UNTIL LIONS BECOME LAMBS: MOTIVATIONAL CLIMATE, ORGANIZATIONAL IDENTIFICATION, AND THE DISCLOSURE OF A FIRM'S PROPRIETARY KNOWLEDGE

Giada Di Stefano
Bocconi University
Via G. Roentgen 1
20136 Milan, Italy
Email: giada.distefano@unibocconi.it

Maria Rita Micheli
IESEG School of Management
1 Parvis de La Défense
92044 Paris - La Défense Cedex
Email:m.micheli@ieseg.fr

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How can firms prevent the disclosure of proprietary knowledge through their employees? In this paper, we examine the role of organizational climate as a powerful tool firms can act upon. To this end, we engage in an extensive field study of the two largest CERN experiments. Despite sharing institutional linkages, key resources, and the location of their headquarters, the two experiments are (and were indeed created to be) in competition with each other, so to ensure the validity of scientific discoveries through replicability. Our empirical strategy consists of a mixed-method approach, in which we sequentially engage in inductive theory-development followed by a field experiment aimed at testing our theory. Our findings suggest that employees are less likely to disclose proprietary knowledge when they feel an integral part of the organization, but more likely to disclose when the motivational climate is oriented towards performance, with the organization encouraging them to outperform coworkers. We further argue that, even in the presence of an unfavorable organizational climate, the threat of knowledge disclosure can be mitigated by acting upon the individual employee through job design and socialization regime.

INTRODUCTION

Organizational knowledge is more than the sum of the individual knowledge of each single employee within an organization (Cohen and Levinthal 1990). Still, employees are crucial repositories of a firm's proprietary knowledge, and as such important conduits for potential spillovers thereof. Employees can leave a firm to join a competitor or create a firm of their own (Castanias and Helfat 2001, Coff 1997, Ganco et al. 2015, Kacperczyk and Balachandran 2018), but also, more simply, they may talk to employees from other organizations, thus letting knowledge flow outside organizational boundaries (Singh 2005). Independent of the reasons why employees may engage in such conversations, and of whether they are aware of the potential harm caused to their organization, such knowledge leakages erode a major source of an organization's competitive advantage and constitute a serious threat to its survival and prosperity (Brown and Duguid 2001, Faems et al. 2008, Jarvenpaa and Majchrzak 2016). It is hence reasonable to expect organizations to put in place protection mechanisms that shield them against such threat.

Most of previous literature has tended to focus on the role of formal protection mechanisms such as legal barriers and financial incentives (e.g., Agarwal et al. 2009, Ganco et al. 2015, Kim and Marschke 2005). The rationale is to align the employees' individual goals with those of the organization by acting on extrinsic motivation. In conformity with a more elaborated view of human motivation (Gottschalg and Zollo 2007, Obloj and Sengul 2012), recent work has started to look at how firms can employ informal protection mechanisms that act upon an individuals' *intrinsic* motivation not to disclose organizational knowledge. An example is constituted by the work of Flammer and Kacperczyk (2019), who argue that, by increasing engagement in corporate social responsibility, firms can reduce the likelihood that employees leave the company, as well as their propensity to disclose proprietary knowledge in case of departure.

In this paper, we follow their precedent and examine the existence of other, nonpecuniary levers that firms may maneuver in order to align their goals with those of their employees, thus preventing the disclosure of proprietary knowledge. In particular, we examine the role of organizational climate as a powerful tool firms can act upon. We claim that employees will be: (i) less likely to disclose proprietary knowledge when they feel an integral part of the organization they belong to (*organizational identification*); but (ii) more likely to disclose proprietary knowledge when the organization encourages them to outperform coworkers (*performance-oriented motivational climate*). We further argue that even in the presence of an unfavorable organizational climate (that is, a climate characterized by a performance orientation and/or low organizational identification), the threat of knowledge disclosure can be mitigated by acting upon the individual employee. Employees will be less likely to disclose proprietary knowledge if they: (i) hold a position of responsibility (*job design*); or (ii) are located in the headquarter (*socialization regime*).

