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On the effects of authority on peer motivation: Learning from Wikipedia

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Research Summary: We investigate the conditions under which authority can be deployed without reducing subordinate motivation. We show that lateral authority, the legitimacy to resolve task-specific problems, is welcomed by members of an organization in the resolution of coordination conflicts, the more so (a) the fiercer the conflict to be resolved, (b) the higher the competence-based status of the authority, (c) the lower the tenure of, and (d) the more focused the organizational members are. Analyzing the discussion behavior of members of Wikipedia between 2002 and 2014, we corroborate our allegations empirically by analyzing 642,916 article–discussion pages. Our findings, obtained for a modern collective production community, provide learning opportunities for how traditional organizations may want to govern activities of their idiosyncratically motivated staff.

Managerial Summary: When managers use their (legitimate) power to take decisions on behalf of their staff, they risk setting back employees and making them detach from the firm. This danger is particularly salient whenever highly motivated teams of staff autonomously work on corporate problems and are used to governing themselves. Examples range from skunkwork initiatives within traditional firms to entire team-based organizations, such as Valve or Zappos. When and how managers can add value by resolving conflicts within and across these teams once their self-organization fails is what we study in this article. Inspired by data from Wikipedia, we suggest that managers should not intervene prematurely, benefit from visible competence, and are respected most for their actions by specialized peers who recently joined the organization.

1 | INTRODUCTION

Few questions in the field of strategic management merit more attention than that the one of what
limits the use of managerial authority. After all, the discipline's raison d'être—studying firms because
they can outperform markets—hinges on the very image of executives having the power to demand
their subordinates' obedient behavior within a specified realm of actions (Coase, 1937; Weber, 1921).
Exerting such authority, however, appears to come at a cost. This article explores how firms may
deploy authority without incurring a major cost: their intrinsically motivated employees reducing
their efforts toward the corporation. To this end, we provide an in-depth study of the use of authority
within an organization that has managed the above splits while becoming a major competitor to
incumbents in its industry: Wikipedia. Our findings, despite being obtained in the context of a not-
for-profit entity, appear generalizable to many corporate settings where restricted forms of managerial
authority are intended to help resolve coordination conflicts among intrinsically motivated staff—for
example, in skunkworks, in crowdsourcing processes, and in pressure groups. Moreover, they seem
relevant and timely in the context of the burgeoning debate of hierarchy-less management by corpo-
rations such as The Morning Star Company, Valve, and Zappos.

We frame our arguments by recalling that firms traditionally employ positional authority as the
default mechanism for dividing labor and integrating effort—the latter including conflict resolution
(Lawrence, Lorsch, & Garrison, 1967; March & Simon, 1958). But they usually pay a price for exert-
ing their power, which can manifest in many ways, depending on the type of controversy (pure incen-
tive conflict vs. coordination conflict with asymmetric equilibria) and the type of authority a superior
holds (person- vs. task-related). When superiors and subordinates have distinct dominant strategies,
centralizing decision rights safeguards a principal's interests; however, it also increases his or her costs
of monitoring her agents (Cruz, Gomez-Mejia, & Becerra, 2010; Jensen & Meckling, 1976; Le
Breton-Miller, Miller, & Lester, 2011; Nyberg et al., 2010; Wowak & Hambrick, 2010). When subor-
dinates and their bosses have similar preferences but disagree about the optimal way to attain their
common goal,[1] exercising authority may resolve the coordination problem at hand; however, it may
come at the expense of subordinates rationally reducing their effort (Van den Steen, 2006). To ensure
continued employee participation in corporate activities in any case, managers can often reduce the
above costs, whether monitoring expenses or employee detachment, by providing extrinsic incentives
effectively. In at least two instances, however, financially mitigating the downside of exercising
authority becomes unfeasible. First, resource-constrained organizations—for example startups—may
lack the slack cash required to provide additional pecuniary rewards. Second, financial compensation
may be ineffective, if not counterproductive, for incentivizing staff who are highly intrinsically moti-
vated (Gubler, Larkin, & Pierce, 2016). This raises the question of how firms can govern their
employees at all when the latter are driven by a passion for their own ideas—for example, personnel
working in R&D.

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[1]The classic example would be a battle-of-the-sexes coordination game.

Building on earlier work, we argue that the use of "lateral" authority (Dahlander & O'Mahony, 2011)—the legitimacy to exercise power over project-related tasks as opposed to co-workers' careers—may offer a design solution when either of the two above restrictions apply. Although lateral authority is observable in a variety of corporate settings, most of our current knowledge of it stems from the study of online peer communities. Innovation collectives, notably open source software (OSS) communities, are stereotypical of organizations in which highly intrinsically motivated members (Lakhani & Wolf, 2005; Roberts, Hann, & Slaughter, 2006) contribute voluntarily to the organization and are often not incentivized financially (Jeppesen & Frederiksen, 2006; Shah, 2006). To resolve internal coordination conflicts, the collectives rely on lateral authoritative governance, and it appears that this approach does not demotivate their members as much as it would in other settings. That being known, pressing questions remain regarding the best use of such authority—such as when to intervene, for whom to intervene, and which reactions to authoritative intervention to expect from different types of contributors.

In this article, we examine the above questions using a novel approach. For our study we resort to the context and data of a major collective production community: Wikipedia. Its workings seem relevant for strategy scholars from at least two angles—mechanistic and phenomenological. Mechanistically, Wikipedia not only lends itself to studying questions of shared leadership (Zhu, Kraut, & Kittur, 2013), but if also offers an ideal testing bed for our research questions pertaining to individual lateral authority. Whereas the use of restricted forms of lateral authority matters in many corporate settings in which managers merely coordinate pools of highly motivated and largely self-organized collectives, traditional managerial and lateral authority will often still be entangled, rendering empirical identification of micro mechanisms difficult. In Wikipedia, by contrast, not only are contributions to the collective voluntary, but lateral authority used for coordinative purposes is also cleanly separable from the use of other authority (Forte, Larco, & Bruckman, 2009). Phenomenologically, Wikipedia is an important organization by any measure, serving 500 million unique users every month—only Facebook, Google, Microsoft, and Yahoo have more visitors (Cohen, 2014)—providing more than 45 million articles in 290 languages; it is also the largest website run by a nonprofit institution, the Wikimedia Foundation. Its alternative form of organizing is thus not restricted to serving a niche market, but has become a very real threat to the annual multibillion-dollar business of extant competitors globally. Understanding how such a large, decentralized, and virtually operating entity manages the multitude of conflicts among its members without losing more contributors than it gains appears critical to management scholars. Drawing on our data, we first establish that authoritative exception management—the resolution of unforeseen events by legitimized power—need not lead to motivational losses among contributors overall. In addition, we argue and find that contributors embrace authoritative intervention more (a) the fiercer the conflict they resolve, (b) the more authorities are legitimized through competence-based status, and (c) the less tenure organizational members have and the more focused they are on specific projects.

Our study speaks to strategy scientists and executives alike. By demonstrating that restricted forms of authority, notably lateral authority to resolve coordination conflicts, can be exercised without having to counterbalance motivational losses, we raise several design-related questions; among them, how bestowing different forms of authority—to task allocation, incentivization, and exception management—to different persons within the firm may benefit organizations. Colleagues studying disruptive innovation across industries may find the learnings from Wikipedia insightful in order to predict under which conditions collective production of public goods may substitute for private business. We discuss the generalizability of our findings to other organizational settings in more detail toward the end of this article.

2 | THEORY AND HYPOTHESES

2.1 | Managerial and "lateral" authority—The scope of perceived legitimacy to exercise power

Authority denotes a superior's legitimate ability to demand a subordinate's obedient behavior within a specified realm of actions (Simon, 1951). Weber's (1921) work marks the beginning of modern studies on the question of what legitimizes individuals to exercise such power. He suggests that when subordinates accept a superior's decision without independently examining its merits, they do so because they (1) believe in the legality of the system endowing the superior with her authority, (2) do not question accustomed mores and habits, or (3) are inspired to follow the superior because of her heroic or divine Gestalt. Simon's definition and Weber's reasoning have endured over many decades (Blau, 1964; French, Raven, & Cartwright, 1959; Gamson, 1968; McIntosh, 1970; Parson, 1958) and continue to shape our thinking. However, recent work has refined our theoretical understanding in two ways important for this article.

