jt} : Seasonality: year and month dummies

X_{ijt} : Duration Effects: dummies of # months on SO

α_{ij} : individual FE for Answers and Edits

D_{it} : dummy for the 1520 job changes and periods used in DD analysis

$S_{it}=1$ if new job, 0 if old job

$J_j=1$ if $j = a$, 0 if $j = e$

Diff-in-Diff Estimates

	Panel A: $y \in \{\text{Answers}, \text{Edits}\}$		Panel B: $y \in \{\text{Votes}, \text{Edits}\}$	
	(1)	(2)	(3)	(4)
$NewJob (S)$	-0.080*** (0.02)	-0.082*** (0.02)	-0.080*** (0.02)	-0.082*** (0.02)
$NewJob (S) \times Answer / Vote (J)$	-0.165*** (0.02)	-0.124*** (0.03)	-0.179*** (0.03)	-0.136*** (0.04)
Seasonality Dummy		x		x
Duration Dummy		x		x
# Users for Trend Control	-	96k	-	96k
R^2	0.001	0.031	0.001	0.026

Panel A: all activity data of 1301 users as controls

Panel B: uses a sample of 60k users from SO as controls

Number of contributors for DD analysis: 1301; Number of job switches: 1520.

Robust standard errors in parentheses, clustered at the level of the individual-activity type level.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Month-to-Month Comparison

$$y_{it} = \alpha_i + \sum_{\tau=-20}^{20} \beta_\tau \mathbb{1}(P_{it} = \tau) + \lambda_t + X_{it} \theta + \epsilon_{it}$$

where:

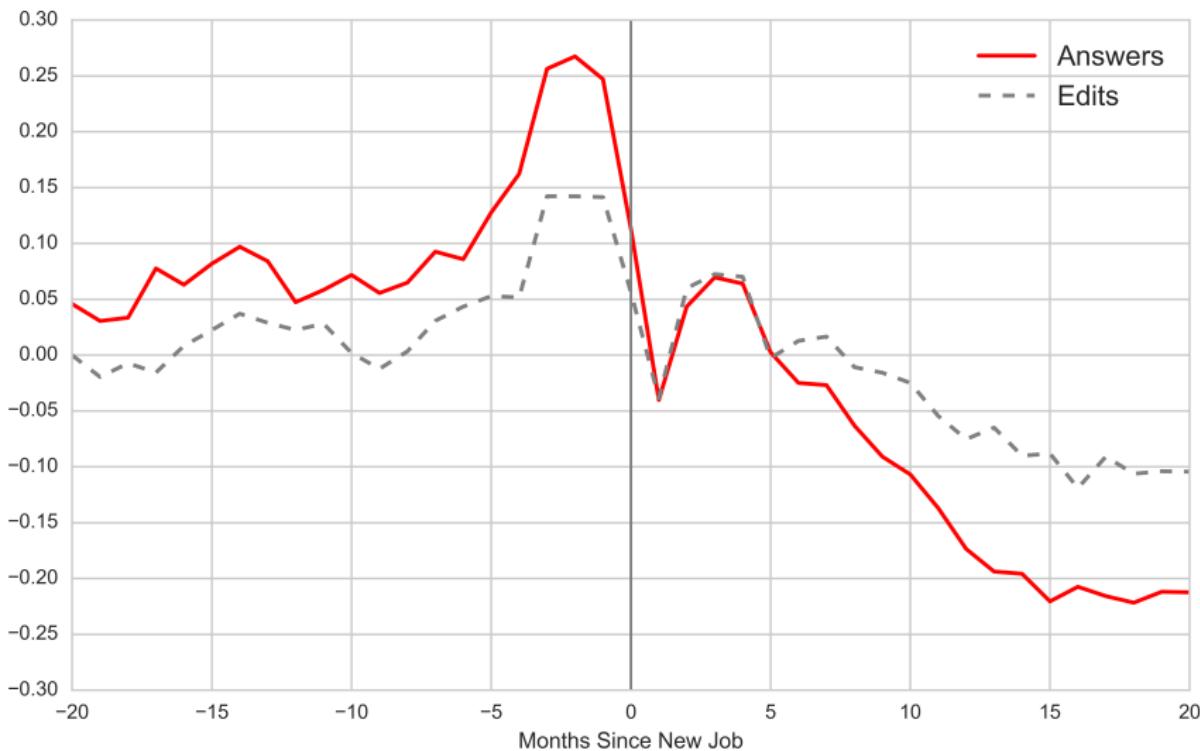
α_i : individual FE

$\mathbb{1}(P_{it} = \tau)$: dummy for time period (relative to job switch)

λ_t : Seasonality: year and month dummies

X_{it} : Duration Effects: dummies of # months on SO

Plotting of Demeaned $\hat{\beta}_T$



Month-to-Month Comparison (DD)

$$y_{ijt} = \alpha_{ij} + \sum_{\tau=-20}^{20} (\beta_\tau \mathbb{1}(P_{it} = \tau) + \gamma_\tau J_j \mathbb{1}(P_{it} = \tau)) + \lambda_{jt} + X_{ijt} \theta + \epsilon_{ijt}$$

where:

