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Fast success and slow failure: An examination of the costs of collaboration across formal boundaries

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Abstract

Collaborating across formal organization boundaries is beneficial for performance outcomes like innovation. Yet it also costly as it requires actors to overcome spatial distance and enter new knowledge domains. The question then arises as to whether the benefits outweigh costs? We seek to answer this question by examining 5079 collaborations in the Internet Engineering Task Force (IETF). Our findings suggest that crossing formal boundaries is positively related to success of the collaboration, as well as efficiency of the project. Yet there are high costs associated with cross boundary collaborations for unsuccessful projects, as these take longer to fail, and therefore hold up resources that could be reallocated to other projects. We simulate the costs for these projects and show that even with a boost in success, the costs are higher than the expected benefits, suggesting that firms may be better off investing in non-diverse projects. This finding has important implications for how we think about organization design and the expected benefits of seeking novelty.

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Keywords: collaboration, innovation, formal boundaries, informal networks, online communities, Internet Engineering Task Force.

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Introduction

Do the benefits of cross-boundary collaborations outweigh the costs? Much recent work has documented the benefits of collaboration across formal organization boundaries for performance outcomes like innovation (Dahlander and Frederiksen, 2012; Gibson and Gibbs, 2006); R&D efforts (Allen, 1977; Ancona and Caldwell, 1992; Powell, Koput and Smith-Doerr, 1996; Rosenkopf and Nerkar, 2001) and project performance (Daniel, Argawal, and Stewart, 2012). The advantages associated with cross-boundary collaboration primarily come from the possibility to combine knowledge from different knowledge domains (Haas, 2010; Hansen, 1999; Tortoriello and Krackhardt, 2010). Operating across geographic distance has also been argued to provide advantages given the diversity of knowledge that comes from operating across geography and the associated benefits such as innovation (e.g., Almeida, Song, and Grant, 2002; Bell and Zaheer, 2007), access to novel knowledge (McEvily and Zaheer, 1999) and wider diffusion of ideas (Waguespack and Birnir, 2005).

Yet we also know that crossing formal boundaries is costly for a variety of reasons. Crossing into new knowledge domains will expose actors to diverse knowledge, which may be difficult to integrate and absorb (Maskell, 2001; Mors, 2010). Actors residing in different organizations are likely to differ in terms of norms and organizational language (Bechky, 2003; Dougherty, 1992) and may therefore have problems sharing mutual knowledge (Cramton, 2001). Moreover, actors are likely to be encouraged by formal structures to focus interactions inside the firm, thus making it more costly to connect to others outside the firm (Barnard, 1938; Karim and Kaul, 2015; Kleinbaum, Stuart and Tushman, 2013). Finally, interacting across organizational boundaries is likely going to lead to higher coordination costs (Gulati and Singh, 1998; Rawley, 2010). Operating across geographic distance poses the additional challenges of having to overcome spatial

distance, potential language or cultural differences, and/or facilitating interactions across time zones (Barkema and Vermeulen, 1997; Hansen and Løvås, 2004; O'Leary and Cummings, 2007). All of these challenges pose barriers to successful collaborations across geography and may also lead to high co-ordination costs (Cummings and Kiesler, 2007). Consequently less knowledge may flow between actors based in distant geographies (Bell and Zaheer, 2007: Singh, 2005; Ter Wal, 2014) and in some instances the costs may be so high that collaborating across geographic distance leads to lower innovation (Singh, 2008; Tzabbar and Vestal, 2015; Tallman and Phene, 2007) and performance (Espinosa et al., 2007).

Hence, it is fairly well documented that collaboration across organizational boundaries and geographic distance provides certain benefits, but also that it is associated with costs. Nevertheless we still do not know much about whether these costs or benefits persist over time and whether collaborations over a longer period of time might help overcome some of the costs associated with cross-boundary collaborations. For example, a recent study by Bercovitz and Feldman (2011) on cross-boundary teams finds that although there are coordination costs associated with reaching across boundaries, performance improves with the experience of the team. It has also been shown that institutions may be willing to incur the costs associated with distance in order to collaborate with high quality partners (Laursen, Reichstein and Salters, 2011). In addition, we know little about what happens to the failed attempts at cross boundary collaborations and whether or not they incur costs. Hence, while the literature generally suggests that there is a tradeoff between the benefits and costs of cross boundary collaborations, it remains an open question as to whether the benefits actually outweigh the costs?