2.1.1 | Scope of legitimacy

First, scholars acknowledge that the scope of power that persons may be perceived as legitimately holding can vary significantly across contexts. Of the different authoritative forms deployed across organizations, the two of particular interest here are traditional managerial (a.k.a. vertical) authority and "lateral" authority. Managerial authority gives superiors the right to incentivize and sanction their subordinates within classical hierarchical relationships; lateral authority solely gives its holders the right to make decisions on project-related work without bestowing on them the legitimacy to affect the careers of others. The latter term, coined by Dahlander and O'Mahony (2011), recalls the thoughts of (Follett et al., 1941/2003), who introduced the concept of horizontal authority. According to her, (asymmetric) "sideways" influences (as Simon, 1947, would later put it) are prone to emerge within organizations. These influences help peers resolve their internal conflicts without having to invoke the corporation's line of command. Dahlander and O'Mahony's concept of lateral authority marries Follett's thinking with the work of contingency theorists on lateral connections within firms (Galbraith, 1973). In essence, it denotes the legitimate power to coordinate task by task between peers, representing a narrower managerial authority. Conceived of in the context of traditional firms, lateral authority is increasingly studied among nontraditional organizations, notably online peer communities.

2.1.2 | Perception of legitimacy

Second, social scientists today agree that superiors neither fully possess nor completely lack authority—irrespective of its scope—but that their perceived legitimacy can vary along the entire spectrum of subordinates' acceptance of leaders' actions, leaving leaders' decisions less or more contested by their followers (Fox et al., 1977; Read, 1974; Skitka, Bauman, & Lytle, 2009; van der Toorn, Tyler, & Jost, 2011). On the one hand, variation in such perceived legitimacy seems to be correlated with a superior's personal attributes. Personal attraction (Berkowitz, 1957; French & Snyder, 1959), tenure with the organization (Read, 1974), and task-based competence (Hamblin, Miller, & Wiggins, 1961; Hollander, 1960; Hollander & Julian, 1970) have been identified in particular as personality traits of leaders that legitimize their authority—just like "the favorability of the outcomes that [superiors] dispense, and [.. .] the degree of outcome control that they are seen as possessing" (van der Toorn et al., 2011, pg.127). On the other hand, the attributes of the perceiver of such

authority, such as her dependence on the resources the authority commands, also affect perceived legitimacy (Overbeck & Park, 2001).

2.2 | The benefits and costs of using managerial authority

Organizations, particularly bureaucratic ones, overwhelmingly resort to managerial authority to divide labor, integrate effort, and resolve incentive and coordination conflicts (Puranam, Alexy, & Reitzig, 2014). While its benefits are trivial, deploying managerial authority is also costly. Using power to resolve obvious *incentive* conflicts (as in the typical Principal–Agent Problem, e.g., Jensen & Meckling, 1976) increases monitoring costs for managers. Using power to resolve *coordination* problems (Schelling, 1984) between superiors and subordinates can lead to costs that manifest as motivational losses among employees. Notably, motivational losses may arise when decisions are centralized but subordinates believe they can make better decisions at a decentralized level. When subordinates lack trust in their superiors' understanding of the relationship between quality and subordinate effort, this leads subordinates to underinvest in their work (Van den Steen, 2006). Field-empirical and experimental studies both confirm the relevance of related psychological mechanisms to those proposed by Van den Steen (2006). Building on work in social psychology (Fragale et al.*,* 2012; Glass & Singer, 1972; Parker, 1993; Pennebaker et al.*,* 1977; Seligman, 1975; Wortman, Brehm, & Berkowitz, 1975), organizational scholars recently suggested (Fang, Kim, & Milliken, 2014) and empirically corroborated within the setting of bureaucratic for-profit corporations (Reitzig & Maciejovsky, 2015) that subordinates may detach from corporate-wide decisions the more they are removed from the locus of decision-making through layers of authority.

When individuals detach because of experiencing a superior's authority, in many instances this effect can at least partly be offset by management through the provision of extrinsic incentives. The very notion of Simon's (1947) "zone of indifference," within which employees are willing to accept a superior's authority, has traditionally been deemed a function of monetary remuneration—and it appears that giving more money to subordinates to have them follow more commands has worked well for many bureaucratic firms in the past. In at least two instances, however, this approach stops short of its goals. First, and obviously, it fails when the organization is financially unable to provide sufficient monetary incentives. Second, and more subtly, providing financial incentives may be counterproductive to soliciting acceptance for heteronomy or other-directness among those employees who engage with the organization out of a largely intrinsic motivation as defined by Ryan and Deci (2000, p. 56): "the doing of an activity for its inherent satisfactions rather than for some separable consequence." This so-called crowding-out of intrinsic motivation through the provision of financial incentives (Frey & Jegen, 2001) has been empirically corroborated repeatedly, also within traditional organizational settings (Gubler et al., 2016).

2.3 | Conditions for the effective use of "lateral" authority

In corporate life and in the world of organizations more broadly, however, there appear to be instances in which the benefits of authority in resolving issues among participants can be enjoyed without incurring the costs of either their detaching or needing financial compensation as such. Many successful skunkworks initiatives within R&D-heavy organizations begin as internal ventures with little or no budget, drawing solely on the idiosyncratic motivation of their members. Their often informally elected heads cannot reward team members financially, not even when authoritative coordination creates a situation in which one person's views are overruled in favor of another's. Yet such ventures often flourish and grow. Similar situations can arise among corporate pressure groups or

within successful corporate ideation campaigns that depend on voluntary participation. Arguably, all the aforementioned initiatives rely on a form of governance in which self-coordination is complemented by lateral authority that is legitimized bottom-up. Elected leaders have no power to directly influence their peers' careers or standing in the community (Mateos-Garcia & Steinmueller, 2008), and a leader's role is mainly to coordinate rather than to incentivize or sanction. However, they do enjoy legitimacy, albeit to various degrees, as a mechanism for resolving burgeoning conflicts in which different parties have asymmetric preferences for corporate outcomes but may overall always gain from coordinating. Nowhere are the mechanics of this form of authority as cleanly observable as in nontraditional production communities, notably online peer communities. Not only are they textbook examples of organizations in which financial remuneration is not offered (von Hippel & von Krogh, 2003), the institutionalized exclusive use of lateral authority also prevents a person's shadow of managerial authority from potentially distorting the perception of her actions—something that may happen in a corporate context in which a person holds both managerial and lateral authority across two different domains simultaneously.

Reiterating the insights on the varying *scopes* of legitimate power, we can thus explain why the presence and exercise of lateral authority creates lower costs of peer detachment for a self-organizing collective than does that of managerial authority, all else being equal. How low the costs of deploying lateral authority may be, however, is likely a function of the *(perceived) legitimacy* of exercising power. Such legitimacy, so we argue, may be driven by a variety of contextual and individual determinants.

2.3.1 | When to intervene

Lateral authority can be exercised at different stages. In those better-documented instances from either the corporate or not-for-profit domain, in which some form of lateral authority eventually prevails, peers initially rely on self-coordination when conflicts arise (Forte et al., 2009; Jensen & Scacchi, 2005). Such disputes about the right course of action are often debated among the peers involved, without their resorting to a referee or other higher authority. They would expect to have sufficient opportunity to reconcile different views and to experience intervention solely when their own attempts of finding a solution take too long or seem to fail (Arazy et al., 2011). The very notion of restricting the scope of lateral authority to resolve specific task-related conflicts indicates its "ultima ratio" purpose: the use of authority as a last resort, confined to the termination of an otherwise badly managed situation. The ability of the organization—be it a not-for-profit community or a corporate team of peers—to self-govern a critical situation relies on its members' mutual respect, their ability to listen to one another, and their valuing a functional, tolerant discussion over particular self-interests. When these conditions are not met, debates grow fierce and conflicts are less likely to be reconciled without authoritative intervention. We thus argue that authoritative interventions are more appreciated the fiercer the discussion leading up to them. The less controversial a prior discussion, the more the intrusion of an authority might create negative sentiments that recall the peers' loss of control over their own affairs. Assuming (a) that authoritative intervention frees some of the peers' resources formerly devoted to resolving a coordination conflict, and (b) that peers can choose how many of their regained resources to dedicate to other activities within the organization, we thus **measure** a peer's *"embracing of authority"* as the amount of regained resources from one activity that she devotes to another activity within the same organization. Against this definition of authority embracement, we posit:

Hypothesis 1 (H1) *The fiercer a coordination conflict resolved by a lateral authority within an organization, the more organizational members will embrace the exercise of her power, all else being equal.*

2.3.2 | For whom to intervene—Competence and perceived legitimacy

Particularly when self-coordination is the default way of organizing, the competence of an individual drives her recognition by peers and her rise within the organization. Within The Morning Star Company, for example, one of the most prominent instances of a commercial firm dismissing the use of managerial authority altogether, "moving up is about competency and reputation," according to founder and president Chris Rufer (Hamel, 2011). If that is so, however, competence should be of similar, if not higher importance within a peer organization that was to bestow some level of lateral authority on distinct members. More specifically, the perceived competence of a person exercising authority should affect her perceived legitimacy as a coordinator, thereby moderating the acceptance of her actions by her peers.