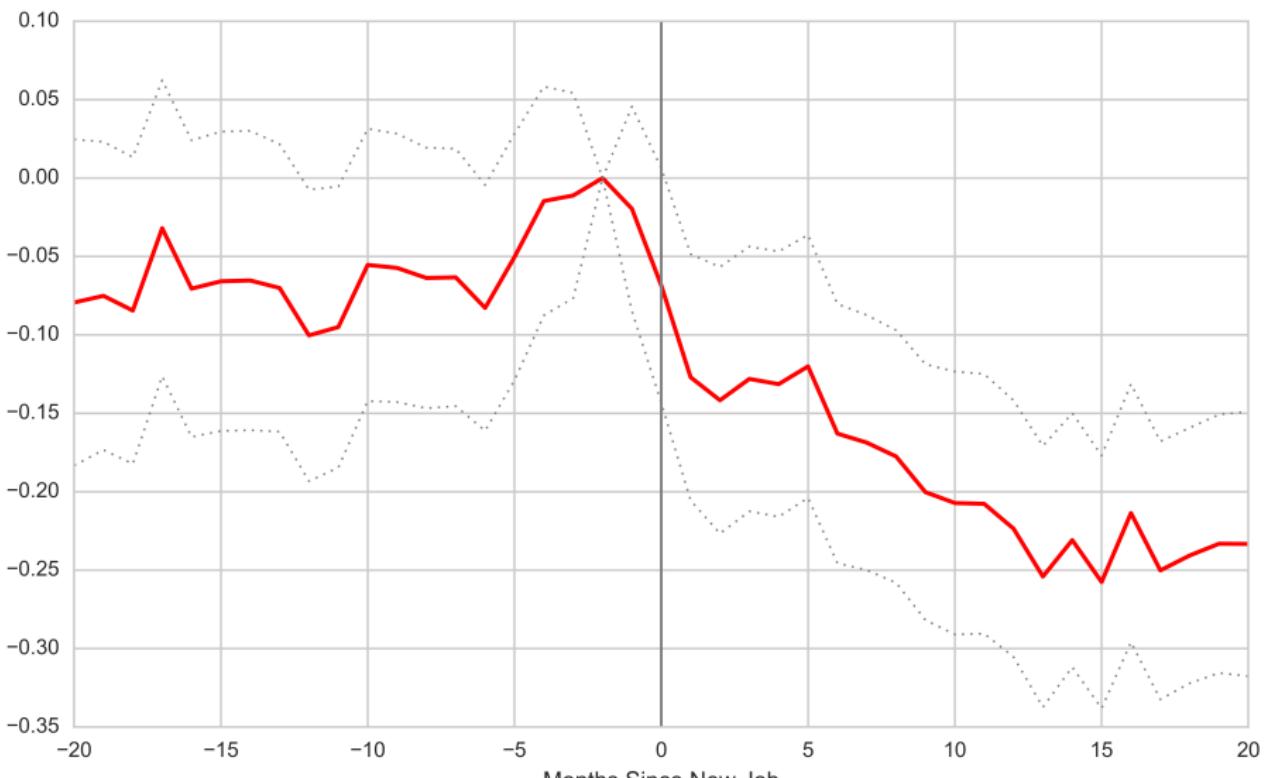
α_{ij} : individual FE for Answers and Edits

$\mathbb{1}(P_{it} = \tau)$: dummy for time period (relative to job switch)

