Stack Overflow badges and user behavior
An econometric perspective

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Introduction

Stack Overflow is a question and answer community designed for programmers. It is the largest of 130 communities in the Stack Exchange network. Created in 2008, the knowledge organized by Stack Overflow has become a valuable resource for software developers. On January 20, Spoelsky (2015) announced that Stack Exchange had raised $40 million in venture capital funding. Stack Exchange gives users who ask questions access to expert technical help, users who answer questions build their reputation for technical expertise and use that reputation to find better jobs.

Although Stack Overflow's creation was rooted in computer science, the social sciences will provide important insights as the platform matures. There are a number of big picture questions to consider. How should Stack Overflow design its platform to maximize profits? Is the firm's profit-maximizing strategy efficient - does it maximize total surplus? How equitable is the profit-maximizing strategy - Stack Overflow creates value by improving job matches, how much of that value is captured by the platform, employers, and employees? What motivates users to contribute to Stack Overflow - how important are self-interested motives versus pro-social motives? What combination of reputation rules and badge awards maximize the quantity and quality of user contributions?

This paper takes a first step along the path of applying econometric analysis to publicly available Stack Overflow data. Specifically, I study how users behave around the time they are awarded badges. Taking a closer look at user actions, we find some badges are effective at motivating user contributions while others are not.

Rules of the game

Deterding et al. (2011) define "*gamification* as the use of game design elements in non-game contexts." Stack Overflow gamifies the process of asking and answering questions as follows. A user earns reputation points when another user votes on her posts (5 points when a question is voted up, 10 points when an answer is voted up, 15 points when an answer is accepted, and 2 points when an edit is approved). As a user earns reputation points she unlocks privileges on the site. For instance, a user must have at least 15 reputation points to vote up a question or answer.[1] Users are awarded badges for special achievements. One receives the *Informed* badge by reading the tour page.[2]

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[1] A full list of privileges and necessary reputation points is available at http://stackoverflow.com/help/privileges.

[2] The Stack Overflow tour can be found at http://stackoverflow.com/tour, and all badges are listed on http://stackoverflow.com/help/badges.

How users behave when earning badges

Grant and Betts (2013) present empirical evidence that three badges awarded for editing encourage recipients to make more edits in the two months preceding receipt of the badge compared to the two months after receiving the badge. This paper extends their findings by:

1. examining all types of user activity (posting questions, posting answers, and editing posts), and
2. comparing the impact of different badges. In addition to the three editing badges, this paper also looks at two badges awarded for asking questions.

Let y_{it} be the number of edits user i makes on day t, and t_i^* denote the day user i recieves the badge of interest. Following the approach of Jacobson, LaLonde, and Sullivan (1993), I regress the number of edits user i makes on day t on a user fixed effect α_i, a set of dummy variables indicating whether the user received the badge on day $t - k$, while controlling for day of the week effects γ_j

$$\log(1 + y_{it}) = \alpha_i + \sum_{k=-29}^{30} \mathbb{1}\{t = t_i^* + k\}\delta_k + \sum_{j=1}^{6} \mathbb{1}\{t \bmod 7 = j\}\gamma_j + \epsilon_{it}.$$

The model parameters are estimated using an ordinary least squares regression, and standard errors are clustered at the user level. Figure 1 plots the expected number of actions taken on the k'th day since receiving the badge

$$f(k) = \mathrm{E}\left[\log(1 + y_{it}) \mid t = t_i^* + k\right].$$

The 95% confidence interval is tight around the linear prediction, standard errors were calculated using the delta method (Williams 2012). Figure 1 confirms the findings of Grant and Betts (2013). Editing increases gradually before receiving a badge for editing, with a large jump in activity on the award day. We also see that editing drops quickly after receiving the badge and gradually declines over time. It's interesting to see how few questions were asked by the recipients of the editing badges in the two months around receiving the badge, and to see that the rate of answering questions tends to be constant throught the two month window.

Figure 1 also plots user activity around receiving badges for asking questions. User activity around question badges differs in interesting ways to badges for edits:

1. All types of actions tend to increase in the thirty days leading up to earning the badge. In Figure **??**, only edits increase. In Figure **??**, the number of questions, answers, and edits posted all increased.