Indirect support for such an argument comes from research on innovation communities, showing that such collectives tend to confer authority on a meritocratic basis (Kogut & Metiu, 2001; Lee & Cole, 2003; Moon & Sproull, 2010). Across cases, authors corroborate that individual technical competence and the ability to coordinate are key to assuming positions of authority within the organization (Dahlander & O'Mahony, 2011; Fleming & Waguespack, 2007; O'Mahony & Ferraro, 2007). Jointly, these prior works clearly emphasize the importance of a person's competence to assume a position of authority within a community. They also reveal that the process of allocating authority based on observable competence necessarily produces variation. Not all community leaders seem equally capable or have identical records.

Yet, whereas the objective competence of an individual should positively correlate with her legitimacy to exercise power, *perceptions* of such legitimacy may still differ across fellow peers, all else being equal. Notably, as van der Toorn et al. (2011) point out, the perception of authority should be a function of the perceiver as much as of the coordinator herself (van der Toorn et al., 2011: 114). Related prior work proposed and corroborated that perceivers of authority would legitimize the latter more strongly the more perceivers depend on authorities for resources in their work (Overbeck & Park, 2001). This also means, however, that if competence was viewed as a resource truly critical to determining the best solution to a coordination conflict, we would expect relative competence differences between authorities and peers to increase peers' willingness to accept a decision by one authority as opposed to another.

Relative differences in proven competence between two individuals, however, are known to account for these individuals' positional differences within their social environment. Put differently, they constitute differences in the competence-based status between the two parties. We therefore posit

Hypothesis 2a (H2a) *The higher the competence-based status of a lateral authority, the more members within her organization will embrace the exercise of her power when resolving a coordination conflict, all else being equal.*

Naturally, status is a multi-dimensional construct. It not only speaks to perceived difference in competence. More generally, status can arise through occupational membership (Blau & Duncan, 1967) or affiliations with distinct others (Berger, Cohen, & Zelditch, 1972), without these being necessarily characterized by superior competence. As Sorenson (2013) points out, status stems from position—

irrespective of whether it was acquired through reputable actions. When an individual's reputation is not observable from her record, her overall status often serves as a substitute to predict the quality of her actions (Podolny, 1993). Yet, while status may not always be attributable to prior actions, there are instances in which it can be acquired through the latter (Sorenson, 2013). The more easily one's reputation—derived from trackable past achievements—becomes observable and assessable to others, the more one's prior actions should contribute to one's overall status within a group, and the less important other potential indicators of one's relative position in the group should become. In the context of legitimizing an individual's lateral authority, so we argue, prior actions should thus assume paramount importance. Lateral authority is used to manage exceptions (Puranam et al., 2014) in the process of self-governance among peers; as such, every peer's prior contributions to achieving the team's common goal are observable to all members of the organization. Secondary indicators such as a peer's relative seniority—in other scenarios used to predict the quality of judgments that have credence attributes (Ghosh & Moon, 2005; Sorenson, 2013)—should, in this situation, pale in comparison to the weight that trackable competence-based status carries in legitimizing the exercise of power. Hence we posit

> **Hypothesis 2b (H2b)** *When resolving a coordination conflict, a lateral authority's competence-based status leads to more embracement of her exercising of power than her seniority-based status, all else being equal.*

2.3.3 | Which reactions to expect—Effects of peer tenure and activity

Third and finally, it makes sense that heterogeneity in the acceptance of authoritative interventions will not only be driven by the fierceness of the conflict to be resolved and by the competence differences between an authority and her peers. The recipients of the authoritative verdict will react differently to the exercise of power, independently of who exercises it. A person's absolute tenure with the organization may affect how she responds to authoritative intervention. Related prior work by Snyder, Williams, and Cashman (1984) examines the effects of employee tenure on the rejection of performance feedback. The authors propose and find negative effects of an employee's tenure on her acceptance of performance feedback. Like Ilgen, Fisher, and Taylor (1979), they reason that the hardening of internal convictions and standards with increased employee tenure leads to the observed behavioral patterns. Although receiving performance feedback and experiencing the resolution of a coordination conflict through a lateral authority are two different scenarios that may trigger different behavioral responses by peers, they have some similarities. Notably, prolonged tenure of a peer may leave her feeling entitled to act in accordance with established mores and norms of her organization. This means, however, that even if she was positively reacting to the exercise of lateral authority overall, she might embrace interventions less the longer she has been with the organization. Post conflict resolution, she would thus reallocate less of her freed-up resources to novel projects within the organization. In summary, we would expect to observe the following:

> **Hypothesis 3a (H3a)** *The longer the tenure of a member within an organization, the less she will embrace the exercise of power by a lateral authority when resolving a coordination conflict, all else being equal.*

Finally, members who are very invested in one conflict will likely appreciate the result of resolving that particular conflict more than those users who have spread their efforts across many projects. Invoking fundamental arguments from behavioral strategy more broadly (Ocasio, 1997; Simon,

1947) we suggest that contributors with a diverse profile of project activity may simply not pay enough attention to one particular conflict at a time to understand and appreciate why and how it was resolved by an authority. The contrary should hold for those members of the organization who have spent effort and time in shaping a particular project and have substantially invested in self-coordination. Hence we posit:

> **Hypothesis 3b (H3b)** *The higher the concentration activity of a member within an organization, the more she will embrace the exercise of power by a lateral authority when resolving a particular coordination conflict, all else being equal.*

3 | EMPIRICAL SETTING AND TESTING LOGIC

3.1 | Setting

The empirical setting used for this study is the English-language version of Wikipedia. Launched in 2001, Wikipedia is as of this writing the fifth-most-visited website in the world.[2] With more than five million article pages and more than 100,000 active editors[3] working to create the world's largest, most comprehensive free encyclopedia, Wikipedia is one of the largest examples of a non-traditional production community. All Wikipedians are unpaid volunteers,[4] and their reasons for joining and contributing to Wikipedia range from prosocial behavior (Cho, Chen, & Chung, 2010) to experiencing a sense of belonging (Xu & Li, 2015) and enjoyment (Rafaeli & Ariel, 2008). Thus, Wikipedia and OSS projects are relatively similar in terms of member motivations and contributor rewards, with the potential difference being that participation on Wikipedia may not increase a contributor's hiring potential for a commercial firm as much as her contribution to an OSS project might.

Anyone, whether Wikipedian or nonregistered user, can contribute to Wikipedia ("the free encyclopedia that anyone can edit") (Gorbatai, 2014). Contributions can be made by editing so-called article pages. The Wiki technology enables any user, even without previous experience, to revise an article page. Often, multiple users work on the same page simultaneously. Therefore, each article page (e.g., a page on the life of former U.S. president Abraham Lincoln) is accompanied by its discussion-page counterpart, or talk page. On a talk page, contributors to Wikipedia can discuss changes to the corresponding article page and coordinate on how to further develop it (Kittur et al., 2007; Medelyan et al., 2009; Viegas et al., 2007). Users have two pathways for changing a Wikipedia page's content: by directly revising parts of the article page—anticipating that the community will accept their suggested alteration (and not undo it)—or by discussing their proposed change on the talk page before implementing it (Piskorski & Gorbatai, 2017). Thus, talk pages are especially important for coordinating and planning tasks (Kane, Johnson, & Majchrzak, 2014; Schneider, Passant, & Breslin, 2011); they are the coordination device that is most easily accessible and visible to all potential contributors, registered and unregistered, of an article page (Jemielniak, 2014).