In order to get a better understanding of the benefits and costs of collaborating across organizational boundaries and geographic distance, we study collaborations between authors in the Internet Engineering Task Force (IETF). In this open innovation community participants collaborate in work groups to develop and maintain Internet standards. We examine 5079 collaborations in the IETF from 1995 to 2003.

The contribution of this paper is three-fold. First, we are able to shed further light on the costs and benefits of collaboration by showing that generally collaboration across formal boundaries is more likely to lead to success. Specifically, we show that despite the fact that authors face the difficulties of connecting across geographic and organizational boundaries they are more likely to end up with a publication. Second, we highlight the real benefits of cross-boundary collaborations by showing that they are more efficient in that successful collaborations go through fewer revisions and take fewer days to publication than non-diverse collaborations. Most interestingly, however, we show that unsuccessful collaborations, i.e., those that don't result in publication, take longer before they are abandoned and go through more revisions. This means that the projects have high opportunity costs in that they hold up resources that could be reallocated to other projects. We simulate the costs for these projects and show that even with a boost in success, the costs are higher than the expected benefits, suggesting that firms may be better off investing in non-diverse projects. This slow failure finding has important implications for how we think about organization design and the expected benefits of seeking novelty. To the extent that our work helps inform managers about these costs it will be possible to design interactions in organizations to help overcome such costs.

Theory and Hypotheses

Building on prior work, we argue that connecting across geographic and organizational boundaries will generally increase the benefits of collaboration (Tzabbar and Vestal, 2015). A long stream of work has shown that crossing formal organization boundaries poses challenges to collaboration, as it often requires actors to reach outside the specifications of their job roles and most organizations therefore mandate actors to interact within the formal organizational boundaries (Barnard, 1938; Karim and Kaul, 2015; Kleinbaum et al., 2013). To the extent that the formal role or job description does require organizational members to enter cross-boundary collaborations, it still poses challenges as it will require interactions across organizational frameworks, which often lack a common language (Dougherty,

1992) or the common knowledge (Cramton, 2001) required for seamless coordination.

The two main formal boundaries that have been considered in prior work in this area are geography and formal organization boundaries (e.g., Haas and Cummings, 2015; Sorenson, Rivkin and Fleming, 2006; Tzabbar and Vestal, 2015). These boundaries constitute the two main organizing dimensions for inter- and intra-organizational collaborations and are both associated with a number of unique challenges. As explained by Haas and Cummings (2015) in their study of interactions in a multinational firm, both geography and formal organization has to do with the job position and responsibilities of the individual actor and hence these will likely influence patterns of interaction. Hence they consider both actors' formal location geographically, as well as their formal job role in the organization. Sorenson et al (2006) in their study of collaborations on patent filings, focus on social proximity in networks, but also control for geographic and organizational proximity. Drawing on research in sociology the authors argue that these are important determinants of social interaction and hence proximity in the social network (2006: 1005). In line with these and other studies, we consider both organizational and geographic boundaries as the main formal boundaries separating collaborations.

Collaborating across geography has been argued to give access to diverse knowledge, which in turn has benefits such as innovation or access to new business (Bell and Zaheer, 2007; McEvily and Zaheer, 1999; Mors, 2010). Similarly crossing organizational boundaries has been shown to facilitate interactions across knowledge domains, which has also been associated with beneficial outcomes such as innovation and new idea generation (Tortoriello and Krackhardt, 2010). We therefore expect that when actors collaborate across geographic and organizational boundaries they will be able to benefit from the advantages of access to diverse knowledge and information. The higher the diversity as associated with crossing geographic and organizational boundaries, the greater will be the benefits. As a baseline and in line with prior literature, we therefore predict that:

Hypothesis 1. There will be a positive association between higher (a) geographic or (b) organizational diversity of a particular collaboration and a higher likelihood of success of that collaboration