Our claims are based on an extensive field study of CERN (European Organization for Nuclear Research), a leading institution operating the largest particle physics laboratory in the world. Scientists at CERN are organized in seven large research teams (called 'experiments' in CERN's language) all using the Large Hadron Collider (LHC), the world's largest and most powerful particle collider (Knorr-Cetina 1995, Tuertscher et al. 2014).[1] Despite using the same collider, the seven experiments differ along many dimensions, such as size (ranging between ~100 and ~3,000 affiliated scientists) and types of physics studied (e.g., cosmic rays derived from particles collisions, the Standard Model, heavy ions). Our analysis focuses on the two largest CERN experiments, namely ATLAS and CMS. The two experiments, similar in size and type of physics studied, are (and were indeed created to be) in competition with each other, so to ensure the validity of scientific discoveries through replicability. This makes the disclosure of organizational knowledge particularly dangerous: if knowledge flows from one experiment to another, not only is the validity of the scientific process compromised, but also claims of priority are in jeopardy, and so is access to human and financial resources. Still, it is impossible to ignore that the two organizations share institutional linkages (through CERN), employ the same key resource (LHC accelerator), and their

[1] An eighth experiment called FASER has been recently approved at CERN and will be operational in 2021.

headquarters are physically co-located (in Geneva, Switzerland). This makes the threat of knowledge leakages extremely tangible, and brings centerstage the individual choice of each organizational member to keep knowledge within the organizational boundaries or let it flow across them.[2]

Our empirical strategy consists of a mixed-method approach (Edmondson and McManus 2007, Guler 2007). In particular, we sequentially engaged in inductive theory-development followed by a field experiment aimed at testing our theory, as illustrated by Fine and Elsbach (2000) and implemented, among the others, by Huang and Pearce (2015). We started by investigating the propensity of members of the two experiments to disclose knowledge to members of their own vis-à-vis the competing experiment. Our in-depth interviews highlighted different patterns across the two organizations, prompting us to dig deeper by means of additional interviews, triangulated with field observations and extant theory, in the spirit of a grounded theory approach (Glaser and Strauss 1967). This iterative investigation made us realize that not only do members of ATLAS and CMS differ in their propensity to disclose proprietary knowledge, but also, they differ across other relevant organizational dimensions, namely the extent to which organizational members identify with their organization and feel in competition with their colleagues. We further observed differences across informants, based on whether they held positions of responsibility and were located in the headquarters – characteristics that may arguably contribute to better align individual to organizational goals (Gottschalg and Zollo 2007) and increase organizational identification, thus shielding individuals from any outside pressures towards disclosure (Schilke 2018).

Based on these insights, we next designed the experiment that is at the core of our study. In the experiment, which we administered to 5,732 scientists working at ATLAS and CMS, we put participants in front of a hypothetical counterpart characterized by different features including her affiliation to the same or the competing experiment. Results from our analyses show that at ATLAS, where organizational identification of members is higher, and the motivational climate is less oriented towards outperforming coworkers, knowledge flows tend to stay *within* organizational boundaries. On the other hand, at CMS,

[2] Knowledge produced by each single scientist is, within this context, considered knowledge that is proprietary to the experiment. The norm in this field is that each physicist affiliated to an experiment at CERN is a contributor to the production of a broader organizational knowledge and, as such, a co-author on every major publication. Every major publication coming out of research conducted by any member of ATLAS or CMS when using the LHC accelerator has indeed a list of ~3,000 authors, from the most seasoned physicists in the organization down to the latest employed Ph.D. students. The number of authors is lower for papers called 'Internal Notes', which are not intended for publication and stem from the initiative of smaller teams of physicists, who use such Notes to diffuse information about the status of their work (e.g., status reports of sub-detectors or subsystems, physics discussions, etc.). In addition, individual scientists may decide to write a paper with a smaller team of authors; this is allowed as long as they do not rely on data used in the collective publications.

where organizational identification is lower, and the motivational climate is more oriented towards outperforming coworkers, knowledge tends to be disclosed *across* organizational boundaries. However, in line with our intuition, CMS scientists in positions of responsibility or located in the headquarter exhibit opposite tendencies, and tend to keep knowledge inside their own organization. These two factors reduce the threat of disclosure, thus contributing to better align individual and organizational interests.