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[2]According to alexa.com (http://www.alexa.com/topsites), accessed July 25, 2017.

[3]According to Wikipedia (https://en.wikipedia.org/wiki/Wikipedia), accessed July 25, 2017. By "active" Wikipedia refers to editors that "have made one or more edits in the past 30 days."

[4]The Wikimedia Foundation pays several employees to maintain the Wikipedia platform. Employees are not paid for editorial work, however. Some contributors are paid by third parties for their contributions to Wikipedia; this activity is highly controversial.

3.2 | Authority in Wikipedia

In 2002 the founder of Wikipedia, Jimmy Wales, introduced the role of administrator[5] to help coordinate the increasing number of contributors and to ensure the encyclopedia's quality (Forte et al., 2009). Without using the exact same terminology prior scholars would have employed, the type of authority he intended to bestow on administrators matches almost perfectly the definition of lateral (as opposed to traditional managerial) authority.

> I just wanted to say that becoming a sysop [administrator] is *not a big deal*. . . . I want to dispel the aura of "authority" around the position. It's merely a technical matter that the powers given to sysops are not given out to everyone. I don't like that there's the apparent feeling here that being granted sysop status is a really special thing. (Wales, wikimedia.org archive entry, February 11, 2003)

Consequently, any Wikipedian can apply to become an administrator, or "admin" ("Request for Adminship"). If a consensus of active admins and users emerges on the application (which conventionally equates to about 80% approval), the applicant obtains admin status and, with it, access to several functions not available to regular members, among these the right to (a) (un)block user accounts, (b) remove or apply page protection, (c) delete or move pages, and (d) edit fully protected pages.[6] Although there are no official requirements to become an admin, aspirants to this position are expected to have sufficient experience with the Wikipedia community and guidelines and to have regularly contributed to Wikipedia articles before applying (Burke & Kraut, 2008). The community guidelines also emphasize the admin's role as "custodian," one who focuses on maintenance tasks and conflict resolution, rather than as "police or judges" (Forte et al., 2009).

Wikipedia, as part of its transparency policy, makes all interactions, changes, and discussions available to the public. Therefore, contributions to an article page or to a discussion, contributions by particular users, and interventions and actions by admins are all trackable. We exploit this observability for our study.

3.3 | Methods and identification strategy

The objective of our empirical tests is to determine the effect of authority on contributor effort; specifically, we seek to scrutinize under which conditions the legitimate exercise of power deployed to resolve coordination conflicts would not significantly reduce or might even increase a contributor's motivation to engage within Wikipedia. But whenever authority is used, pursuing the above question requires assessing the effort that contributors would have invested without intervention. We suggest that one viable way to test our research questions is to track how contributors spend their time *overall* once a *specific* conflict has been ruled on by a person with authority.

Based on the above, we argue that an individual should reduce her self-coordination effort on a specific problem once an admin intervenes. If that reduction of effort is (at least partly) accompanied by her increased engagement with community activities elsewhere, however, we interpret this as evidence for acceptance of lateral authority in the first place.[7] Finally, the more that peers

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[5]Alternatively called system operator (sysop).

[6]Refer to https://en.wikipedia.org/wiki/Wikipedia:Administrators, accessed October 10, 2015.

[7]Note that peers may not be able reallocate all of their freed-up resources even if they are not irritated by the authoritative intervention at all. There may simply not be equally much for them to do on other pages. Put differently, embracing authority on a focal pages does not require a complete re-allocation of resources to other pages.

engage in such community activities elsewhere, the less problematic (or even more desirable) the initial use of authority should have been. Thus, our general research questions translate into the following concrete empirical investigations: (1) Do peers reduce their effort to self-coordinate on a specific problem once an admin steps in to help resolve the problem? (2) Do they take their spare time to other problems within Wikipedia? (3) And if so, what drives how much they do so? Affirmative answers to questions 1 and 2 will establish Wikipedia as a testing bed in which lateral authority shows the theoretically expected effects. Pursuing question 3 will shed light on our Hypotheses 1 through 3b.

We follow an identification strategy consisting of two difference-in-differences (DID) analyses (called Analysis 1 and Analysis 2), comparing contributor effort prior and post focal page restriction for different groups of Wikipedians – those active (treatment) and those inactive (control) on restricted focal pages. This strategy deploys the dual nature of contributor effort as (a) a measure of individual engagement in or motivation for contributing to a given topic, and (b) a measure of individual effort dedicated to resolving coordination conflicts between peers. First, we look at users' efforts on discussion (talk) pages for articles with and without authoritative intervention. We argue that such interventions by admins in the form of article-page restrictions denote instances in which coordination conflicts over the right course of action prevailed between peers before the restriction. Thus, we propose that the admin's authoritative intervention should reduce the need for peer-to-peer coordination. Contributors would reduce their participation in the discussion-page counterpart of the restricted article page following intervention, yielding to the admin's decisions.

Second, we then track the overall coordinating contribution behavior to Wikipedia by those individuals affected by the restriction of the focal page. If they reallocate at least part of their effort to unrestricted pages beyond the levels of what a control group of other users would do, we conclude that the admins' authoritative intervention on the focal page was welcomed. Figure 1 summarizes the two-step analyses regression logic: per the above, in Analysis 1 we test whether contributors reduce their effort on a restricted page. To establish that they do so because they see a reduced need for coordination (and are not simply frustrated with the intervention by the admin), we run several Analysis 2 regressions in a second step: here, we test whether and how contributors, affected by a restricted article page, change their effort to Wikipedia overall. If they exert more effort on nonfocal pages than before (compared with a control group), we can interpret this as a reallocation of their freed-up
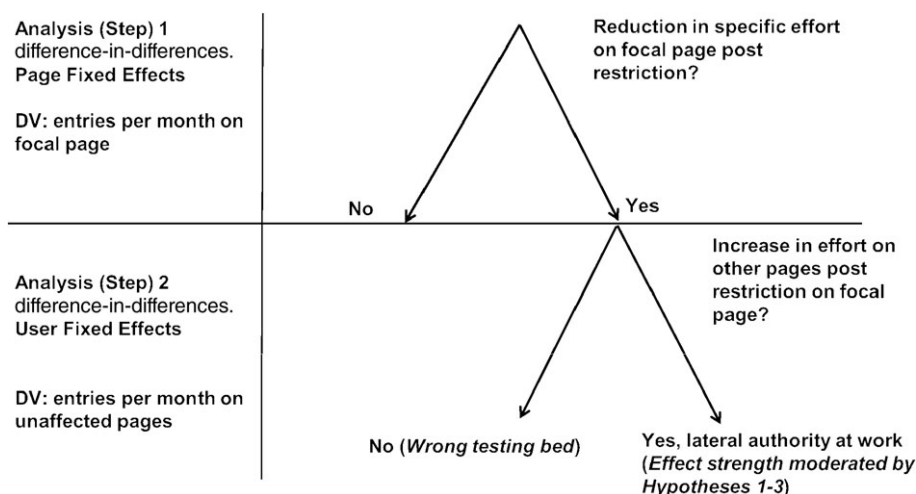

FIGURE 1 Identification strategy. *Note.* DID = difference-in-differences

resources from the focal-page activities. Importantly, contributors do not have to reallocate their total effort to other pages to embrace authority. As long as contributors do not reduce their effort on nonfocal pages as well, this would support our identification strategy.

In both Analyses 1 and 2, we treat the focal-page restriction as a shock that affects all contributors to the focal page. For our Analysis 1, we observe how average effort on the specific page changes due to the restriction. For Analysis 2 we observe how these (treated) contributors change their overall coordinating effort to Wikipedia after being affected by a page restriction. To that end we track their contributions to nonfocal pages on which they had been active around the time at which the focal page was restricted. We measure user contribution to Wikipedia pages one month before and after the focal page is restricted. To control for other possible influences, we estimate a DID model between treated contributors and unaffected contributors before and after page restriction. In order to determine the treatment group of users (identical for Analysis 1 and 2), we focus on all article pages that were restricted at least once, leaving us with a total of those 23,928 pages. Of these we use 6,379 pages on which we find users that (a) are active on the focal page 1 month before the restriction (we refer to this activity as Treatment Page Activity – TPA), and (b) show activity on nonfocal pages at the same time (we refer to this activity as Non-Treatment Page Activity – NTPA).

