Authority and Delegation in Online Communities

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How can platforms incentivize user-generated content?

- Wikipedia, Q&A websites, product support forums,...

This paper: **Through delegation of authority on editing tasks**

Platform decision in Stack Exchange

Objective of Platform: **incentivize** users in **answering** and/or **editing** task

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2. **Edit** content:
   - **suggestions** (e.g. Quora) → Users do **not have Authority**
   - **actual edits** (e.g. Wikipedia) → Users **have Authority** (full delegation)
   - **actual edits conditional on performance** (e.g. Stack Exchange) → partial delegation

Platform decision in Stack Exchange

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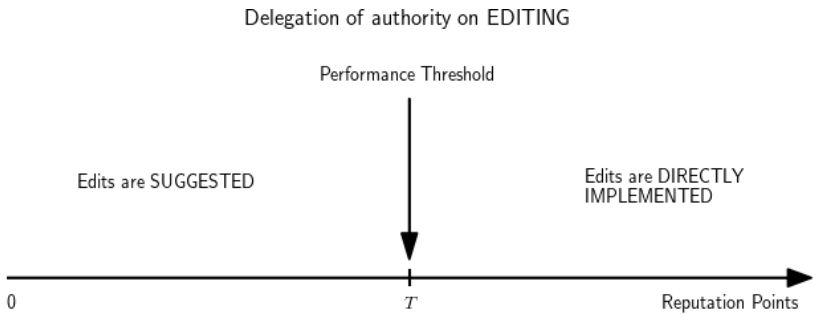
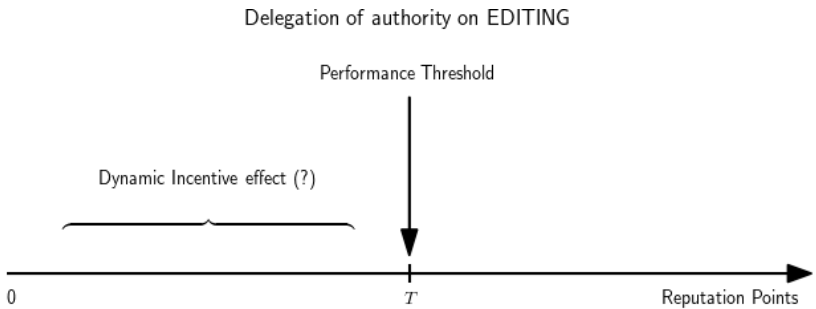
Trade-off between strategies?

Rationale for delegation of authority: the case of Stack Exchange



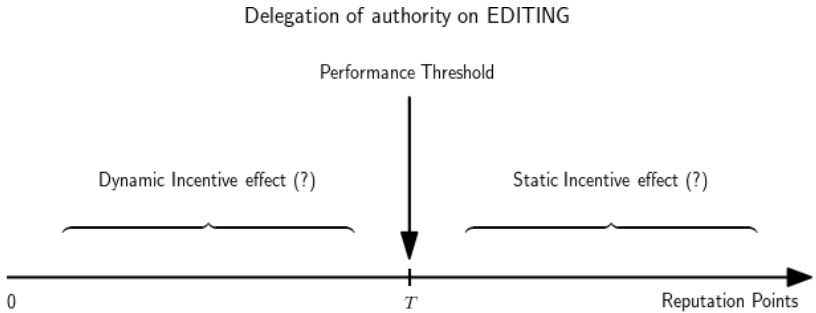
Rationale for delegation of authority: the case of Stack Exchange

- If users value **to gain** authority $\rightarrow$ **increase contribution to reach the threshold**



Rationale for delegation of authority: the case of Stack Exchange

- If users value **to have** authority $\rightarrow$ **relaxed participation constraint for editing**



This paper provides

- **the Identification of user types**

Literature

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- **a dynamic discrete choice model** to:
  - quantify the **marginal utility of obtaining authority** $\rightarrow$ *Dynamic incentive*

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  - quantify the **change in willingness to participate** when endowed with authority → *Static incentive*

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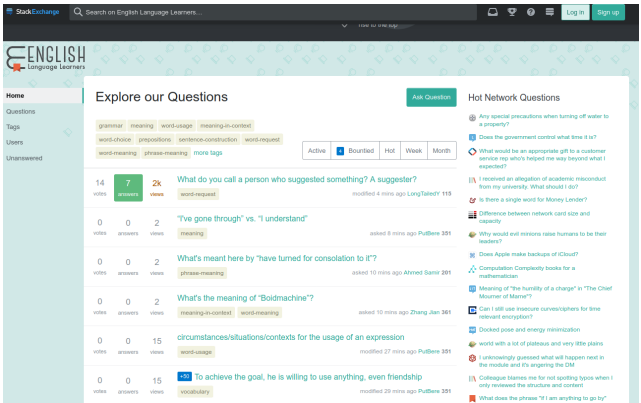
- **a dynamic discrete choice model** to:
  - quantify the **marginal utility of obtaining authority** → *Dynamic incentive*
  - quantify the **change in willingness to participate** when endowed with authority → *Static incentive*
  - Counterfactual contribution under different **performance thresholds**
    - To explain **different strategies adopted** by Quora, Wikipedia, Stack Exchange

Literature

Stack Exchange - English Language Learners



- Questions and Answers about English use
- Complete data (no sampled)
- 2013-2020
- 9,797 active users
- 123K answers
- Full history of contributions for all users

Delegation in ELL

How the threshold affects the dynamics of contribution?