Prior work on networks and repeat interactions has shown that collaborations over time allow for actors to develop trust (Ter Wal, 2014; Vanneste, Puranam and Kretschmer, 2014) and learn from their prior interactions (Sorenson et al., 2006). Collaborations with higher levels of trust, as well as those where actors can draw on learning from prior interactions, may be able to overcome the costs associated with cross-boundary collaborations (Zaheer, McEvily and Perrone, 1998). Developing informal relationships has also been shown to help facilitate the costs of geographic distance. Hansen and Løvås (2004) in their study of new product development teams in a multinational found that actors preferred to seek out familiar contacts as opposed to contacts with related competencies and that the negative effects of geographic distance could be overcome through familiar contacts. We therefore also argue that repeat interaction will allow actors to overcome the costs associated with collaborating across geographic and organizational diversity.

For example, a recent study by Bercovitz and Feldman (2011) on cross-boundary teams finds that although there are coordination costs associated with reaching across boundaries, performance improves with the experience of the team. They argue that this is because teams that have worked together through several iterations can develop routines that might help overcome the costs of coordination. Laursen and colleagues (2011) also recently showed that institutions are willing to incur the costs associated with distance in order to collaborate with high quality partners (Laursen, Reichstein and Salters, 2011). It has also been argued that as actors interact over time they are likely to develop stronger relationships imbued with trust that may facilitate knowledge transfer (Bell and Zaheer, 2007; Hansen, 1999; Wilson, Strauss and McEvily, 2006) and absorptive capacity (Reagans and McEvily, 2003), which in turn will lead to efficiencies and generally ease the ability to collaborate across boundaries. We therefore propose that:

Hypothesis 2. Successful collaborations will have lower costs as measured by shorter time and fewer revisions to publication the higher the (a) geographic and (b) organizational diversity.

Testing for collaboration type effects in an observational setting is complicated by the fact that individuals self-select into remote and/or organizationally diverse collaborations (Shaver, 1998). In the setting we study, it may be that individuals are aware that diverse collaborations are potentially costlier to maintain as the project develops, and therefore tend to select into these diverse collaborations only when the idea has greater ex ante quality or lower ex ante risk. In other words, it may that authors know that those collaborations that cross formal organization boundaries entail higher coordination costs and as a results they are only willing to engage in those project that have more certain outcomes. This also means that once authors have engaged in a diverse collaboration they are more likely to keep engaging in this work even when it starts to become apparent that the project is unsuccessful. Or in other words, the engagement of the project is likely to lead to escalation of commitment (Staw, 1976). Authors may feel a stronger feeling of commitment to cross boundary collaborations because they know that they are potentially more costly and hence they only are willing to make such a commitment to ideas they believe in. Yet this also means that they are more likely to cling on to them before abandoning the effort. In addition, due to the high costs associated with cross boundary collaborations, the sunk costs are also likely to lead to reluctance to abandon the projects. In sum, we therefore propose:

Hypothesis 3. Unsuccessful collaborations will have higher costs as measured by longer time and a higher number of revisions before abandonment the higher the (a) geographic and (b) organizational diversity.

Data and Results

We study collaborations in the Internet Engineering Task Force (IETF). In this open innovation community, participants collaborate to develop and maintain Internet

standards. Work is done through working groups that produce documents detailing Internet standards. Any interested individual can participate and documents are freely available on the Internet. We look at 5079 unique collaborations in the IETF in the period from 1995 to 2003. Further descriptions of the data can be found in Fleming and Waguespack's (2007) work on leadership in open innovation communities and more information on the IETF in Simcoe's (2012) recent paper on standard setting committees. One of the benefits of studying collaborations in this community is that it is entirely voluntary. As such, it is an ideal environment in which to observe the real costs and benefits of collaborations. When authors collaborate in the IETF, they work together to produce working drafts of new standards for the Internet. Hence it is possible to look at the number of drafts, that is, the number of iterations that a document goes through or in other words the time to success or failure. Another feature of the data is that we can observe individual authors collaborating across both firm and geographic boundaries as most authors belong to a company such as for example Alcatel or Microsoft and are based in locations all over the world from North America to Europe and Asia.