To identify suitable control groups of users (identical for Analysis 1 and 2), we first identify unrestricted pages that are similar to restricted 6,379 pages mentioned before. Here we rely on propensity score matching (PSM) at the page level. Matching criteria included topic, form of discussion and activity by users and admins (all at page level). Appendix A1 (Appendix S1) lists all variables deployed in the PSM.[8] Following this approach, we identify 4,651 control pages on which users fulfill further analogous inclusion criteria: being active on both (a) the control page one month prior to the pseudo restriction (we refer to this activity as Control Page Activity – CPA) and (b) on other pages at the same time (we refer to this activity as Non-Control Page Activity – NCPA).

Next, we identify the contributors that are active on treated or control pages one month before a restriction. We compute monthly contributions for treatment and control groups at the user level one month pre and post restriction. For Analysis 1, we focus on the activity of users on treatment and control pages pre and post restriction, whereas for Analysis 2 we compare these users' activities pre and post restriction date on the other pages they had been active on a month prior to restriction. More specifically, for Analysis 1 we compare TPA pre- and post-shock to CPA pre- and post-shock. For Analysis 2 we compare NTPA pre- and post-shock to NCPA pre- and post-shock. For our regressions, we build on the classic DID estimator (Wooldridge, 2010):

$$Y_{it} = \beta_0 + \beta_1 * d_i^{Treat} + \beta_2 * d_t^{Post} + \beta_3 * d_i^{Treat} * d_t^{Post} + \alpha_i + \gamma_t + u_{it} \tag{1}$$

where d_{Treat} is a dummy variable indicating whether the observation is part of a user active on the focal (to be restricted) page. The dummy d_{Post} takes the value 1 if the observation occurs after a page restriction. The coefficient β_3 shows the effect of the interaction, the differences-in-differences. α_i refers to the time-invariant intercept (user or page, depending on the type of model), whereas γ_t is the control intercept for each month. For Analysis 1, 17,064 users show TPA with 12,599 users showing CPA. For Analysis 2, 13,493 show NTPA, and 7,045 users show NCPA.

To test Hypotheses 1 through 3ba, we use a series of moderator variables (see also "Moderator variables," below). We capture each moderator effect by adding an additional (triple) interaction term to our DID regressions:

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[8]We employ a k nearest neighbor matching of k = 10. We arrive at 32,517 suited control pages, because several pages could serve as controls for multiple treatment pages

$$Y_{it} = \beta_0 + \beta_1 * d_i^{Treat} + \beta_2 * d_t^{Post} + \beta_3 * d_i^{Treat} * d_t^{Post} + \beta_4 * Moderator_{i(t)} + \beta_5 * Moderator_{i(t)} * d_i^{Treat}$$
$$+ \beta_6 * Moderator_{i(t)} * d_t^{Post} + \beta_7 * \boldsymbol{Moderator_{i(t)}} * \boldsymbol{d_i^{Treat}} * \boldsymbol{d_t^{Post}} + + \alpha_i + \gamma_t + u_{it} \tag{2}$$

Here, β_7 captures the potential change in overall effort due the moderating variable. Note that some moderators are time-variant, whereas others are not. When estimating the user fixed-effects model, the treatment dummy becomes collinear with the fixed effect, and the equation is reduced to

$$Y_{it} = \beta_0 + \beta_2 * d_t^{Post} + \beta_3 * d_i^{Treat} * d_t^{Post} + \beta_6 * Moderator_{i(t)} * d_t^{Post} + \beta_7 * \boldsymbol{Moderator_{i(t)}} * \boldsymbol{d_i^{Treat}} * \boldsymbol{d_t^{Post}} + \alpha_i + \gamma_t + u_{it} \tag{3}$$

We block bootstrap standard errors to account for serial auto-correlation in the data (Bertrand, Duflo, & Mullainathan, 2004).

4 | DATA AND VARIABLE OPERATIONALIZATIONS

4.1 | Data selection

Our dataset consists of content provided by the Wikimedia Foundation. The publicly available data include information on each article page, its editing history, the discussions on talk pages, the activity of admins, and page views. To trace discussions between users, we collect information on all talk pages, their corresponding article pages, and their full history.

Because of the unstructured data format (Viegas et al., 2007), we eliminate entries that lack information on entry date or author. Additionally, we use the change logs made by admins to classify each page protection. The sample includes all article–discussion pairs for which there has been activity on the discussion page. Our baseline sample consists of 1,101,033 users on 642,916 article–talk-page pairs from 2002 to 2014.

4.2 | Dependent variable

4.2.1 | Contributor effort

We use the number of monthly discussion entries as the dependent variable to measure contributor effort (for a similar approach see also Zhu et al., 2013, p. 1030). All else being equal, users may exert effort on discussion pages for two not mutually exclusive reasons: motivation and perceived need for coordination. The more entries a user provides, the greater the user's individual engagement with the discourse and/or the need for coordination with others. We measure the effort of contributors on talk pages rather than their effort on article pages to focus on the collaboration and coordination efforts among Wikipedians. Also, by focusing on the discussion page, we can still trace participation by all users, registered or not, even when an article page is being restricted (our IV). In other words, we maintain variation in our independent variable irrespective of the value that our dependent variable acquires.[9]

4.3 | Independent variables

4.3.1 | Exercise of authority (page protection)

The main independent variable is a dummy (*Restricted*) equal to 1 when the article-page counterpart to the focal discussion page is restricted, and 0 otherwise. If changes to an article page begin to derail

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[9]Note that we do not intend to measure the quality or performance of the contributions.

(e.g., in the form of "edit wars," "wheel warring,"[10] vandalism) and refocusing and coordination become necessary, admins may restrict the article page—in which case, changes to it can no longer be made by unregistered individual users (Martin, 2011). Admins can independently decide whether to restrict a page, but are often called upon by affected contributors. Depending on the cause of the disruption, admins can restrict the page for unregistered users—through semi-protection—or for all users—through full protection (Table 1).[11] A restriction implies that the hitherto decentralized organization of building the article page is no longer considered efficient, due to either individual vandalism or group conflict, and the article page becomes subject to administrative monitoring. The repercussion, so we argue, is that discussions on the focal discussion page become less pertinent as a consequence.[12] Overall, we thus argue that protecting a page is an act of authority.[13]

4.4 | Moderator variables

4.4.1 | Dispute

To classify the fierceness of the discussion preceding a page protection, we use three measures. The variable *Page Controversial* (1/0), as described above, determines whether the article page has been classified by the Wikipedia community as more likely to be disputed by users. The variable *Negative Edits* measures the ratio of deletions to overall edits on the article page in the month prior to the protection. *Reverts* calculates the relative number of times a previous article entry has been turned back and deleted. All three variables capture the strength of the disagreement on the discussion page before a page protection. We deploy them separately and compare results across specifications.

4.4.2 | Competence-based status

In contrast to earlier work that takes the legitimacy of formal leaders within Wikipedia for given (Zhu et al., 2013, p. 1026), we depart from the premise that administrators' perceived legitimacy will substantially vary with their competence-based status. We capture the difference of competence between administrators and other organizational members by calculating the difference in the *Awards* ("barnstars") an admin has received vis-à-vis another organizational member. Barnstars are awarded to by any Wikipedian for significant contributions to any part of Wikipedia (Gallus, 2017).[14] We argue that barnstars are perceived as more competence indicators in the community.

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[10]Users repeatedly reverting each other's edits.

[11]In this article we focus on semi-protections as opposed to full protections for a variety of reasons, the main one being that we can run tests with more statistical power. To avoid obtaining biased results, we run tests on the universe of both unregistered and registered users. As semi-protections restrict unregistered users more than registered ones, we would run the risk of observing spurious findings if we focused only on registered users' reactions to administrative intervention. Finally, we can report that robustness checks using full protections as incidences of intervention reveal qualitatively similar main results to the one reported in this article. Full protections restrict both registered and unregistered users equally and more severely, in that no further edits can be made to the article page. More information is available from the authors upon request.

Tests for H2b, H3a and H3b in this manuscript are restricted to a sample of registered users only to incur less noise with regards to the tenure-related variables, as these are confounded with random error on the sample of unregistered users. However, results also uphold when testing these predictions on the sample of unregistered users.