λ_{jt} : Seasonality: year and month dummies

X_{ijt} : Duration Effects: dummies of # months on SO

Plotting of $\hat{\gamma}_T$

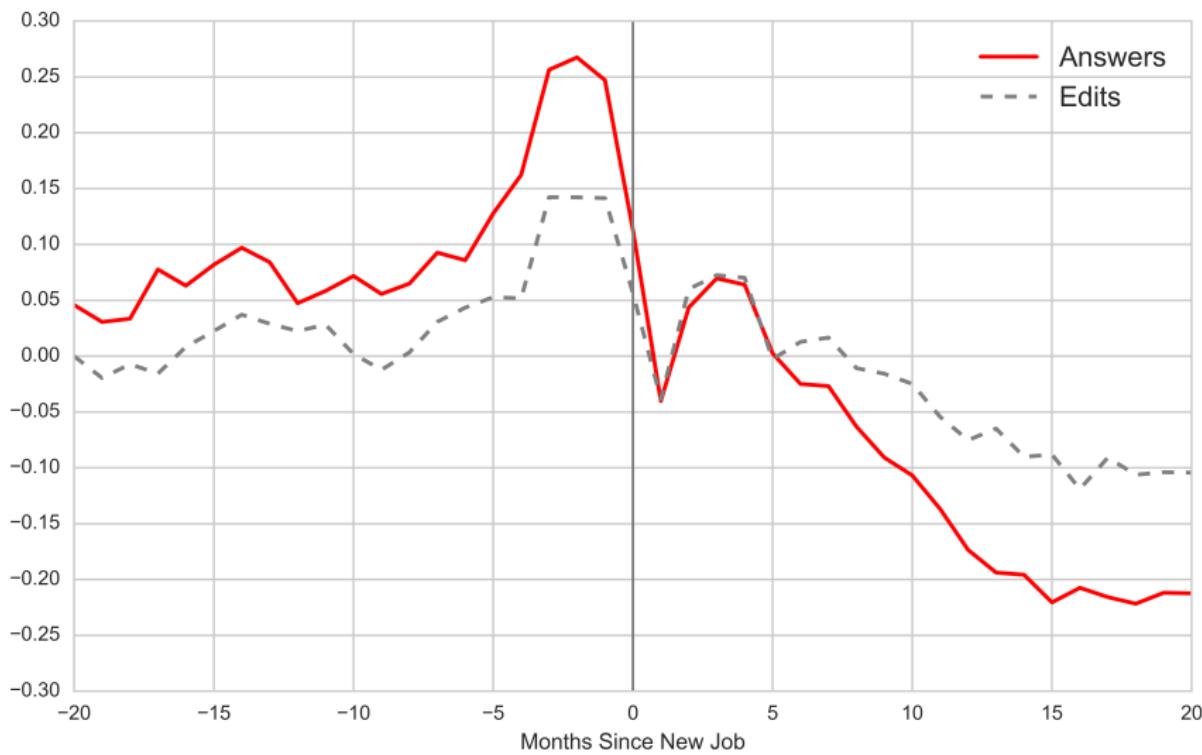


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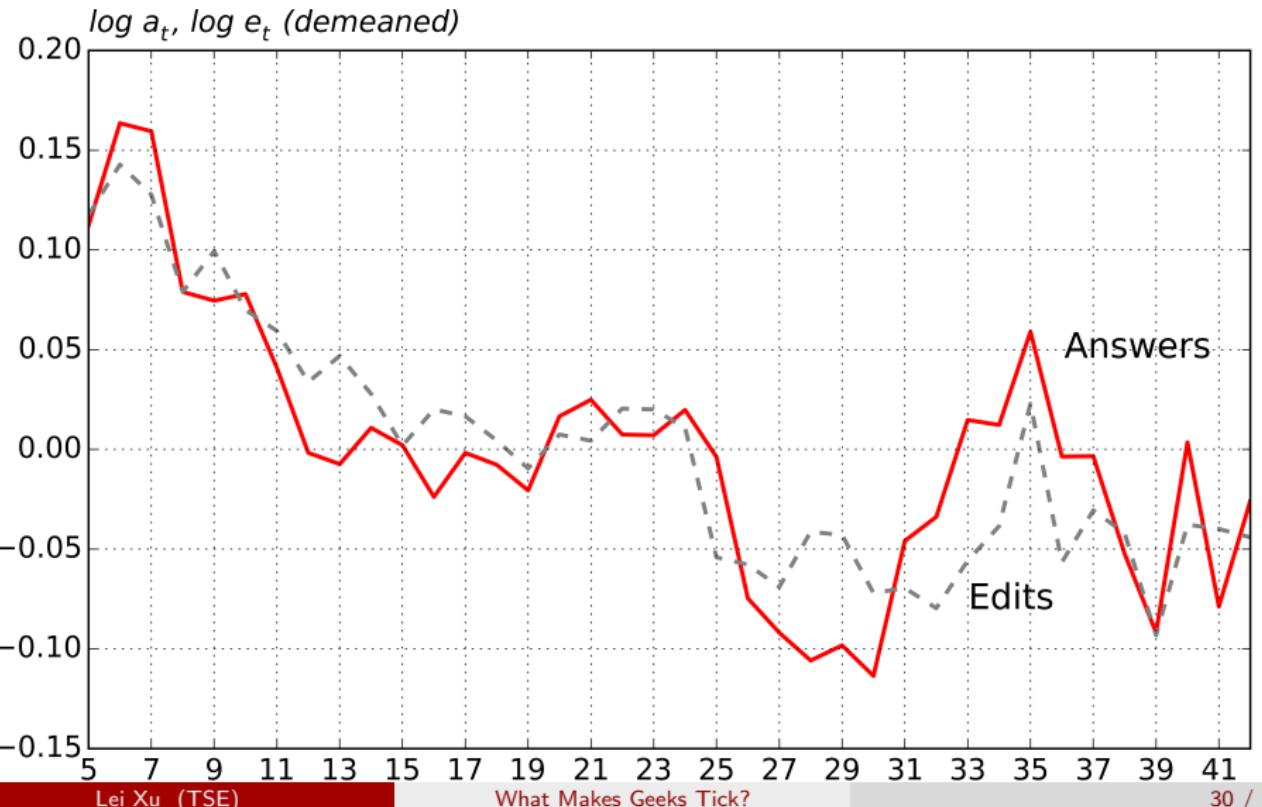
Robustness Checks

- Identifying Assumption: Common Trend
 - Model: Homothetic utility function
 - Time elasticity of Answers and Edits are the same: If no change in career incentives, then Answers and Edits should change in a similar fashion
 - Evidence
- Challenges
 - Integer Constraints
 - Skills Mismatch
 - Dynamic Selection Effects (Ashenfelter's Dip)

Plotting of Demeaned $\hat{\beta}_T$



Within Job Activity Variation



Integer Constraints

- Q: Answers take more time to finish than Edits.
- Busier job means no blocks of free time?