Users are forward looking:

- **Choice of effort** today is **based on expected returns**
- **Expected returns depend on the value of reaching the threshold**

Identification and estimation: Dynamic Discrete Choice model

- logit: **revealed-preference** approach
- Value function estimation: exploitation of *finite dependence* to allow for larger state state space and choice set

Dynamic Discrete Choice Model

User chooses a combination of effort levels: $\alpha \equiv \{N_A, N_E, Q_A\} \in \boldsymbol{A}$

- N_A, N_E : Quantity of answers and edits
- Q_A : Quality of answers (linear combination of textual measures Details)

such as to **maximize** the discounted **expected utility**:

$$\mathbb{E}\left[\sum_{t=\tau}^{T}\sum_{\alpha\in\boldsymbol{A}}\delta^{t-\tau}d_{\alpha,t}\left(U_{\alpha t}(\boldsymbol{z}_t)\right)\right]$$

Details on Beliefs Details on Identification Details on estimation

Users' preferences

$$U_{it} = \beta_0 R_{it} + \beta_1 CA_{it} + \beta_2 CE_{it} + \beta_3 cumT_{it} + Authority_{it}\left(\beta_4 + \beta_5 CA_{it} + \beta_6 CE_{it}\right) + \varepsilon_{it}$$

where:

- R_{it}: Number of points accumulated
- $CA_{it} = Q_A + N_A^{\frac{\max(\log(avail))}{\log(avail)}}$ Details on avail
- $CE_{it} = N_E$
- $cumT_{it}$: Number of privileges obtained
- $Authority_{it} = 1$ if user has full authority on editing at t

Measuring the sensitivity to the incentives

$$U_{it} = \beta_0 R_{it} + \beta_1 CA_{it} + \beta_2 CE_{it} + \beta_3 cumT_{it} + Authority_{it}(\beta_4 + \beta_5 CA_{it} + \beta_6 CE_{it}) + \varepsilon_{it}$$

- $\beta_5 \neq 0 \rightarrow$ **Static** incentive effect on **answering**

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- $\beta_6 \neq 0 \rightarrow$ **Static** incentive effect on **editing**

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- $\beta_6 \neq 0 \rightarrow$ **Static** incentive effect on **editing**
- $(\beta_4 + \beta_5 CA_{it} + \beta_6 CE_{it}) \neq 0 \rightarrow$ **Dynamic** incentive effect

Flow payoff estimates

$$U_{it} = \beta_0 R_{it} + \beta_1 CA_{it} + \beta_2 CE_{it} + \beta_3 cumT_{it} + Authority_{it}\,(\beta_4 + \beta_5 CA_{it} + \beta_6 CE_{it}) + \varepsilon_{it}$$

Variables	(no Heter.)	(*Anonymous*)	(*Identifiable*)	(*Informative*)
R	0.0069***	0.0064***	0.0057***	0.0045***
	(0.0001)	(0.0005)	(0.0002)	(0.0004)
CA	-0.0001	-0.3563***	0.00005	0.0007***
	(0.0008)	(0.0196)	(.0006)	(0.0002)
CE	-10.3311***	-7.9549***	-6.1724***	-5.7740***
	(0.4979)	(0.8927)	(0.4051)	(0.4757)
cumT	-0.7745***	-0.4177***	-0.7855***	-0.7681***
	(0.0206)	(0.0322)	(.028)	(0.0563)
Authority	1.3162***	1.5223***	0.1713	1.4709***
	(0.1203)	(0.3577)	(0.2535)	(0.5118)
CA x Authority	0.0609***	-0.0048***	-0.0018	-0.0008
	(0.0036)	(0.0016)	(0.0011)	(0.0014)
CE x Authority	12.2064***	0.6338***	0.2507***	0.2703***
	(0.5247)	(0.0593)	(0.0308)	(0.0274)
N. users	9,783	3,700	5,407	676
Sample size	991,657	471,837	407,098	112,722

$* p < 0.05$, $** p < 0.01$, $*** p < 0.001$

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CE x Authority (Static on Edits)	12.2064***	0.6338***	0.2507***	0.2703***
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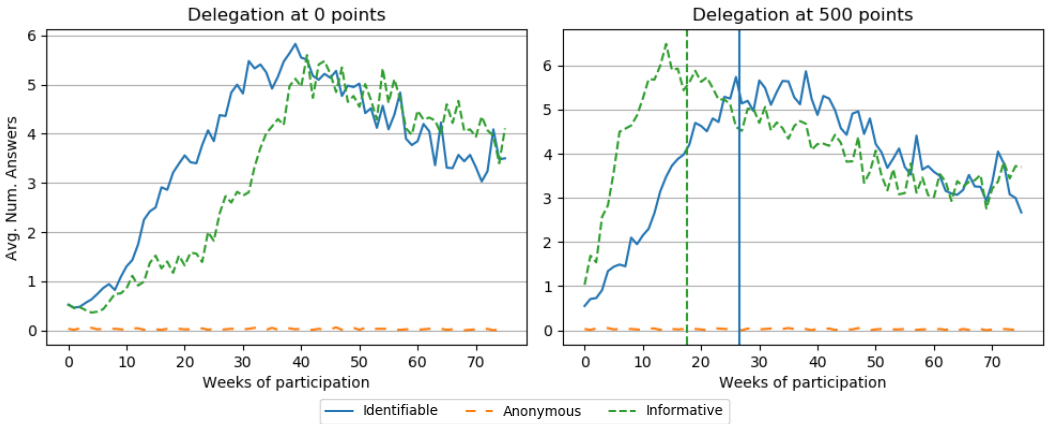
Counterfactuals: average num. of answers per week of participation