Dependent variables. As we focus on collaborations, we will focus on those documents that have more than one and up to nine authors. Once authors have started working on a project they produce drafts of the document. Each of these drafts may go through several iterations where they are changed and updated. As would be expected, some drafts of the documents go through several iterations, whereas other drafts go through few. The revision time on each working group draft varies from just a few weeks up to more than a year for some drafts. The dependent variable *publication* is a dummy coded as 1 for published drafts. We do not observe the precise termination date for the last version of *failed* projects, but by the IETF rules projects "expire" at 180 days of no activity. *Duration* to publication is measured by the number of days from the submission of the first draft until publication and number of *versions* is the number of drafts submitted in the interim period.

Geographic boundaries. We look at whether author pairs within a collaboration are remote from one another in terms of geographic distance. The

authors are based in many different locations across the world. For those based in the USA, we utilize the capital city in the state in which they are based to determine their locations, whereas for authors located outside the US we utilize the capital of the country. Once we have determined the city location of each author, we code the longitude and latitude of that location; we then calculate the distance in miles between each pair of authors. We generate a remoteness index, which is a count of the number of author pairs within a draft that are further than 2500 miles apart, divided by the total number of author pairs within a draft. In a robustness check, we tried coding close as those authors that are less than 50 miles apart and find similar results.

Organizational boundaries. In order to explore the effects of crossing organizational boundaries on collaboration we similarly create an organizational diversity index, calculated as the number of author pairs within a draft that have different organizational affiliations, divided by the total number of author pairs within a draft.

Control variables. We also include a number of control variables, including whether the collaboration has only US authors, whether the authors have prior experience working together, the file size of the draft, whether the authors have prior publications, and whether it is a working group submission. We also control for organizational presence as measured by presence in the data, as it might be argued that larger or more powerful organizations are more likely to get published. We do not find that this is the case. However, the results do show, in line with extant work, that previous experience working together or publications within the IETF does improve the chances of publication.

Main results. The main results are reported in tables 1 and 2. Table 1 reports the likelihood of publication. The data are a cross-section selecting the first version of the draft that was submitted. The results show as expected that more diverse projects, both in terms of crossing organizational and geographic boundaries are more likely to get published. The effect sizes are such that geographic diversity increases publication rate by 4% and organizational diversity increases publication by 6.6%. Table 2 shows the efficiency of collaborations and

the duration and number of versions to publication or failure. In general published drafts have 3.2 more versions. But relative to successful projects, geographically diverse failed projects have .04 more versions and organizational diverse failures have .14 more versions. Published drafts generally take 245 more days. Relative to successful projects we see that geographically diverse failures take 13 more days to fail and organizational diverse projects take 23 more days to fail.

---------- Insert Tables 1 and 2 about here ----------

The combination of diversity improving the odds of success and increasing time to failure implies that the performance advantage associated with diversity is not as great as we might expect, and under reasonably probable circumstances may in net result in inferior performance. Our logic here is simple: for organizations that wish to undertake multiple projects, slower failure means that they are delayed in re-allocating resources, and have fewer opportunities to initiate new projects. In other words, over some fixed period of time the performance benefits associated with diversity may be offset by having fewer rolls of the dice. Given multiple projects and a fixed number of resources to re-allocate, the net superiority of a "diverse strategy" is a function of a) the size of the success benefit, and b) the size of the failure duration penalty. Figure 1 explores some alternative scenarios using our results as a baseline.

---------- Insert Figure 1 about here ----------

The "not diverse" line shows the predicted number of successes for a non-diverse strategy over 10K days, with a baseline success set at 18.2%, success requiring 623 days, and failures requiring 401 days. This is the control scenario. The other three lines show predicted successes for the diversity strategy as a function of changing: 1) the performance advantage: lines with 2%, 4%, and 6% boost to the baseline publication rate; and 2) the duration for diverse failures, i.e., the horizontal axis. When a diverse strategy line is below the "not diverse" line, then in net, the diversity produces fewer successes despite the publication advantage. The figure reveals that using plausible values for the benefits and costs associated with diversity, a non-diverse strategy may in fact be superior.