Overall, we obtain similar results for H1-H3b irrespective of the sample restriction (registered vs unregistered).

[12]Another reason for restricting a page is repeated vandalism committed by an anonymous user or a group that uses changing IP addresses—which renders user-blocking ineffective.

[13]For the sake of completeness, we note that admins have the right not only to restrict pages but also to block users, which implies that restricting a page more likely denotes a group-coordination conflict. Admittedly, in such instances admins exercise a form of authority that exceeds the lateral. Notably, however, such use of non-lateral authority is by statute limited to those rare cases in which a single user supposedly acts against the rules of the entire collective.

[14]https://en.wikipedia.org/wiki/Wikipedia:Barnstars

TABLE 1 Overview of page protection levels (adapted from Wikipedia:Protection policy)

	Unregistered	Registered	Admin
No protection	Normal editing		
Semi-protection	Cannot edit	Normal editing	
Full protection	Cannot edit		Normal editing

The relative number of barnstars an administrator holds in comparison to any given Wikipedian thus denotes the administrator's competence-based status.[15] For our tests of H2a, we aggregate administrator competence-based status at the page level.

4.4.3 | Seniority-based status

We capture the tenure difference (in years) (*Tenure Difference*) of an administrator and other organizational members by calculating the difference in the time an admin has spent with Wikipedia vis-à-vis another organizational member.

4.4.4 | Concentration of activity

We measure how focused users are in contributing to particular pages, by calculating a Herfindahl index of each user's activity. The Herfindahl measure has been used in management studies to describe the concentration of firms in an industry or a firm's diversification profile (Palepu, 1985). The more users distribute their effort to many pages, the lower their Herfindahl index.

5 | RESULTS

5.1 | Analysis 1—Contributor effort as a function of focal-page restriction

Table 2 reports descriptive statistics and correlations for all variables. On average, users provide 3.9 discussion entries per month. Less than 10% of entries take place on restricted pages, confirming that most pages are not restricted.[16]

Table 3 presents the result of Analysis 1 DID estimations pertaining to Equation (1) of our identification strategy. The results demonstrate that users reduce their effort on a specific restricted page by 0.5 entries per month more than users would on similar unaffected pages (95% CI [−1.01, −0.20]). This is a clear indication that users react to authoritative intervention and reduce their effort. As mentioned, this reduction may or may not signal motivational losses on the part of the contributors.

5.2 | Analysis 2—Reallocation of effort

Whereas Analysis 1 results show that Wikipedians reduce their effort on focal pages, Analysis 2 seeks to identify under what circumstances authoritative intervention leads to fewer overall motivational losses for or perhaps even increase Wikipedians' motivation. We present regressions using a user fixed-effects ordinary least squares (OLS) estimation; we categorize users exclusively into treatment

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[15]We validated barnstars as a measure for competence on a subsample of administrators. To that end, we compared information on the approval rate of an admin during her election (*Approval*) with her barnstar count. The two measures are correlated, lending support to our choice of competence proxy. By definition, approval rates can only be computed for administrators, however, so that we cannot test H2a using two different operationalizations for competence-based status. See also our "Discussion and Exclusion of Alternative Explanations" for further tests we conducted to validate the *Awards* measure.

[16]Compare with https://en.wikipedia.org/wiki/Wikipedia:Protection_policy, accessed on November 1, 2015.

TABLE 2 Descriptive statistics and correlations (page, user, and admin level)

	Page-month level (N = 2,335,706)	**Mean**	**S.D.**	**Min**	**Max**	**1**	**2**	**3**
1	Page controversial	0.015		0	1	1		
2	Reverts per month (article page)	1.297	4.671	0	834	0.08	1	
3	Deleting edits per month (article page)	7.304	18.906	0	3,014	0.08	0.7	1
	User level (N = 241,549)	Mean	S.D.	Min	Max	1	2	3
1	Edits per year	272.055	2,620.182	0	734,676	1		
2	Awards	0.372	3.515	0	325	0.27	1	
3	Activity concentration	0.381	0.257	0	1	−0.09	−0.12	1
	User-month level (N = 1,542,477)	Mean	S.D.	Min	Max			
	User tenure (years)	2.165	2.233	0	13.679			
	Admin level (N = 1,570)	Mean	S.D.	Min	Max	1	2	3
1	Awards	17.339	26.18	0	231	1		
2	Approval	0.905	0.204	0	1	0.06	1	
3	Awards per year	0.321	0.475	0	4.196	1	0.05	1

or control group to ensure that the groups are not contaminating each other. Therefore, the treatment dummy will be perfectly correlated with the user fixed effect and cannot be estimated.

Interaction effects in our DID estimations are positive (Table 4, Model 1.1): affected users increase their effort on unaffected pages by 0.63 entries (95% CI [.033, 0.91]). Wikipedians reallocate effort to other pages when affected by page restrictions. Models 1.2 through 1.4 provide tests

TABLE 3 Panel OLS regression with page fixed effect of diffs-in-diffs (analysis 1) on entries per month on focal page (unit of analysis: User-month discussion entries)

VARIABLES		
d_Treat	−2.778	[0.772]
	(9.589)	
d_Post	−1.519	[0.000]
	(0.198)	
d_Treat X d_Post	**−0.514**	**[0.041]**
	(0.252)	
Month dummies	Yes	
Constant	27.621	[0.000]
	(6.257)	
Observations	53,938	
R-squared	0.006	
Number of pages	15,502	

Bootstrapped standard errors (block bootstrapped around users with 1,500 iterations) in parentheses, p-values are between square brackets.

TABLE 4 Panel OLS regression with user fixed effect of diffs-in-diffs (analysis 2) on discussion entries per month on nonfocal pages, moderators on the fierceness of the coordination conflict (unit of analysis: User-month discussion entries)

VARIABLES	1.1 Main model		1.2 Interaction fierceness (reverts)(H1)		1.3 Interaction fierceness (Neg. Edits)(H1)		1.4 Interaction fierceness (controversial) (H1)	
d_Post	−5.318	[0.000]	−5.217	[0.000]	−4.502	[0.000]	−5.075	[0.000]
	(0.284)		(0.300)		(0.321)		(0.282)	
d_Treat X d_Post	**0.628**	**[0.038]**	0.328	[0.344]	0.474	[0.272]	0.442	[0.110]
	(0.303)		(0.346)		(0.431)		(0.277)	
Fierceness moderators:								
Reverts X d_Treat X d_Post			**9.861**	**[0.045]**				
			(4.929)					
Reverts X d_Post			**−7.336**	**[0.091]**				
			(4.347)					
Neg. Edits X d_Treat X d_Post					**3.059**	**[0.051]**		
					(1.570)			
Neg. Edits X d_Post					**−4.968**	**[0.000]**		
					(1.194)			
Controversial X d_Treat X d_Post							**4.667**	**[0.009]**
							(1.783)	
Controversial (dummy) X d_Post							**−5.183**	**[0.001]**
							(1.624)	
Month dummies	Yes		Yes		Yes		Yes	
Constant	24.348	[0.000]	24.732	[0.000]	5.776	[0.517]	7.175	[0.417]
	(6.554)		(6.468)		(8.913)		(8.834)	
Observations	41,076		40,670		40,030		41,076	
R-squared	0.076		0.076		0.077		0.077	
Number of contributors	20,538		20,335		20,015		20,538	

Bootstrapped standard errors (block bootstrapped around users with 1,500 iterations) in parentheses, p-values are between square brackets. Coefficient estimates for key independent variable in bold.

pertaining to H1, featuring moderators that describe the dispute prior to page protection. The dummies indicating the triple interactions of our main treatment effect with *Negative Edits* and *Reverts* are positive but not significant (Neg. Edits: β = 3.06, 95% CI [−0.02, 6.14]; Reverts: β = 9.86, 95% CI [0.2, 19.52]). The respective coefficient for the triple interaction with *Page Controversial* is positive (β = 4.66, 95% CI [1.17, 8.16]). On average, a Wikipedian who is affected by a page restriction on a controversial page contributes 6.5 entries to nonfocal pages in the month after the focal page's restriction, whereas an unaffected user only writes 1.9 entries. Her effort thereby exceeds that of a comparable unaffected Wikipedian by almost a factor of 6.