Changes in production

Dynamic Incentive effect - Production of Answers

Performance required	Answers	Change	*Anonymous*	*Identifiable*	*Informative*
0 Points	12562.0		92	10967	1503
500 Points	13374.0	+6.46%	+13.04%	+1.6%	+41.52%

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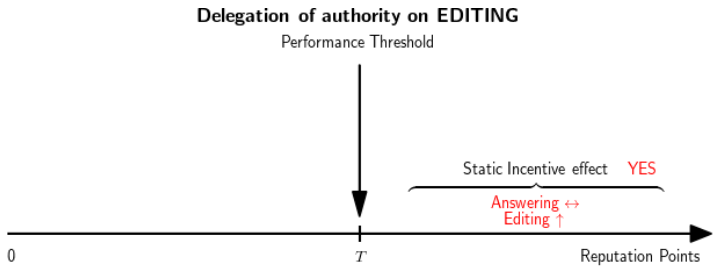
Static Incentive effect - Production of Edits

Performance required	Edits	Change	*Anonymous*	*Identifiable*	*Informative*
0 Points	16.0		2	11	3
500 Points	7.0	-56.25%	-50.0%	-54.55%	-66.67%

Conclusion

This paper shows that the delegation of authority can be an incentive device:

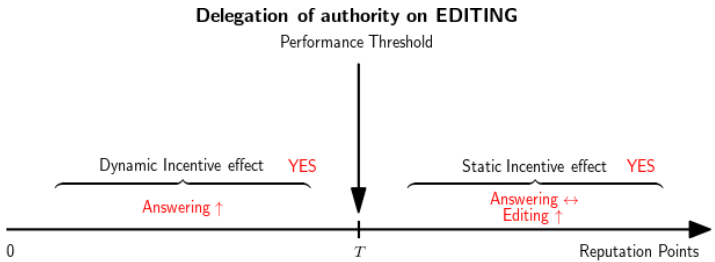
1. *Static incentive* effect: **More authority in editing**
   - **increases** willingness to participate in **editing**
   - does **not affect answering** (small substitution effect for *Anonymous users*)



Conclusion

This paper shows that the delegation of authority can be an incentive device:

2. *Dynamic Incentive effect*: **Tying authority to performance**
   - strongly **increases contribution of *Informative*** users
   - would incentivize *Anonymous* users, but too high costs
   - does **not affect *Identifiable*** users.



Conclusion

Choice of delegation design should depend on:

- **composition** of the community
  If *Informative* users are too few, *Dynamic Incentive* effect is negligible

- **objective** of the platform:
  1. **Full delegation** maximizes number of edits → **Wikipedia**
  2. **Delayed delegation** maximizes number of answers → **Stack Exchange**

Literature

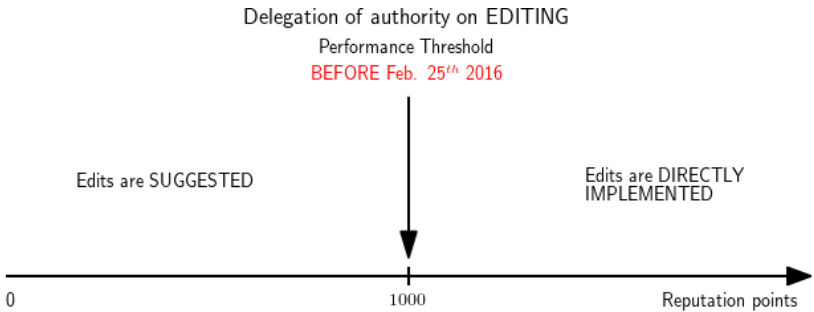
- **Intrinsic value of authority (experiments)**: Fehr, Holger, Wilkening (2013); Bartling, Fehr, Herz (2014); Owens, Grossman, Fackler (2014), Pikulina, Tergiman (2020)
  -> This paper: **confirms results with non-experimental data**

- **Delegation as incentive**: Gibbons, Matouschek, Roberts (2013); Gambardella, Panico, Valentini (2015)
  -> This paper: **brings theoretical insights to empirics**

- **Voluntary contribution and non-monetary motives**: Belenzon, Schankerman (2015); Goes, Guo, Lin (2016), Chen, Wei, Zhu (2017)
  -> This paper: **proposes novel channel** of non-monetary preferences

Back

Delegation system



Back

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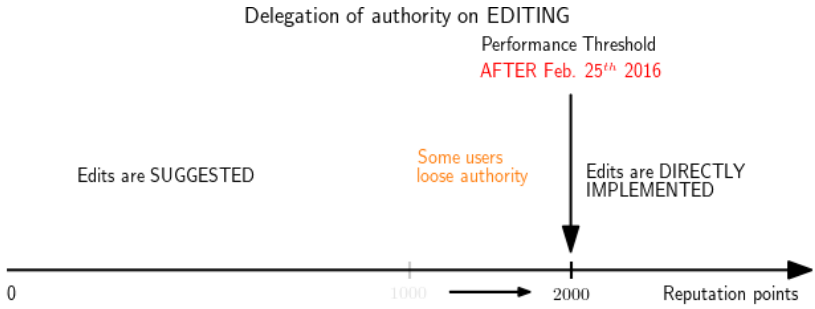


Time to approval / rejection | How to accumulate points | Back

Identification of user types

Assumption: **what information** is disclosed in user pages **is proxy for the motives of participation**