Discussion and conclusion

Our study of collaborations in the IETF reveals that crossing formal boundaries generally leads to increased chances of success in terms of publication. Moreover, diverse collaborations have faster success in that they go through fewer revisions and take less time to publication. Yet, we also find that diverse collaborations take longer time to fail. This may be due to sunk costs or escalation of commitment. Regardless of the mechanism, this has important implications, as there is an opportunity cost associated with holding up resources in failing projects. Our simulation of the potential for success of diverse collaborations shows that even with an added success bonus the diverse projects may in fact be more costly than non-diverse projects. Consequently, organizations may be better off pursuing non-diverse projects, which calls into question the constant pursuit for novelty.

Limitations. A major limitation of our study lies in the quality of the projects on which authors choose to collaborate.

Testing for collaboration type effects in an observational setting is complicated by the fact that individuals self-select into remote and/or organizationally diverse collaborations (Shaver, 1998). Hence the authors in our setting may select into diverse collaborations only when the project that has a more certain outcome. Consequently, the low diversity population of collaborations may contain a higher proportion of risky or speculative ideas because the collaborators are more inclined to initiate these projects. If it is true that diversity is a proxy for unobserved risk or quality, then our statistical models may be biased with respect to estimating the effect of diversity on project persistence. While we are unable to completely rule out this endogeneity, by choosing a cross section of the data at the point of initial submission, we believe that some of these quality differences are overcome and we see variation in the likelihood of success of the diverse submissions. Moreover the finding that there are variations in the rate of success and failure of diverse collaborations, suggests that the outcomes are related to coordination costs and not the quality of the projects per se. Future studies may be

able to disentangle the deeper mechanisms at work by analyzing the quality of the ideas as well as the quality of the authors.

Contributions. Our results suggest that the costs of cross boundary collaborations may in fact outweigh the benefits. As such our findings may add to our understanding of the organizational tendency to towards exploitation at the cost of exploration (March, 1991). While all firms need to explore in order to pursue successful growth, diverse collaborations may not always be the best solution to this dilemma.

The findings also have implications for organization design. Recent work on organization design has showed the importance of facilitating informal interactions in organizations – particularly across formal organization boundaries (e.g., Gulati and Puranam, 2009; Kleinbaum, Stuart and Tushman, 2013; McEvily, Soda, and Tortoriello, 2014; Soda and Zaheer, 2012). Yet, we suggest that even in a setting where authors voluntarily chose to collaborate across formal boundaries, this may have unexpectedly high costs.

Third, our work has implications for work on strategy implementation and resource allocation in organizations (Amit & Schoemaker, 1993; Bower 1970). In particularly, because diverse projects take longer to fail, they will hold up resources that could otherwise have been allocated to other efforts at innovation. As such, the pursuit of novelty has high opportunity costs in terms of resource allocation.

Finally, our work has important managerial implications. To the extent that managers know more about the costs of cross boundary collaborations it may be possible to design interactions in organizations to help overcome such costs. If the underlying mechanisms that lead to failure are indeed related to sunk costs and escalation of commitment senior management may be able to put in place levers to avoid overinvestment in failing projects. Regardless, our work sheds an interesting light on the relentless pursuit for novelty in organizations.

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Table 1: Estimates for Internet Draft Publication