Integer Constraints: Weekdays vs. Weekends

- Busier jobs affect time availability on the weekdays only but not on the weekends
- Separate regressions for weekdays and weekends

Integer Constraints: Weekdays vs. Weekends

	Panel A: $y \in \{\text{Answers, Edits}\}$		Panel B: $y \in \{\text{Votes, Edit}\}$	
	(1)	(2)	(3)	(4)
$\text{NewJob}(S)$	-0.072*** (0.02)	-0.060** (0.02)	-0.072*** (0.02)	-0.060** (0.02)
$\text{NewJob}(S) \times \text{Answer/Vote}(J)$	-0.122*** (0.04)	-0.103** (0.04)	-0.135*** (0.04)	-0.124*** (0.05)
Seasonality Dummy	x	x	x	x
Duration Dummy	x	x	x	x
Days	Weekday	Weekend	Weekday	Weekend
# Contributors	1159	374	1159	374
N	7378770	2895384	7378770	2895384
R ²	0.031	0.043	0.026	0.031

Robust standard errors in parentheses, clustered at individual-activity type level.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Integer Constraints: Internal Promotion

	Panel A: All		Panel B: Same Company		Panel C: Promotion	
	(1)	(2)	(3)	(4)	(5)	(6)
<i>NewJob</i> (<i>S</i>)	-0.072*** (0.02)	-0.060** (0.02)	-0.070 (0.05)	-0.039 (0.08)	-0.151** (0.06)	-0.157 (0.10)
<i>NewJob</i> (<i>S</i>) × <i>Answer</i> (<i>J</i>)	-0.122*** (0.04)	-0.103** (0.04)	-0.090 (0.09)	-0.119 (0.13)	-0.156 (0.11)	-0.008 (0.19)
Seasonality dummy	x	x	x	x	x	x
Duration dummy	x	x	x	x	x	x
Days	Weekday	Weekend	Weekday	Weekend	Weekday	Weekend
No. of contributors (DD)	1159	374	142	41	80	21
No. of contributors (control)	96422	51296	96422	51296	96422	51296
No. of observations	7378770	2895384	7364466	2890896	7363686	2890644
<i>R</i> ²	0.031	0.043	0.031	0.043	0.031	0.043

Robust standard errors in parentheses, clustered at individual-activity type level.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Integer Constraints: Switch to Similar Job

	Baseline	Same Job Title			
	(1)	(2)	(3)	(4)	(5)
<i>NewJob (S)</i>	-0.074*** (0.02)	-0.028 (0.06)	-0.028 (0.06)	-0.008 (0.07)	-0.028 (0.08)
<i>NewJob (S) × Answer (J)</i>	-0.124*** (0.03)	-0.181* (0.11)	-0.138 (0.11)	-0.161 (0.11)	-0.244* (0.14)
Seasonality dummy	x		x	x	x
Duration dummy	x		x	x	x
Days	-	-	-	Weekday	Weekend
No. of contributors (DD)	1301	155	155	144	45
No. of contributors (control)	96422	-	96422	96422	51296
No. of observations	7380646	1992	7365094	7364828	2919924
R ²	0.031	0.010	0.031	0.031	0.043

Robust standard errors in parentheses, clustered at individual-activity type level.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Skills Mismatch

- New job requires a different set of technology.
- Contributors are unfamiliar with new technology thus unable to give answers.

Skills Mismatch: Job Tags

Experience [show all](#)

Software Developer, Stack Overflow

January 2011 - Current

asp.net-mvc c# sql-server performance redis dapper mini-profiler internationalization elasticsearch

Database Programmer, Credit Union Service Corporation

March 2009 - December 2010

asp.net c# sql-server oracle crystal-reports route-map visual-basic c++ jquery

Skills Mismatch: Job Tags

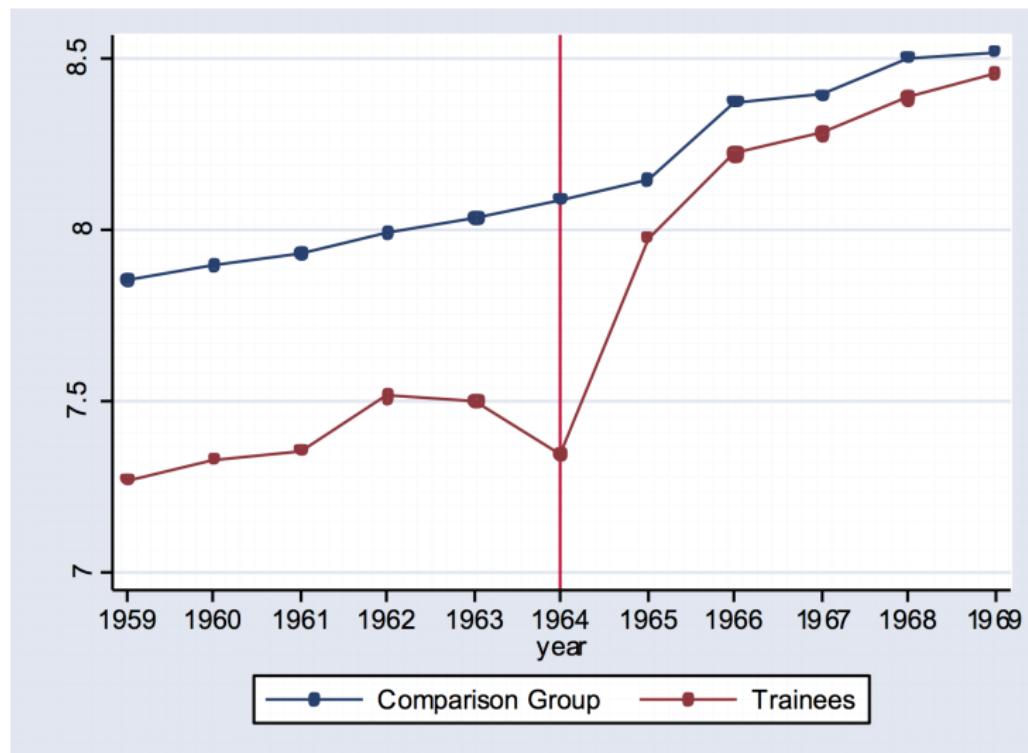
	(1) $y \in \{a, e\}$	(2) $y \in \{a, e\}$	(3) $y \in \{a, e\}$	(4) $y \in \{a, e\}$	(5) $y \in \{a, e\}$
<i>NewJob</i> (S)	-0.011 (0.06)	-0.055 (0.05)	-0.071** (0.04)	-0.078*** (0.03)	-0.082*** (0.02)
<i>NewJob</i> (S) \times <i>Answer</i> (A)	-0.215** (0.10)	-0.158* (0.08)	-0.162*** (0.06)	-0.159*** (0.05)	-0.164*** (0.03)
Job Similarity (by Tags)	$\geq 100\%$	$\geq 75\%$	$\geq 50\%$	$\geq 25\%$	$\geq 0\%$
Contributors	160	237	401	769	1236
N	2024	2948	5092	10136	17346
R^2	0.012	0.011	0.014	0.014	0.015