Method: **data driven clustering of users**: MCA + K-Means Details

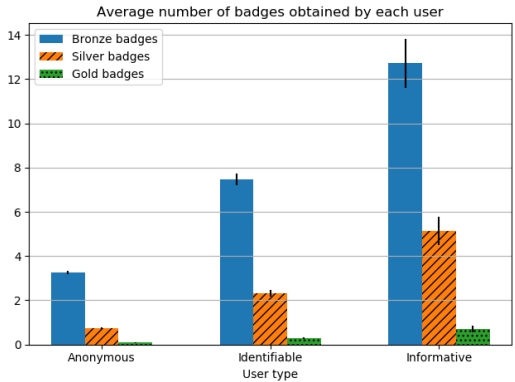
user type	Num. users	Share of users who have ... full name	website	location	LinkedIn	bio	links
Anonymous	5414	24.9%	2.4%	8.53%	0.0%	3.77%	0.0%
Identifiable	3705	25.32%	47.72%	80.08%	0.0%	80.54%	2.05%
Informative	678	39.38%	72.27%	86.43%	17.11%	98.08%	85.69%

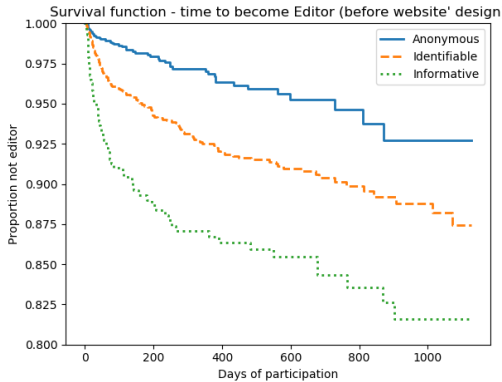
Details on behavior

Types' behavior

Back

Type	Num Users	num answers		num suggested edits		num direct edits	
		Total	Avg. per user	Total	Avg. per user	Total	Avg. per user
Anonymous	5414	32511.0	6.00	309.0	0.06	465.0	0.09
Identifiable	3705	63500.0	17.14	836.0	0.23	2272.0	0.61
Informative	678	18915.0	27.90	264.0	0.39	4022.0	5.93





Suggested edits: time to approval / rejection

	all suggested edits	edits approved	edits rejected
count	10981	8806 (80.19%)	2175 (19.81%)
mean	3 hours 16 min. 31 sec.	2 hours 42 min. 5 sec.	5 hours 35 min. 57 sec.
std	3 days 0 hours 52 min. 1 sec.	2 days 15 hours 39 min. 12 sec.	4 days 5 hours 58 min. 45 sec.
min	1 sec.	8 sec.	1 sec.
25%	11 min. 46 sec.	11 min. 13 sec.	14 min. 8 sec.
50%	33 min. 36 sec.	31 min. 13 sec.	45 min 28 sec.
75%	1 hour 40 min. 40 sec.	1 hour 29 min. 38 sec.	2 hours 28 min. 21 sec.
max	246 days 1 hour 34 min. 53 sec.	246 days 1 hour 34 min. 53 sec.	181 days 11 hours 11 min. 47 sec.

Back

How to gain / loose points Back

You can earn a maximum of 200 reputation per day from any combination of the activities below. Bounty awards, accepted answers, and association bonuses are not subject to the daily reputation limit.

You gain reputation when:

- question is voted up: +5
- answer is voted up: +10
- answer is marked “accepted”: +15 (+2 to acceptor)
- suggested edit is accepted: +2 (up to +1000 total per user)
- bounty awarded to your answer: + full bounty amount
- one of your answers is awarded a bounty automatically: + half of the bounty amount (see more details about how bounties work)
- site association bonus: +100 on each site (awarded a maximum of one time per site)
- example you contributed to is voted up: +5
- proposed change is approved: +2
- first time an answer that cites documentation you contributed to is upvoted: +5

If you are an experienced Stack Exchange network user with 200 or more reputation on at least one site, you will receive a starting +100 reputation bonus to get you past basic new user restrictions. This will happen automatically on all current Stack Exchange sites where you have an account, and on any other Stack Exchange sites at the time you log in.

You lose reputation when:

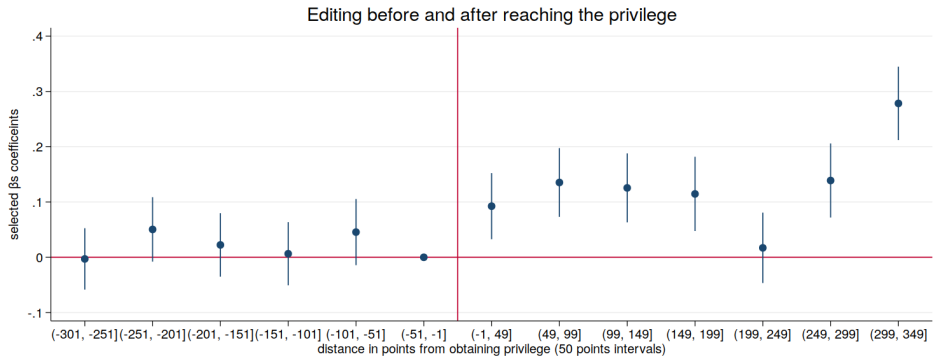
- your question is voted down: −2
- your answer is voted down: −2
- you vote down an answer: −1
- you place a bounty on a question: − full bounty amount
- one of your posts receives 6 spam or offensive flags: −100

All users start with one reputation point, and reputation can never drop below 1. Accepting your own answer does not increase your reputation. Deleted posts do not affect reputation, for voters, authors or anyone else involved, in most cases. If