We believe this study contributes to several streams of literature. For literature on appropriability (e.g., Agarwal et al. 2009, Gambardella et al. 2015), it highlights the role of nonpecuniary incentives that firms may use as a defense against knowledge disclosure. Previous literature in this domain has predominantly focused on legal barriers and financial incentives, with the notable exception of Flammer and Kacperczyk (2019) and their work on corporate social responsibility. We further uncover how knowledge disclosure can be prevented by acting upon the organizational climate as well as job design and socialization regime. For literature on interest alignment (e.g., Gottschalg and Zollo 2007, Mahoney et al. 2009), we show how members of an organization can be motivated to behave in line with organizational goals by acting upon organizational and individual levers. Our results provide clear and actionable recommendations for managers wishing to reach a better alignment of the individual interest of employees to disclose proprietary knowledge with the organizational interest to keep it within the organizational boundaries. Third, by explaining individual behavior as the result of both firm- and individual-level characteristics, we contribute to the emerging literature exploring the complex interplay between micro and macro levels of analysis (Di Stefano and Gutierrez 2019, Felin et al. 2015, Lee et al. 2016). Previous literature has tended to explain the tendency to disclose vs. withhold knowledge by focusing on variance either across individuals, independently on their organizational affiliation (e.g., Argote et al. 2000, Cabrera and Cabrera 2002), or across organizations, holding intra-organizational variance constant (e.g., Lawson et al. 2009, Jarvenpaa and Majchrzak 2016). A notable exception is constituted by the multi-level model developed by Levine and Prietula (2012) to explain how knowledge transfer impact organizational performance. Following their lead, in this paper we explore inter- and intra-organizational variance at the same time. Our results suggest when it comes to preventing knowledge disclosure, some characteristics at the individual level can compensate for unfavorable organizational factors.

OVERVIEW OF FIELD STUDY

In this paper, we are interested in understanding the role of nonpecuniary incentives that firms may use to align their goals with those of their employees and prevent the disclosure of proprietary knowledge. In particular, we uncover how disclosure can be prevented by acting upon the soft fabric of an organization, namely its climate. To this end, we engaged in an extensive field study using a mixed-method approach (Edmondson and McManus 2007, Guler 2007). Our data collection consisted of four different phases, summarized in Table 1. In ***Phase 1*** (2016), we completed extensive desk research and conducted a first round of interviews with members of CERN. The aim of this first phase was to familiarize ourselves with the empirical context and start isolating interesting patterns in our informants' accounts. In ***Phase 2*** (2017), we conducted a second round of interviews with members of ATLAS and CMS. We used these interviews to refine our understanding of differences across the two organizations and develop our theory about the drivers of knowledge disclosure. We leveraged the insights from the qualitative theoretical development to design our experiment, which we administered in ***Phase 3*** (2018). We collected written feedback about the experiment and completed a final round of interviews in **Phase 4** (2018), with the aim of better understanding the results of the experiment and sharing our interpretation with key informants. For ease of reading, we will present the empirical details and main findings of each of these phases consecutively. We will start with the first two phases to discuss our theoretical development, and then move to the last two phases to present our empirical examination.

- Insert Table 1 about here -

THEORETICAL DEVELOPMENT: DESK RESEARCH, INTERVIEWS, AND OBSERVATIONS (2016-2017)

Our field study at CERN started with two rounds of qualitative data collection. We entered the field early 2016 through desk research first, and interviews afterwards, with the aim of getting familiar with the context and developing a situated understanding of flows of knowledge among scientists in different experiments. We used the insights generated from this first phase of data collection to refine our empirical strategy and, most importantly, decide to focus on two organizations, i.e. ATLAS and CMS, within the broader context of LHC experiments at CERN. The second phase of data collection provided us with a deeper dive into these two organizations through more focused desk research, followed by interviews and on-site observations. By the end of 2017, we believed to have reached theoretical saturation (Locke 2001). Not only had we developed a throughout understanding of how knowledge travels within and across organizational boundaries in our empirical context, but also, we were able to connect the insights from our qualitative examination to extant theory. The outcome of this iterative process is a theory of how organizational climate affects the decision of an employee to disclose a firm's proprietary knowledge.