Models 2.1 and 2.2 (Table 5) include moderators measuring competence-based status (H2). Because the measures for competence can, by design, be computed for treated pages only, interaction effects between the post-shock dummy and the moderator (a) as well as between the treatment dummy and the moderator (b) will be perfectly correlated with the user fixed effect. As such, they cannot be

TABLE 5 Panel OLS regression with user fixed effect of diffs-in-diffs (analysis 2) on discussion entries per month on nonfocal pages, moderators on status of administrators (unit of analysis: User-month discussion entries)

VARIABLES	2.1 Interaction status difference (H2a)		2.2 Interaction status difference (H2b)	
d_Post	−6.065	[0.000]	−5.998	[0.000]
	(0.358)		(0.378)	
d_Treat X d_Post	0.538	[0.157]	0.825	[0.059]
	(0.380)		(0.438)	
Status moderators:				
Competence diff. X d_Treat X d_Post	**0.008**	**[0.099]**	**0.012**	**[0.026]**
	(0.005)		**(0.006)**	
Tenure diff. X d_Treat X d_Post			**−0.150**	**[0.108]**
			(0.093)	
Diff. Status moderators				**p = 0.045**
Month dummies	Yes		Yes	
Constant	29.848	[0.001]	32.490	[0.002]
	(9.013)		(10.281)	
Observations	31,446		31,446	
R-squared	0.077		0.077	
Number of contributors	15,723		15,723	

Bootstrapped standard errors (block bootstrapped around users with 1,500 iterations) in parentheses, p-values are between square brackets. Coefficient estimates for key independent variable in bold. Note: Only registered users.

estimated. The triple interaction coefficient between the main treatment effect and the *competence (difference)* moderators are positive (Award Difference β = 0.01, 95% CI [0.06, 0.014]), indicating support for the positive effect of competence-based status. For example, an affected contributor who has 50 barnstars less than the focal admin in total writes 0.8 entries more than an unaffected contributor would. When we include tenure difference to proxy for seniority-based status (Model 2.2), the coefficient of competence remains significant and larger than that of tenure difference. Using a one-sided test of coefficients, we find support that this effect is statistically significant (p = 0.045).

Hypotheses 3a and 3b detail the potential heterogeneous effect of page protection.[17] Table 6 and Table 7 show Analysis 2 split-sample regressions for tenure and activity concentration. In particular, very senior Wikipedians reallocate less effort than any other age group of contributors, supporting H3a at least in part. Users with less tenure seem to embrace the authoritative intervention more. Furthermore, contributors who distribute their effort across pages the most, embrace page restrictions the least, lending at least partial support to H3b.

6 | DISCUSSION AND EXCLUSION OF ALTERNATIVE EXPLANATIONS

Our identification strategy was to show that Wikipedians reduce their effort once focal pages are restricted and that they reallocate parts of their time to other Wikipedia pages instead. Within this

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[17]Because we use IP addresses to identify unregistered contributors, we cannot be sure whether the same IP address belongs to the same user if time periods become larger. Thus, we exclude unregistered users from the regressions testing H3a and H3b for the models reported in this article. Robustness checks do show, however, that our findings also uphold when extending the sample to the universe of registered and unregistered users.

TABLE 6 Panel OLS regression with user fixed effect of diffs-in-diffs (analysis 2) on discussion entries per month on nonfocal pages, sample split according to tenure (H3a) (unit of analysis: User-month discussion entries)

VARIABLES	User tenure quartile 1		User tenure quartile 2		User tenure quartile 3		User tenure quartile 4	
d_Post	−7.739	[0.000]	−7.232	[0.000]	−5.585	[0.000]	−5.983	[0.000]
	(0.944)		(0.887)		(0.744)		(0.840)	
d_Treat X d_Post	**1.343**	**[0.172]**	**1.778**	**[0.022]**	**1.722**	**[0.007]**	**−0.044**	**[0.928]**
	(0.983)		**(0.777)**		**(0.643)**		**(0.484)**	
Constant	36.400	[0.076]	11.857	[0.648]	23.230	[0.220]	−3.796	[0.814]
	(20.499)		(25.970)		(18.939)		(16.099)	
Wald tests								
Diff. Vs. 1			p = 0.376		p = 0.379		p = 0.179	
Diff. Vs. 2					p = 0.398		p = 0.055	
Diff. Vs. 3							p = 0.036	
Month dummies	Yes		Yes		Yes		Yes	
Observations	7,280		7,827		8,329		8,010	
R-squared	0.105		0.103		0.100		0.138	
Number of contributors	4,016		4,560		4,553		4,123	

Bootstrapped standard errors (block bootstrapped around users with 1,500 iterations) in parentheses, p-values are between square brackets. Coefficient estimates for key independent variable in bold. Note: Only registered users.

framework, we provide indirect evidence that Wikipedians react positively to an authoritative intervention. Whereas the average reduction of effort is 2.3 entries per month on the focal page, which we argue is driven by a reduced need for coordination, the average reallocation amounts to 0.6 entries, with the latter figure showing significant variance. This supports the relevant impact of the moderators suggested in H1 through H3b.

TABLE 7 Panel OLS regression with user fixed effect of diffs-in-diffs (analysis 2) on absolute discussion entries per month on nonfocal pages, sample split according to user activity concentration (H3b) (unit of analysis: User-month discussion entries)

VARIABLES	Activity concentration quartile 1		Activity concentration quartile 2		Activity concentration quartile 3		Activity concentration quartile 4	
d_Post	−4.684	[0.000]	−5.861	[0.000]	−6.381	[0.000]	−4.466	[0.000]
	(0.631)		(0.124)		(1.554)		(0.951)	
d_Treat X d_Post	**−0.458**	**[0.546]**	**2.162**	**[0.000]**	**0.889**	**[0.454]**	**1.257**	**[0.148]**
	(0.758)		**(0.349)**		**(1.187)**		**(0.869)**	
Constant	6.887	[0.734]	−2.529	[0.866]	83.799	[0.051]	−38.373	[0.058]
	(20.251)		(14.976)		(42.852)		(20.250)	
Wald tests								
Diff. Vs. 1			p = 0.003		p = 0.253		p = 0.132	
Diff. Vs. 2					p = 0.235		p = 0.250	
Diff. Vs. 3							p = 0.387	
Month dummies	Yes		Yes		Yes		Yes	
Observations	7,201		7,344		6,634		5,668	
R-squared	0.093		0.072		0.115		0.133	
Number of contributors	3,940		4,343		4,112		3,328	

Bootstrapped standard errors (block bootstrapped around users with 1,500 iterations) in parentheses, p-values are between square brackets. Coefficient estimates for key independent variable in bold. Note: Only registered users.

While we believe our approach is trackable, we seek to exclude a series of further alternative explanations for our findings below. We address potential problems arising from variable operationalization (points 6 and 8, below), unobserved heterogeneity (points 1, 2, and 5), sample selection (points 3 and 4), biased estimations (point 6), and agent learning (point 7).

A first challenge to our interpretation would arise if Wikipedians were using different modes of communication, and if they increased their communication frequency on other platforms or via email while contributing less to talk pages. Wikipedians, in general, do not have one another's email addresses, so we deem this problem minor. And although Wikipedians might move some of the discussion to their individual user or user talk pages, this seems unlikely, as not all users will be automatically notified of such discussions (Jemielniak, 2014, p. 93).

Second, a potential weakness of our models lies in the limited amount of variation they explain. The unobserved heterogeneity that our models reflect would only be problematic, however, if the omitted variables were correlated with our independent variable(s) after controlling for all theoretically plausible confounding effects. The setup of the analyses in particular should randomize all remaining factors by selecting comparable treatment and control groups. Therefore, we deem this theoretical problem minor.

Third, our results might be driven by unregistered users only, endangering the generalizability of our results; this is because registered users are permitted to directly change content pages even after they have been restricted, whereas unregistered users are truly technically affected. Thus, in theory, our results might solely be driven by unregistered users decreasing their discussion efforts. Running the regressions on samples composed of solely registered users, however, shows that our results remain robust. We also tested whether admins are driving the results, since their entries are on average fewer than those of regular users. Running the regressions on samples composed solely of registered users and without admins, however, yields robust findings (see Appendix A2 in Appendix S1).