Robust standard errors in parentheses, clustered at individual-activity type level.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

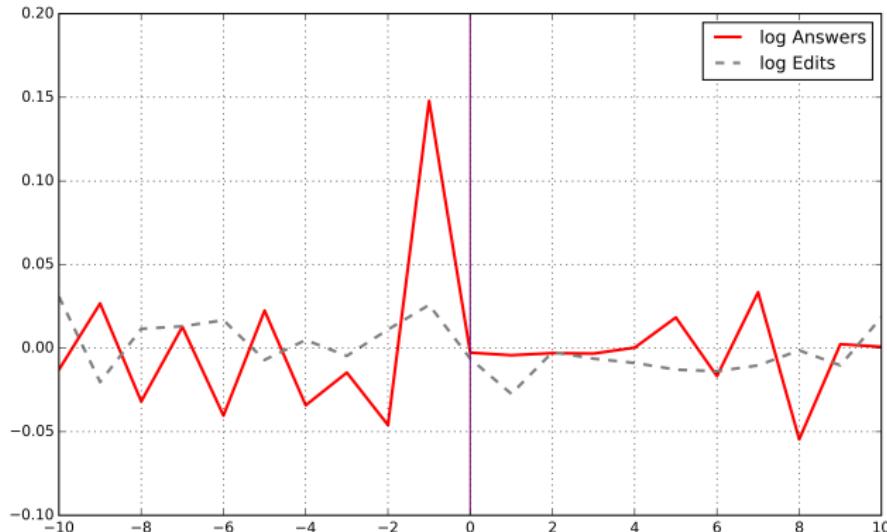
$$\text{JobSimilarity} \equiv \frac{\text{Size}(S_0 \cap S_1)}{(\text{Size}(S_0) + \text{Size}(S_1))/2}$$

Dynamic Selection Effects (Ashenfelter's Dip)



Dynamic Selection Effects (Ashenfelter's Dip)

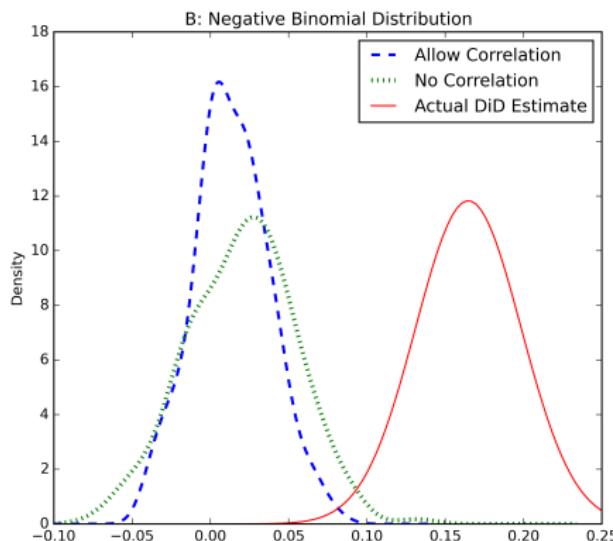
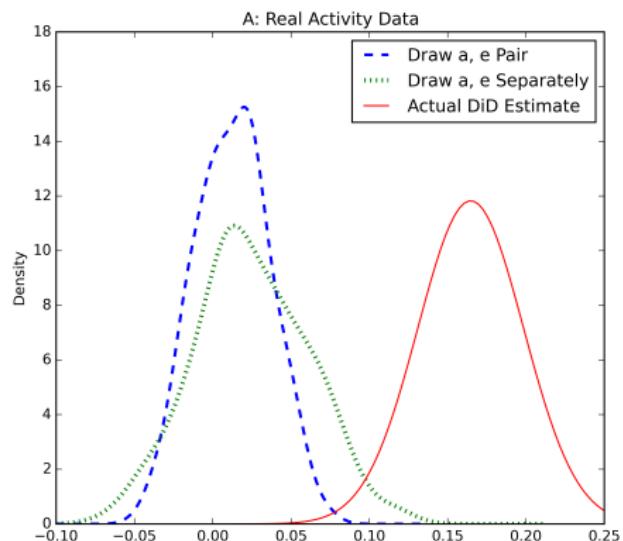
- Reverse Causality
- Random shocks of Answers and Edits
- Answers help with job changes
- The activity plot can be replicated purely due to selection