Phase 1

Overview. At the earliest stages of this phase, we conducted extensive desk research, combining several sources. We used CERN's website (https://home.cern/science) and press releases (https://home.cern/press) to better understand how the institution is organized, which activities it conducts, and how it has been covered in the media. Next, we read literature discussing CERN from a variety of perspectives, mostly in relation to management, philosophy of science, and sociology. Finally, we went through books and monographs discussing the history and achievements of CERN over time.

Once we had made ourselves more comfortable with the context, we entered the field and conducted a first round of eleven exploratory interviews with scientists at CERN. Specifically, we interviewed: (i) eight physicists working for five different LHC experiments (ALICE, ATLAS, CMS, LHCb, and TOTEM); (ii) two theoretical physicists working at CERN but not officially affiliated with any experiment; and (iii) one physicist working at an experiment using a different detector but relying on CERN for some of its analyses. We selected our informants using a mix of theoretical sampling (by contacting the spokespersons for the different experiments and prominent theoretical physicists) and snowballing (by asking former interviewees about suggestions on who to interview next). The interviews lasted between 35 and 70 minutes, and were mainly held on the phone or via video-conferencing by either one or both co-authors. All interviews were recorded and transcribed, for a total of 387 minutes of recording and 152 single-spaced pages of transcripts. We were not able to record one interview because of a technical problem. During interviews, we took detailed notes, for a total of 21 pages, which we also analyzed together with the transcripts. Despite both researchers were outsiders to the organization, one of them had a close acquaintance working at one of the experiments at CERN. We hence asked this 'qualified' informant to act like a sounding board for ideas and observations we developed along the way. We exchanged several emails with this informant and three of his closest contacts at CERN, with the goal of discussing the points that emerged from our analysis over time. By the end of this process, we developed a good understanding of knowledge flows across experiments at CERN.

Main insights. CERN is a leading institution, operating the world's largest and most powerful particle collider, named LHC (Knorr-Cetina 1995, Tuertscher et al. 2014). The project for building LHC was launched in the Nineties and completed in 2008, with the actual operations beginning on November 20th, 2009. The collider successfully operated for a first run in the period 2009–2013, leading, among the others, to the discovery of the Higgs Boson in July 2012.[3] After a two-year shut-down for an upgrade, a second operational run was conducted in the period 2015-2018, with considerable improvements on luminosity and therefore an increased number of collisions. CERN groups together over 12,200 scientists of 110 nationalities, working in large research teams (called 'experiments' in CERN's language) that use LHC for their analyses, namely: ATLAS, CMS, LHCb, ALICE, LHCf, TOTEM, and MoEDAL.

Among these seven experiments, ATLAS and CMS are particularly interesting in the light of our research interests. These two experiments are in fact set up as two separate organizations aimed at the same scientific goals (Boisot et al. 2011). The reason behind the design choice of having two organizations competing with each other is to be identified in the need for them to check on each other – if one makes a discovery, the other should be able to double check on it before any announcement is made. Despite sharing institutional linkages (through CERN), employing the same key resource (LHC), and their headquarters being physically co-located (in Geneva, Switzerland), each of the two organizations has a strong incentive to be the first to make any discovery, so to secure recognition, research funds, and human resources. This tension between competition and collaboration clearly emerged during the first phase of our data collection. It is described in previous academic literature (e.g., Boisot et al. 2011) and openly reported on CERN's official documents. As an example, consider the following excerpt from a post on CERN's website on the occasion of the 25th 'birthday' of ATLAS and CMS in 2017:[4]

> *ATLAS and CMS are like close sisters, the best of friends and competitors all at once. Today they are both celebrating their 25th birthdays. On 1 October 1992, the two collaborations each submitted a letter of intent*

[3] The Higgs Boson is an elementary particle in the Standard Model of particle physics. Despite its existence was first theorized in the 1960s, its actual discovery only took place in July 2012, as the result of a research effort carried out jointly by ATLAS and CMS. See: https://home.cern/topics/higgs-boson (last access: 09/01/2019).

[4] See: https://home.cern/news/news/experiments/atlas-and-cms-celebrate-their-25th-anniversaries (last access: 09/01/2019).

for the construction of a detector to be installed at the proposed Large Hadron Collider (LHC). These two documents, each around one hundred pages long, are considered the birth certificates of the two general-purpose experiments.