Model	(1)	(2)	(3)	(4)	(5)	(6)
	Logit	Logit	Logit	Logit	Logit	Logit
Org. Div.	1.024**	1.115**				
	(5.15)	(5.21)				
Geog. Div.	0.297*	0.646*				
	(2.53)	(2.03)				
US author(s)	0.371**	0.372**	0.387**	0.387**	0.376**	0.370**
	(2.67)	(2.68)	(2.80)	(2.80)	(2.71)	(2.66)
Prior Collaboration	0.268**	0.267**	0.271**	0.262**	0.261**	0.259**
	(2.86)	(2.84)	(2.89)	(2.79)	(2.78)	(2.75)
Ln(file size)	0.155**	0.152**	0.161**	0.158**	0.158**	0.153**
	(2.92)	(2.86)	(3.04)	(2.97)	(2.97)	(2.88)
Ln(prior pubs)	0.128**	0.129**	0.132**	0.132**	0.134**	0.134**
	(3.05)	(3.07)	(3.13)	(3.15)	(3.19)	(3.20)
WG submission	1.707**	1.711**	1.707**	1.713**	1.714**	1.721**
	(19.13)	(19.15)	(19.16)	(19.20)	(19.22)	(19.25)
Org Presence	-0.0460	-0.0498	-0.0498	-0.0588+	-0.0474	-0.0577+
	(-1.38)	(-1.49)	(-1.50)	(-1.75)	(-1.42)	(-1.71)
Org. Div. # Geog. Div.		-0.706				
		(-1.17)				
Auth Close Index			-0.291*	-0.150		
			(-2.22)	(-1.00)		
Auth Same Org Index			-0.450**	-0.0851		
			(-3.21)	(-0.36)		
Auth Close+Same Org Index				-0.547+		
				(-1.85)		
Auth Remote Index					0.304**	1.034**

					(2.58)	(3.04)
Auth Diff Org Index					0.559**	0.648**
					(4.80)	(5.24)
Auth Remote+Diff Org Index						-0.818*
						(-2.26)
Constant	-3.070**	-3.080**	-2.437**	-2.410**	-3.128**	-3.116**
	(-4.58)	(-4.59)	(-3.64)	(-3.59)	(-4.66)	(-4.64)
Observations	5055	5055	5055	5055	5055	5055
Pseudo R^2	0.233	0.233	0.232	0.232	0.232	0.233

t statistics in parentheses

Time Period and Co-author number Fixed Effect coefficients not reported

+ p<0.10, * p<0.05, ** p<0.01

Table 2: Estimates for Project Duration and Versions

	(1)	(2)	(3)	(4)
	OLS - Duration	OLS - Duration	Poisson - Version	Poisson - Version
Auth Close Index	9.396		0.00520	
	(0.59)		(0.16)	
Published=1	-14.01	158.5**	0.416**	0.672**
	(-0.85)	(6.17)	(16.05)	(16.84)
Published=1 # Auth Close Index	32.10		0.0164	
	(0.90)		(0.30)	
Auth Same Org Index	-39.86*		-0.0926**	
	(-2.51)		(-2.83)	
Published=1 # Auth Same Org Index	142.3**		0.234**	
	(3.80)		(4.06)	
US author(s)	2.598	-1.041	0.0108	0.00618
	(0.21)	(-0.08)	(0.43)	(0.25)
Prior Collaboration	-39.26**	-37.70**	-0.0891**	-0.0868**
	(-3.52)	(-3.38)	(-4.43)	(-4.33)
Ln(file size)	35.14**	35.50**	0.133**	0.134**
	(5.66)	(5.71)	(11.92)	(12.01)
Ln(prior pubs)	7.912+	7.766+	0.0416**	0.0417**
	(1.81)	(1.78)	(4.95)	(4.97)

WG submission	238.1**	238.6**	0.566**	0.567**
	(21.69)	(21.72)	(28.41)	(28.46)
Org Presence	1.446	0.904	0.00946	0.00860
	(0.43)	(0.27)	(1.46)	(1.33)
Auth Remote Index		25.23		0.0618+
		(1.56)		(1.95)
Published=1 # Auth Remote Index		-65.69*		-0.139**
		(-2.04)		(-2.72)
Auth Diff Org Index		27.29*		0.0718**
		(2.07)		(2.61)
Published=1 # Auth Diff Org Index		-144.7**		-0.206**
		(-4.66)		(-4.27)
Constant	-135.8	-166.5*	-0.841**	-0.932**
	(-1.61)	(-1.98)	(-5.65)	(-6.29)
Observations	5055	5055	5055	5055
R^2	0.146	0.147		
Pseudo R^2			0.127	0.128

t statistics in parentheses

Time Period and Co-author number Fixed Effect coefficients not reported

+ p<0.10, * p<0.05, ** p<0.01

Figure 1: Simulated Scenarios of Likelihood of Success of a Diverse Strategy