Willingness to edit increases with authority

Back

$$Edits_{it} = \alpha_i + \gamma_t + \beta_\rho \mathbf{1}\{r_{it} - \bar{R} \in \rho\} + \boldsymbol{X}_{it}\boldsymbol{\zeta} + \varepsilon_{it}$$

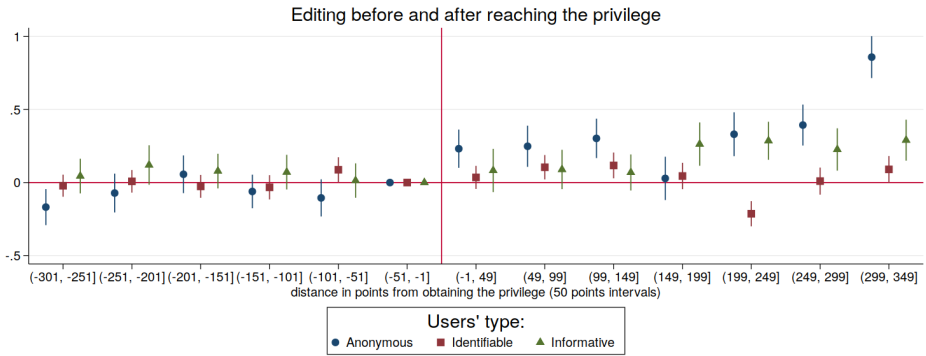


Comparison with number of comments | Alternative status-only threshold | Estimates' table | Effect of losing authority

Effect is heterogeneous

Back

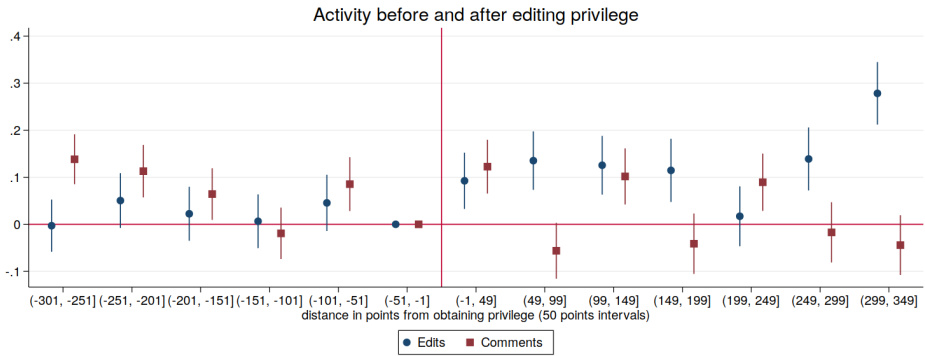
$$Edits_{it} = \alpha_i + \gamma_t + \beta_\rho \mathbf{1}\{r_{it} - \bar{R} \in \rho\} + \boldsymbol{X}_{it}\boldsymbol{\zeta} + \varepsilon_{it} \quad \text{if} \quad \text{type}_i = \theta \quad \forall \theta \in \{Anon., Ident., Inf.\}$$



Note: outcome variable standardized **within** type

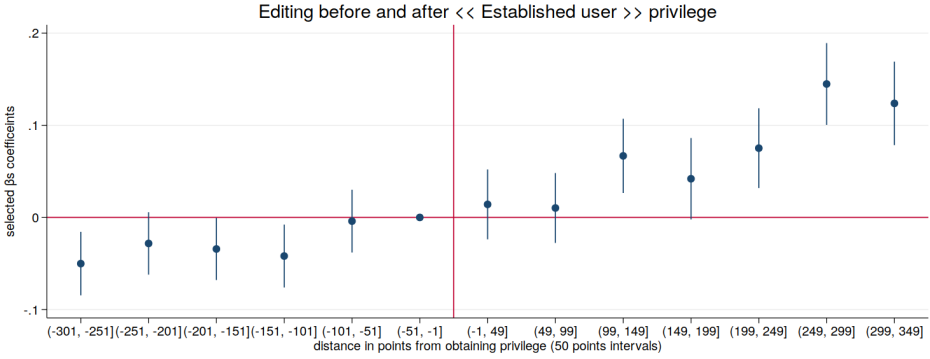
Reduced form: gain of authority

$$Y_{it} = \alpha_i + \gamma_t + \beta_\rho \mathbf{1}\{r_{it} - \bar{R} \in \rho\} + a_{m_{it}} + b_{c_{it}} + \varepsilon_{it}$$



back

Alternative thresholds



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Estimates

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	num Edits	num Comments	num Answers
(...)			
(-301,-251]	-0.00298	0.138***	0.0133
	(-0.11)	(5.11)	(0.51)
(-151,-201]	0.0504	0.113***	0.106***
	(1.70)	(3.97)	(3.85)
(-201,-151]	0.0223	0.0643*	0.0891**
	(0.76)	(2.30)	(3.28)
(-151,-101]	0.00642	-0.0193	0.0110
	(0.22)	(-0.69)	(0.41)
(-101,-51]	0.0456	0.0854**	0.0965***
	(1.49)	(2.93)	(3.41)
(-1,49]	0.0924**	0.123***	0.0427
	(3.03)	(4.20)	(1.51)
(49,99]	0.135***	-0.0563	0.163***
	(4.27)	(-1.86)	(5.54)
(99,149]	0.126***	0.102***	0.124***
	(3.94)	(3.35)	(4.21)
(149,199]	0.115***	-0.0413	0.0905**
	(3.35)	(-1.26)	(2.85)
(199,249]	0.0171	0.0894**	0.0156
	(0.53)	(2.88)	(0.52)
(249,299]	0.139***	-0.0172	-0.118***
	(4.07)	(-0.53)	(-3.73)
(299,349]	0.278***	-0.0442	0.0384
	(8.22)	(-1.37)	(1.22)
(...)			
is Moderator	-1.956***	1.583**	3.171***
	(-3.67)	(3.11)	(6.42)
is Candidate	2.711***	0.911***	1.257***
	(15.68)	(5.51)	(7.84)
Individual FE	YES	YES	YES
Week FE	YES	YES	YES
N	990213	990213	990213