Career Concerns vs. Ashenfelter's Dip: Simulation

- Simulate Ashenfelter's Dip
- Two Inputs:
 - ① Answers and Edits activity
 - Draw directly from real activity data
 - Fit two negative binomial distribution for Answers and Edits, then draw from the distribution
 - ② Job Change Function: $p(S_{t+1} = 1 | S_t = 0) = \frac{\exp(\alpha + \beta * a_t)}{1 + \exp(\alpha + \beta * a_t)}$
 - Endogeneity: β biased upward
 - This stacks the cards in favor of Ashenfelter's Dip
- Simulate for $R = 200$ times

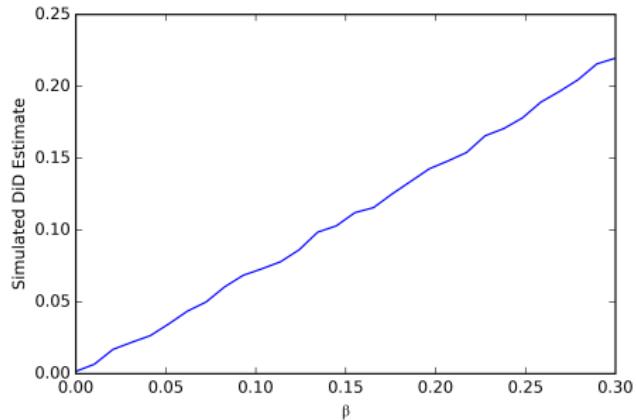
Density Plot of Simulated DD Estimates



Parameters Needed to Reject Career Concerns Hypothesis

Job Change Function: $p(S_{t+1} = 1 | S_t = 0) = \frac{\exp(\alpha + \beta * a_t)}{1 + \exp(\alpha + \beta * a_t)}$

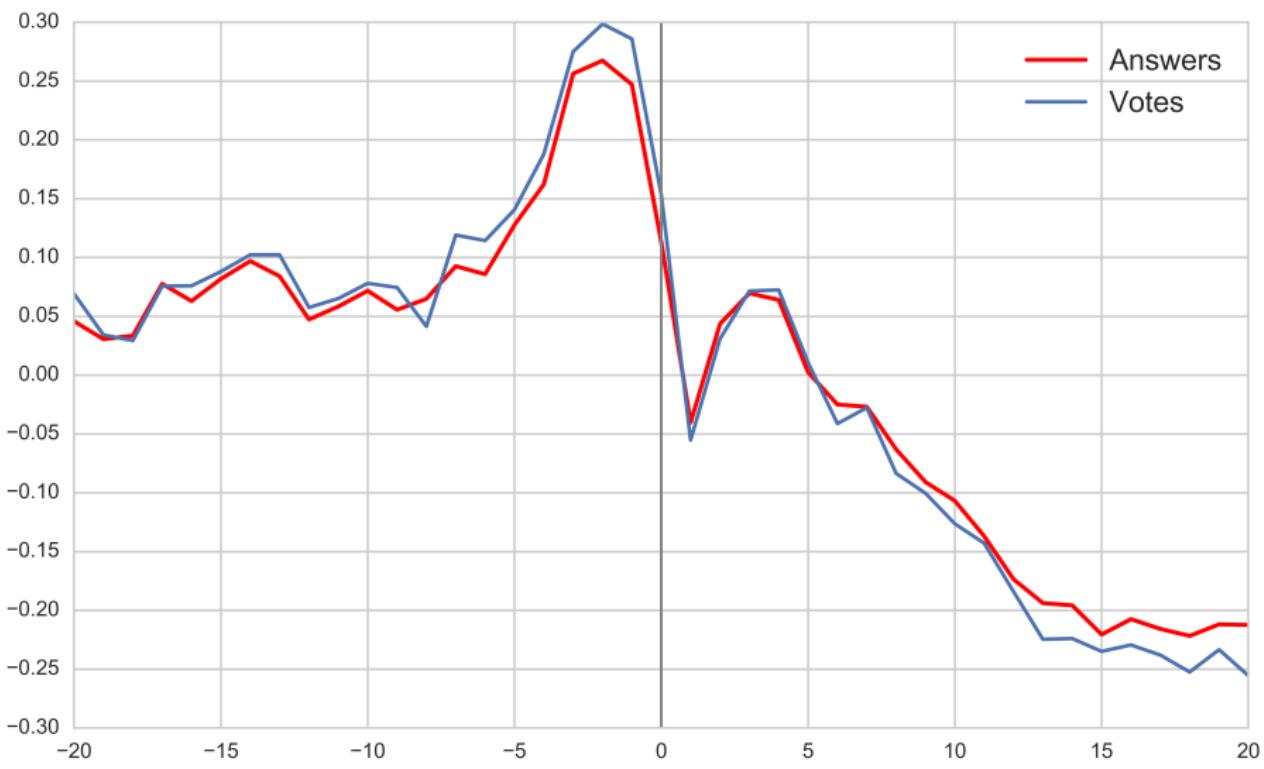
- Step 1: Holding $a_t = 0$, calibrate α such that simulated job length matches to reality. $\rightarrow \alpha = -3.07$
- Step 2: Holding $\alpha = -3.07$, simulate DD by changing β .