Fourth, and related, page semi-protection might lead to the selective attrition of unregistered users from the discussion—because their access to the article page would be de-facto restricted, too. This could create an artificial impression of contributors embracing authoritative intervention overall, when in reality the finding would be driven by the remaining registered users who face fewer coordination challenges. One indication for this not driving our results is that the number of registered as well as unregistered users active on pages after they become restricted does not decrease (see Appendix A4 in Appendix S1). Another indication is that our results also hold when repeating our tests on samples involving full page restrictions only. In these instances, admins disable the page-editing option equally for all registered and unregistered users. When we rerun our analyses, the main effect of focal effort reduction and reallocation to other pages remains intact.

Fifth, we rule out that our results are spuriously driven by our focus on discussion entries, by accounting for the possibility that users react to authority by adjusting both their discussion and their editing activity. As an example, it is conceivable that a user who was frustrated by page restriction, while reducing his editing activity on the article page, starts complaining on as many talk pages as possible. In this case our testing logic would not capture his true sentiments. To exclude this possibility, we collected a sample of overall user activity using Wikipedia revision history. We took all edits, whether on articles, talk pages, or any other Wikipedia page, from inception to 2005. This includes approximately 90 million edits. Using the same identification strategy as before, we can show that users reallocate about 13 entries per month to other pages when affected by page protections (see Appendix A3 in Appendix S1).

Sixth, the use of a DID estimator can potentially overemphasize results, leading to false positives (Bertrand et al., 2004). As a robustness check, we randomized treatment dates and reran Analysis 2 to rule out the latter possibility. The results (see Appendix A5 in Appendix S1) we obtain clearly indicate that our core result is not a random artifact.[18] Additionally, a leads and lags model shows our DID approach satisfies the parallel trend assumption: prior to the restriction, treatment and control group do not differ from one another with regards to contribution activity. Furthermore, the model demonstrates that page restrictions were not anticipated by Wikipedians (see Appendix A6 in Appendix S1). Whereas Wikipedians might not be surprised that a page is restricted, there is no indication that they change their effort prior to a page protection.

Seventh, and finally, regarding the computation of one of our possibly most important measures – *competence-based status* – we need to rely solely on the number of barnstars obtained by both administrators and other Wikipedians. That being said, we ran a series of robustness checks that support the usefulness of this proxy. Most importantly, when testing the absolute (as opposed to the relative) effect of an administrator's reputation (as measured by her barnstarns) on the embracement of her authoritative interventions by others, we obtain consistent results across models that either use barnstars or administrator approval rates during their elections. These findings are reassuring that our measure chosen for competence is a useful one.

7 | CONCLUSIONS AND FURTHER RESEARCH

Previous research has consistently argued that centralization of authority to ensure coordination comes at the cost of demotivating subordinates. In this article we show that this trade-off does not necessarily arise. Specifically, restricting the use of authority to the resolution of coordination problems in a lateral fashion—without policing individual behavior—could resolve coordination conflicts without leading to the detachment of individuals with an organization. Within Wikipedia, a prime example of an organization in which lateral authority is being deployed, we demonstrate that contributors embrace actions by admins more (a) the fiercer the conflict they must resolve, (b) the more that admins are legitimized through competence relative to their peers, (c) and the less tenure the contributors have themselves. Moreover, we have indications that seniority-based status does not enhance the perception of an authority's legitimacy as much as competence-based authority (d), and that users vested in only a few coordination conflicts appreciate authoritative intervention more than others (e).

Our mechanistic insights on the potential use of lateral authority complement earlier work on shared leadership in self-governing organizations (Zhu et al., 2013) and seem relevant to scholars and practitioners alike in the field of strategic management. Our findings seem both directly generalizable to selected domains of corporate life and relevant to the discussion of (recent) approaches to creating self-governing organizations more broadly.

7.1 | Self-governing teams embedded in hierarchical firms

The superior value of using Wikipedia as a clean testing bed to study the effects of lateral authority does not reduce its relevance as an increasingly important coordination mechanism in other corporate domains such as skunkworks, crowdsourcing campaigns for innovation, and pressure groups. Just like in Wikipedia, or OSS communities more broadly, peers operating in the latter corporate domains resort to a default mode of self-governance more often than not, frequently have no mandate to

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[18]We thank Editor Lamar Pierce for making parts of his simulation code available to us.

appoint leaders formally, yet allow for the democratic election of authorities with a limited scope of legitimacy, which includes resolving coordination conflicts. It is these striking similarities which, so we believe, render our findings generalizable and particularly salient when considering how to design corporate activities whose success depends on employees' subjective motivation. An extreme case of the latter situation is one in which a firm seeks to tap into resources beyond its boundaries and openly collaborate with communities. Allowing its corporate technical staff to gain legitimacy as authorities within a collective by assigning them to community problems may seem like a costly proposition (Dahlander & Wallin, 2006), but its relevance is underpinned by the findings of this study.

At the same time, the above domains are often islands of self-governed activity in an otherwise hierarchically structured environment. A comprehensive discussion on the generalizability of our findings must therefore also raise questions that we could not address in this article and that may pose interesting avenues for future research: What are the limitations of using lateral authority within selected domains in an otherwise hierarchical corporate environment? More specifically: will employees distinguish between reactions to lateral authority and managerial authority when both are present at the same time? Pursuing this question would pick up on an important but somewhat forgotten discussion on the optimal authoritative-role composition (Henning & Moseley, 1970).

7.2 | Self-governing organizations

Our findings also appear relevant in the context of the broader debate on designing self-governing organizations. As Lee and Edmondson (2017) describe in their recent review of the field, a renaissance of enthusiastically experimenting with hierarchy-less organizations has recently been observed—the flattening of corporate hierarchies in firms such as The Morning Star Company, Valve, and Zappos being the most prominent examples. Undoubtedly, their radical approaches incur costs of their own—annual personnel turnover rates as high as 20% create substantial costs for all remaining employees involved (Bernstein et al., 2016); also, their actions seem reminiscent of those taken at Oticon or Gore a few decades back. At the same time, however, they provide some interesting novel suggestions for team-based organizing—some plausible in light of our findings and some less so—and thereby trigger further research questions.

Notably, while both Valve and Zappos strongly emphasize self-organization, they differ substantially in their overall governance. Within Valve, managerial authority is virtually not present. In fact, their employee handbook's glossary states:

> **Manager**—The kind of people we don't have any of. So if you see one, tell somebody, because it's probably the ghost of whoever was in this building before us. Whatever you do, don't let him give you a presentation on paradigms in spectral proactivity. (Valve Corporation, 2012: 56).

Self-organization is the default mode of peer interaction. Within "cabals"—another name for multidisciplinary project teams—individuals may temporarily assume the role of "team lead," an informal role with largely coordinative functions. The authority of team leads is explicitly not directive, in that they could assign tasks to fellow employees against the latter's will. Yet while their role in conflict resolution is not clearly defined, our findings in this study would suggest that team leads in cabals could and should be able to successfully serve as conflict resolvers—given that they are elected rather than appointed, and given the restricted scope of their legitimacy. Providing related empirical evidence seems like a promising research endeavor for scholars in the future.

Zappos, by contrast, follows a concept known as holocracy. By its own "constitution," holocracy distinguishes between different types of authority that individuals may hold within the organization. "Lead links" (or project managers) would enjoy formal authority by virtue of their role in the organization. Their authority would extend to task division and task allocation, and would differ from that of "facilitators"—individuals elected by the group to administer a formal process of conflict resolution among employees (HolacracyOne, 2010). Interestingly, however, whereas facilitators would appear to enjoy lateral authority limited to the resolution of conflicts, their decision rights seem to be far more limited than those of Wikipedia administrators. In fact, holocracy facilitators would never be able to take a final stance on a conflict; instead, their task would be to supervise a lengthy and time-consuming process of integrative decision-making among all parties until a consensual solution is achieved. Recalling the findings from our study, one may question whether allocating more decision rights to facilitators may not improve the overall efficacy of the holocracy system. If such decentralization works in an organization as large as Wikipedia, it stands to reason that it can be made to work in other, notably smaller settings, too, in which organizations have embarked on the holocratic method. Running an in-house experiment in which the role of facilitators could be extended accordingly for a treatment group of them would appear to be yet another promising research project.

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