Loss of authority

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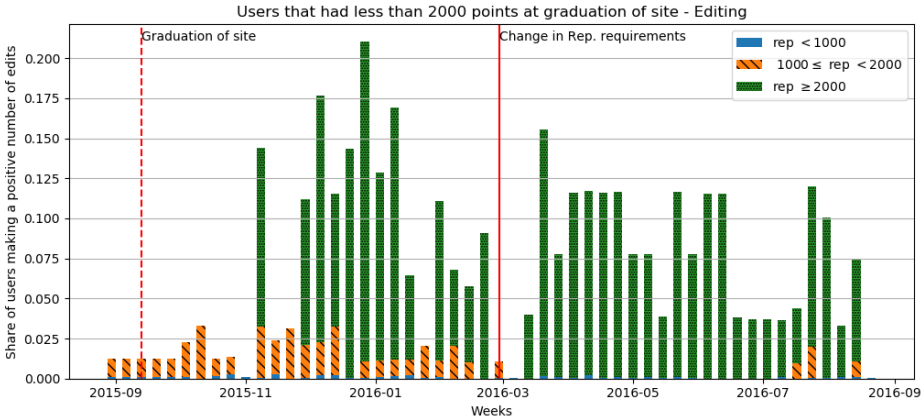

How choices affect arrival of points

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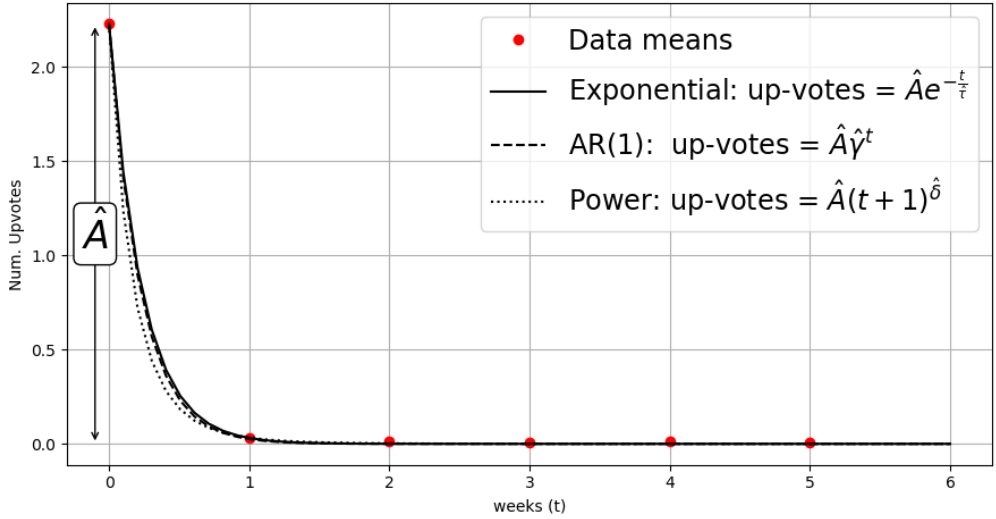

How choices affect arrival of points

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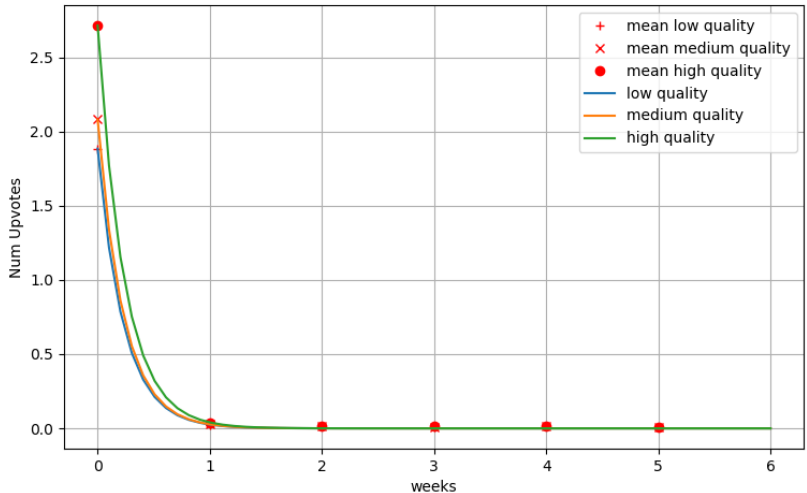