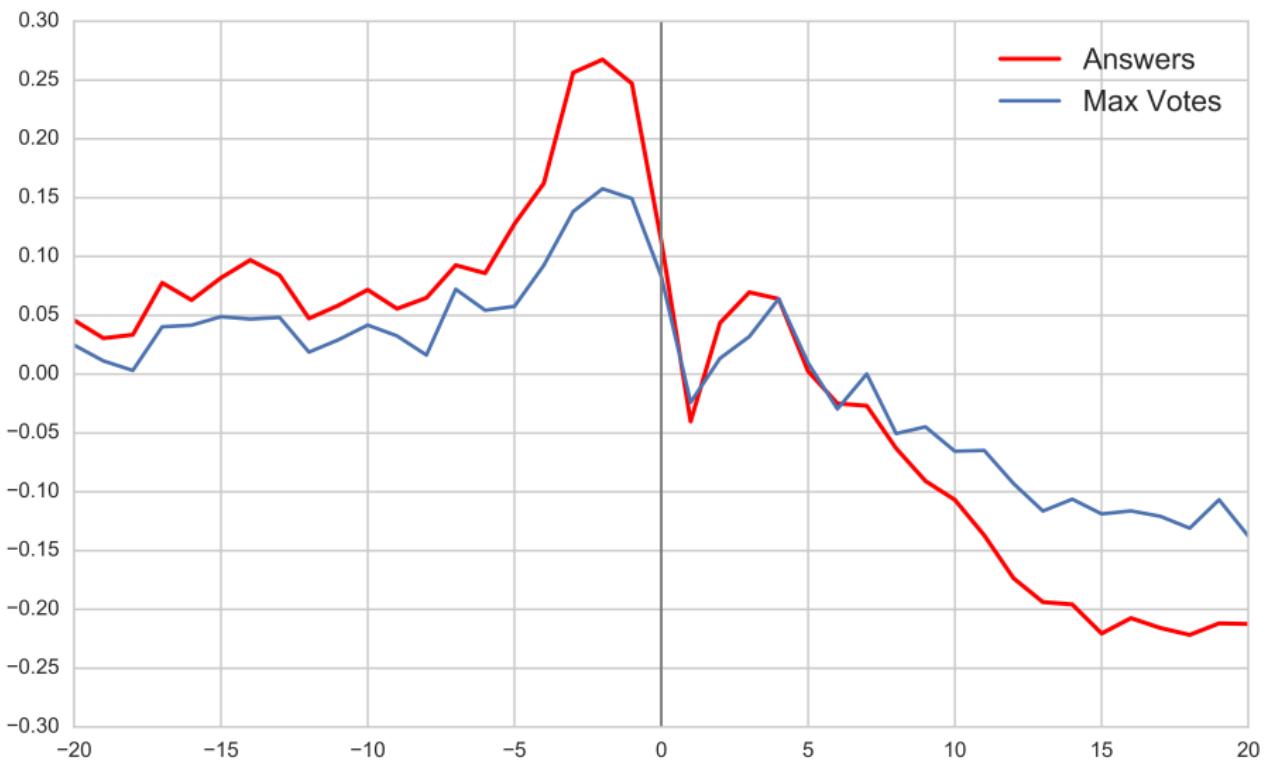
- 7 More Answers Per Month $\rightarrow 25\%$ More Likely to Change Jobs