2. User activity stops almost immediately after receiving the badge.

| Name	Description	Number	Balanced
Strunk & White	Edited 80 posts	7,073	6,923
Copy Editor	Edited 500 posts	1,288	1,207
	(excluding own or deleted posts and tag edits)		
Archaeologist	Edited 100 posts that were inactive for 6 months	691	622
Curious	Asked a well-received question on 5 separate days,	138,264	1,463
	and maintained a positive question record		
Inquisitive	Asked a well-received question on 30 separate days,	14,081	160
	and maintained a positive question record		

Table 1: Badges of interest
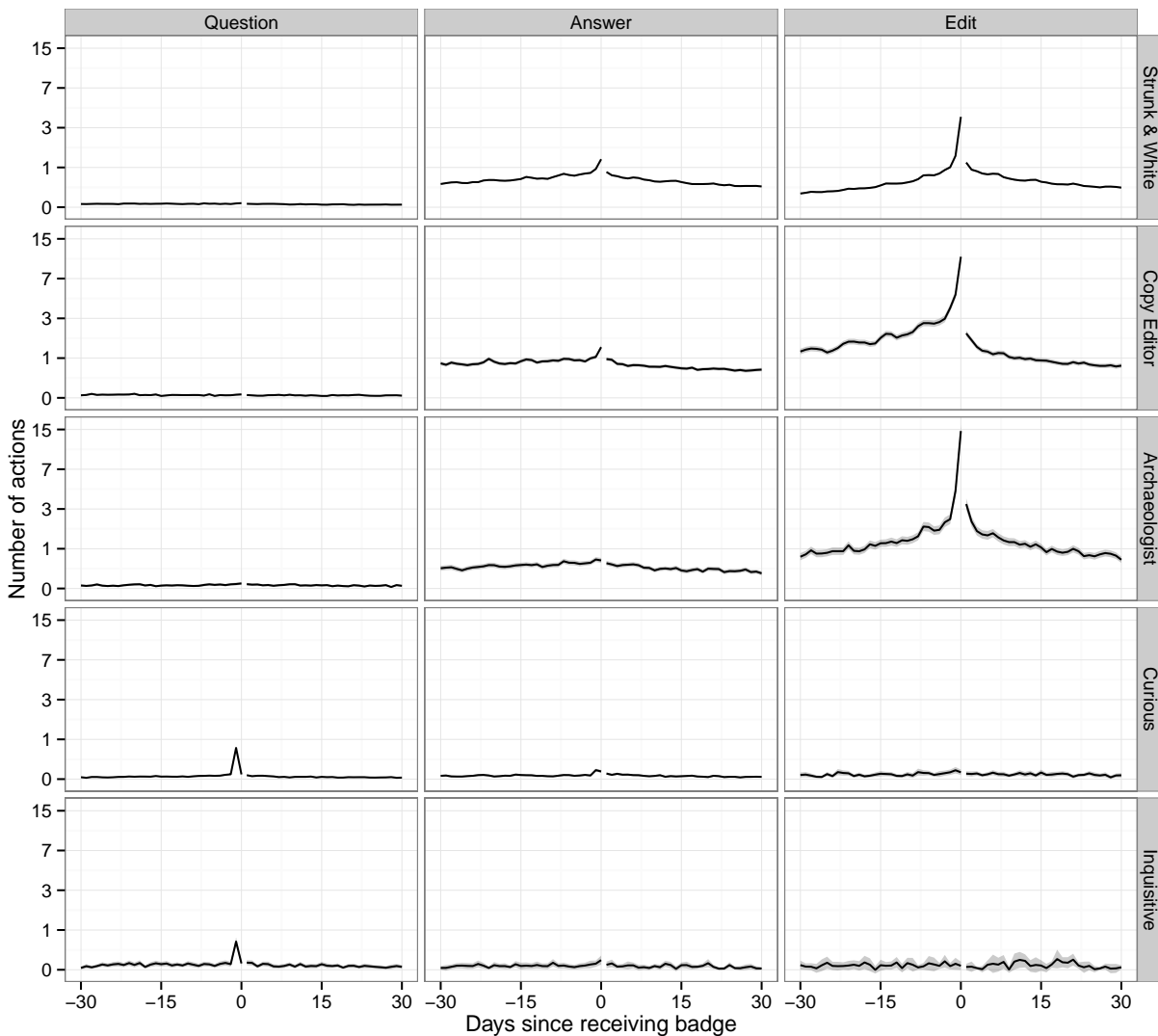
Figure 1: User activity over time

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Conclusion

Stack Overflow provides a platform for job searchers to signal their ability by answering difficult technical questions publicly. Unlike Spence's (1973) model of job market signaling, Stack Overflow enables job searchers to signal their ability in the form of a valuable public good.

When interpreting the empirical results of this paper, please consider Holland and Rubin's motto "no causation without manipulation" (Holland 1986). There is no manipulation of the explanatory variable in this study, consequently we have not identified the causal effect of badges. To estimate the causal impact of badges on user activity we need to find a source of exogenous variation (Miller 2013).

This paper confirms the empirical observation of Grant and Betts (2013), on average users who receive a badge for editing make more edits in the 30 days prior to receiving the badge compared to the 30 days after receiving the badge. In addition, we show that the average number of questions and answers posted do not change around the receipt of an editing badge. Finally, we show that users who received badges for asking questions behaved differently. In particular, we found that

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