How choices affect arrival of points

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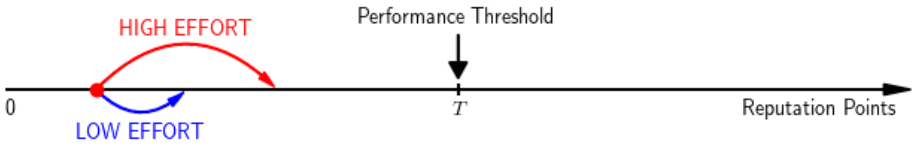
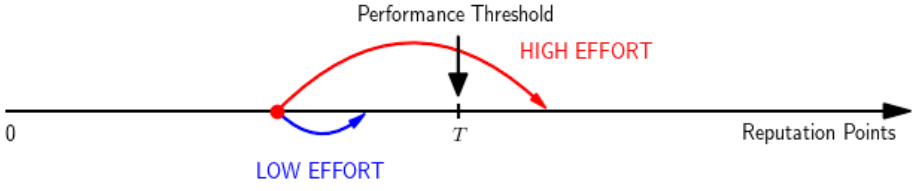
Num Up-Votes	(1) Poisson	(2) Poisson	(3) Poisson	(4) Poisson	(5) OLS
Answer Quality	0.0528***	0.0513***	0.0463***	0.0463***	0.0887***
	(69.61)	(67.06)	(59.88)	(9.58)	(8.84)
Received Edits	0.457***	0.485***	0.472***	0.472***	0.935***
	(55.61)	(58.79)	(57.26)	(20.99)	(15.46)
Experience: num Answers		0.0000465***	0.0000332***	0.0000332	0.0000563
		(11.79)	(8.29)	(0.61)	(0.58)
Experience: days in platform		0.000112***	0.000271***	0.000271***	0.000372***
		(24.04)	(52.35)	(7.17)	(6.34)
_cons	-0.414***	-0.469***	-0.101***	-0.101	0.532**
	(-35.47)	(-39.59)	(-6.87)	(-1.10)	(2.97)
N	118552	118552	118552	118552	118552
Year FE	NO	NO	YES	YES	YES
st. err. clustered at author	NO	NO	NO	YES	YES

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Identification





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Estimation of flow payoff parameters

Estimated by maximum likelihood of the data:

$$L(\beta_0, \beta_1) = \sum_{i=1}^{N} \sum_{t=1}^{T} \sum_{\alpha \in \boldsymbol{A}} \log \left(\frac{\exp(\nu_{\alpha it}(\boldsymbol{z}_{it}))}{\sum_{k \in \boldsymbol{A}} \exp(\nu_{kit}(\boldsymbol{z}_{it}))} \right) \times d_{\alpha it}$$

where:

$$\nu_{\alpha t}(\boldsymbol{z}_t) = u_{\alpha t}(\boldsymbol{z}_t) + \delta \sum_{\boldsymbol{z}_{t+1} \in \boldsymbol{Z}} V_{t+1}(\boldsymbol{z}_{t+1}) f_{\alpha t}(\boldsymbol{z}_{t+1} | \boldsymbol{z}_t).$$

Computational burden is softened by application of Finite dependence property

(Arcidiacono and Miller 2011) How I apply Finite Dependence

- 21 possible choices
- states not binned

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Finite Dependence

$$\nu_{\alpha t}(z_t) - \nu_{\tilde{\alpha} t}(z_t) = u_{\alpha t}(z_t) - u_{\tilde{\alpha} t}(z_t) + \sum_{\tau=t+1}^{t+\Delta_t} \sum_{k \in A} \sum_{z_\tau \in Z} \delta^{\tau-t} \left(u_{k\tau}(z_\tau) - \ln(p_{k\tau}(z_\tau))\right) \times [d^*_{k\tau}(z_\tau, d_{\alpha t} = 1)\kappa_{\tau-1}(z_\tau | z_t, d_{\alpha t} = 1) - d^*_{k\tau}(z_\tau, d_{\tilde{\alpha} t} = 1)\kappa_{\tau-1}(z_\tau | z_t, d_{\tilde{\alpha} t} = 1)]$$

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Dep. var: **points**	(1)	(2)	(3)	(4)	(5)
Length	0.00440***	0.00997***	0.00921***	0.00927***	0.00859***
	(5.65)	(7.48)	(6.80)	(6.85)	(6.34)
Precision	9.219***	9.495***	32.20***	32.02***	30.91***
	(8.81)	(9.06)	(4.38)	(4.35)	(4.20)
Num. figures	3.504***	3.554***	3.555***	6.915***	6.474***
	(8.98)	(9.11)	(9.11)	(10.42)	(9.73)
Num. links	1.818***	1.807***	1.806***	1.784***	2.235***
	(21.86)	(21.73)	(21.72)	(21.44)	(23.50)
Length^2		-0.00000991***	-0.00000926***	-0.00000932***	-0.00000861***
		(-5.15)	(-4.78)	(-4.81)	(-4.44)
Precision^2			-22.54**	-22.39**	-21.81**
			(-3.12)	(-3.10)	(-3.02)
Num. figures ^{2}				-1.231***	-1.172***
				(-6.26)	(-5.95)
Num. Links					-0.0393***
					(-9.78)
_cons	8.978***	8.437***	2.909	2.944	3.292
	(17.16)	(15.81)	(1.57)	(1.59)	(1.78)
N	118552	118552	118552	118552	118552

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

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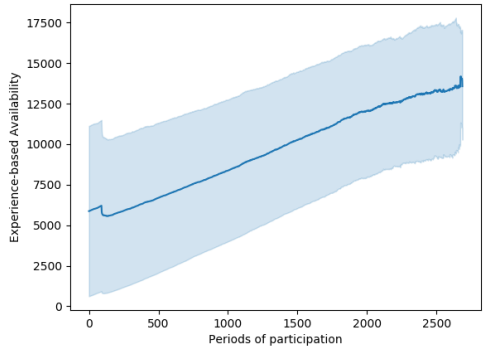
Availability of questions

1. Identify topics from tags and assign tags to topics.

2. Count, at each day the number of questions without accepted answer, on each topic, 3. Construct people expertise based on answered questions across topics, 4. Weight availability per topic by each user's expertise.