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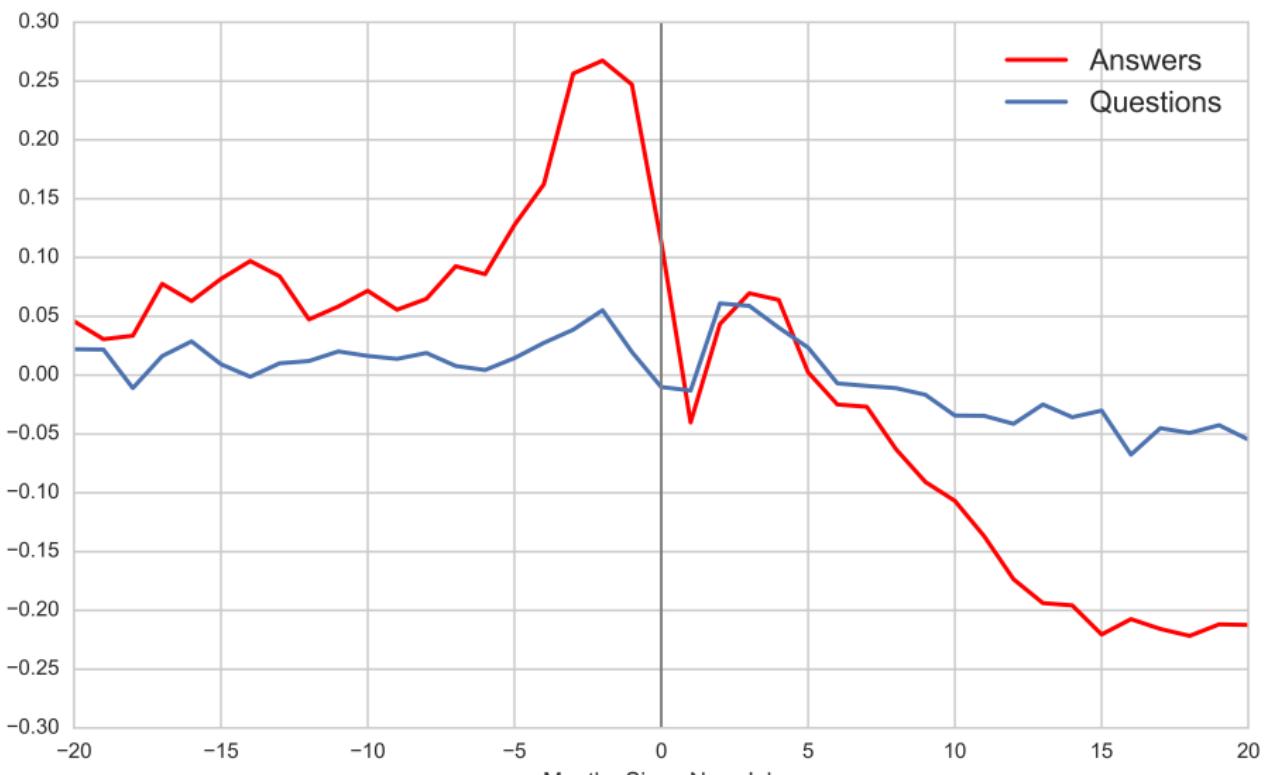
Quantity vs. Quality



Quantity vs. Quality: Best Answer



Questions



DD Estimates by Reputation Groups

	Panel A: $y \in \{\text{Answers, Edits}\}$				Panel B: $y \in \{\text{Votes, Edits}\}$			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
NewJob (S)	0.157*** (0.04)	-0.067* (0.03)	-0.166*** (0.04)	-0.251*** (0.04)	0.157*** (0.04)	-0.067* (0.03)	-0.166*** (0.04)	-0.251*** (0.04)
NewJob (S) \times Answer/Vote (J)	0.102 (0.06)	-0.228*** (0.06)	-0.242*** (0.07)	-0.132* (0.07)	0.133* (0.07)	-0.213*** (0.07)	-0.325*** (0.07)	-0.211*** (0.08)
Seasonality dummy	x	x	x	x	x	x	x	x
Duration dummy	x	x	x	x	x	x	x	x
Reputation	0-25%	25-50%	50-75%	75-100%	0-25%	25-50%	50-75%	75-100%
No. of contributors (DD)	356	350	340	311	356	350	340	311
No. of contributors (control)	96422	96422	96422	96422	96422	96422	96422	96422
N	9092012	9092002	9092012	9092000	9092012	9092002	9092012	9092000
R ²	0.033	0.033	0.033	0.033	0.027	0.027	0.027	0.027

Notes: FE: OLS Regression with Fixed-Effects.

Reputation Percentile: 25%: 770; 50%: 2124; 75%: 5265; 100%: 132067

y: generic activity, a: Answers, e: Edits.

Robust standard errors in parentheses, clustered at individual-activity type level.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

DD Estimates by Education Levels

	Panel A: $y \in \{\text{Answers, Edits}\}$				Panel B: $y \in \{\text{Votes, Edits}\}$			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>NewJob (S)</i>	0.102 (0.16)	-0.084*** (0.03)	-0.045 (0.05)	-0.036 (0.10)	0.102 (0.16)	-0.084*** (0.03)	-0.045 (0.05)	-0.036 (0.10)
<i>NewJob (S) × Answer/Vote (J)</i>	-0.205 (0.25)	-0.121*** (0.04)	-0.164** (0.08)	-0.088 (0.17)	-0.143 (0.31)	-0.145*** (0.05)	-0.189** (0.08)	-0.146 (0.20)
Seasonality dummy	x	x	x	x	x	x	x	x
Duration dummy	x	x	x	x	x	x	x	x
Highest Education Level	HS	College	Masters	PhD	HS	College	Masters	PhD
No. of contributors (DD)	12	778	230	51	12	778	230	51
No. of contributors (control)	96422	96422	96422	96422	96422	96422	96422	96422
No. of observations	8944282	8955016	8947346	8944870	8944282	8955016	8947346	8944870
R^2	0.033	0.033	0.033	0.033	0.027	0.027	0.027	0.027

Robust standard errors in parentheses, clustered at individual-activity type level.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Implications

Career incentives can be used to motivate user participation

- Information asymmetry of all job markets
- 2014 Survey: 93% of employers check social profiles of job candidates
- Activities that can reflect one's ability

Examples

- Stock Market Simulator
- Massive Open Online Courses
- GitHub

Offline Examples

- University Classes
- Volunteer Work

Conclusion

- Question: What motivates private contributions to a public good?
- Career Concerns
- Contribution & Implications
 - Causal effect of career incentives
 - Implications: promote user participation through career incentives
- More Research Questions
 - What's the best way to integrate career incentives?
 - Long-term effect: Extrinsic crowd out intrinsic motivation?
 - How does online activity help?