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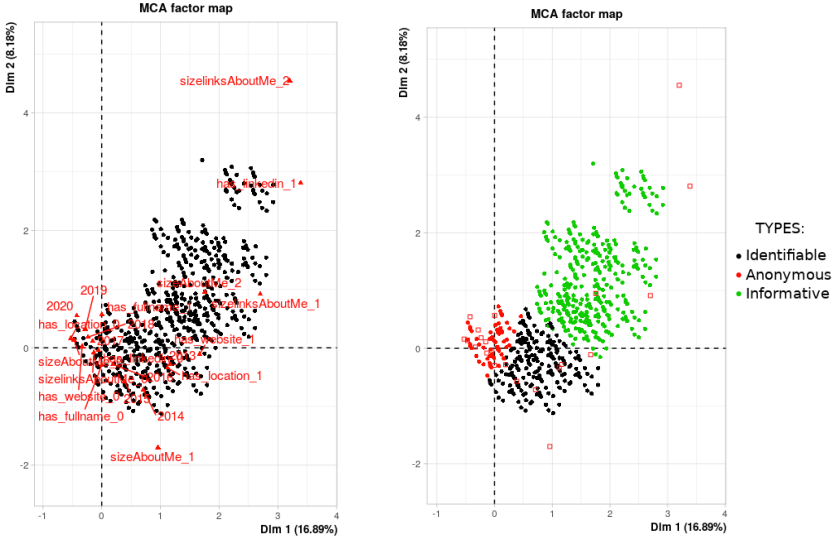
Multiple Correspondence Analysis + K-Means clustering



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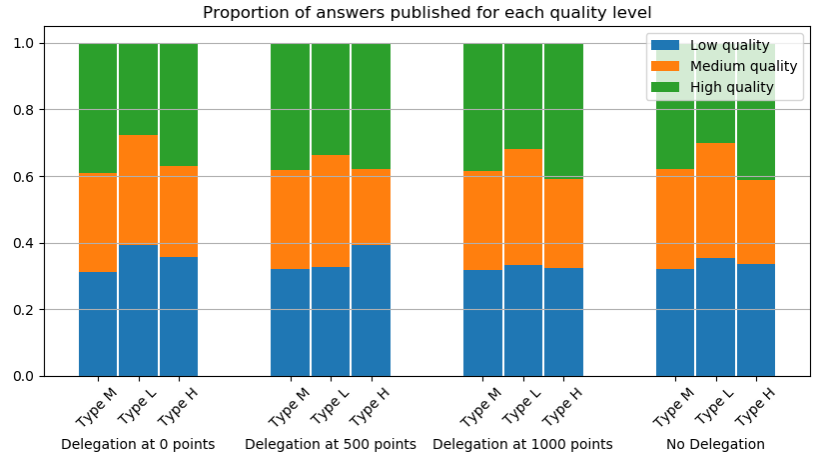
Flow utility parameters (sign refers to net benefit) back

$$U_{it} = \beta_0 R_{it} + \beta_1 CA_{it} + \beta_2 CE_{it} + \beta_3 cumT_{it} + \beta_4 Authority_{it} + \varepsilon_{it}$$

Variables	(no Heter.)	(*Anonymous*)	(*Identifiable*)	(*Informative*)
R	0.0074***	0.0061***	0.0056***	0.0044***
	(0.0001)	(0.0005)	(0.0002)	(0.0003)
CA	0.0004*	-0.3669***	0.00003	0.0007**
	(0.0002)	(0.0192)	(0.0004)	(0.0002)
CE	-0.6133***	-3.3660***	-4.4860***	-2.0967***
	(0.1661)	(0.6046)	(0.3161)	(0.2319)
cumT	-0.8409***	-0.4032***	-0.7842***	-0.8019***
	(0.0205)	(0.0310)	(0.0276)	(0.0548)
Authority	1.2052***	1.5394***	0.1702	1.4503**
	(0.1207)	(0.3577)	(0.2536)	(0.5118)
N. users	9,783	3,700	5,407	676
Sample size	991,657	471,837	407,098	112,722

$* p < 0.05$, $** p < 0.01$, $*** p < 0.001$

Counterfactuals: share of answers produced for each quality level



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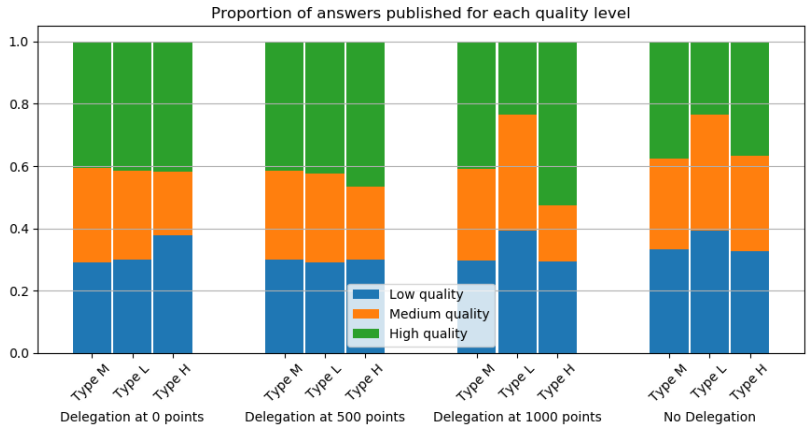
Counterfactuals: share of answers produced for each quality level



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Value for the acquisition of authority

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i.e. sensitivity to the **dynamic incentive**

User type	value in points	value in actions (avg)
Anonymous	252 points	33 posts
Identifiable	30 points	4 posts
Informative	329 points	28 posts

Details