The co-existence of competition and collaboration was also clearly reflected in the way in which our informants talked about the two organizations, as in the case of this CMS physicist: [5]

I work at one experiment at CERN, which relies on LHC, the accelerator that is at CERN. I work at this experiment called CMS. Basically, there is another experiment called ATLAS, which studies more or less the same things of CMS. Well, they are, if you want, in direct competition, and they work more or less on the same things. (Informant #1)

One thing that struck us during this first round of interviews was the difference in attitude between informants from ATLAS and those from CMS. When talking with our two CMS informants, we noticed that they tended to take their individual perspective, or that of the particular research team they worked with, emphasizing competition a lot. On the other hand, our two ATLAS informants constantly referred to the goals of their organization and downplayed competition. In the quote below, one informant explains that scientific advancements are not led by competition, but instead by the need to create a shared language in the organization, so that scientists can leverage it to collaborate:

It's not competition. It's like, how do you say, setting a standard. So, you say: to obtain this specific measurement, you need this specific 'ingredient' and then you need to follow this specific methodology and present the results in this specific way. You should be able to give this information to others so that they can reproduce the result. (Informant #5)

In general, ATLAS scientists painted a much brighter picture of the working atmosphere at CERN. For example, the quote below shows that all ATLAS scientists get the chance to present at conferences, based on a collective rotation system. Note the constant use of the pronoun 'we' as opposed to the 'I' used by our CMS informant above.

At ATLAS, we basically have a committee assigning presentations based on a rotation system. Since we are more than 3,000, we try to alternate. This allows everybody to do at least one or two presentations every three or four years. But this also means that you might have to present stuff you didn't personally do, stuff that was done by someone else in the experiment. (Informant #3)

We observed differences also for what concerns the adherence to formal organizational rules. For instance, when we asked about the existence of any written rule governing the flow of proprietary knowledge across members of CERN, informants from ATLAS immediately mentioned:

Well, yes, we have them. For instance, if I am not mistaken, the official policy says that, when we find something that could be a discovery, we tell the other experiment one week in advance with respect to the moment when the

[5] The informants are identified by a number, in order to preserve their anonymity. All transcripts have been translated to English from the original language in which the interviews were conducted, i.e. English, French and Italian.

> *announcement is planned. One week is not enough to start the analysis from scratch. But if the analyses of the other experiment are advanced enough, the policy allows to have a result that confirms or disconfirms the one of the other experiment. (Informant #5)*

The existence of such rules seemed to be ignored by our CMS informants:

> *Well, I don't know. I believe that, a couple of times when someone disclosed some information, our bosses wrote an email with some guidelines telling people what to share and not to share. But well, these rules are not really codified. There are some guidelines, but it's not something like 'if you do something, you get punished.' Everything is left to the self-management. (Informant #1)*

But it surfaced again when talking to informants from other experiments (e.g., *Informant #10*), as well as a theoretical physicist working at CERN, but not affiliated with any experiment, who explained:

> *Both ATLAS and CMS have quite strict rules about which members of the collaborations co-author papers, and which use of information might be construed as insider information. (Informant #9)*

Given the above, we developed the belief that the two organizations, despite being similar along many dimensions, were characterized by crucial differences, which we further explored in Phase 2 of our study.

Phase 2

Overview. Our preliminary interviews made us realize that a focus on ATLAS and CMS was going to be ideal given our research interests. The first encounters with members from these two organizations sparked our curiosity about the extent to which, despite looking very similar on paper, these two organizations were fundamentally different. We hence devoted Phase 2 of our data collection to gauge a better understanding of the two organizations and the dimensions along which they differed, with what implications on the propensity of their members to disclose organizational knowledge.

To this end, we wanted to establish a contact with the spokespersons of the two organizations, which proved particularly time-consuming. In the meantime, we went iteratively through the material previously collected to get better prepared for the new wave of data collection. We finally got access to the spokespersons after the summer of 2017. We interviewed all the four of them, and then, using a mix of theoretical sampling and snowballing, we gradually involved other organizational members, for a total of thirteen additional interviews, with five informants from ATLAS and five informants from CMS. We interviewed one of the spokespersons from ATLAS and both spokespersons from CMS twice, once at the beginning and once at the end of this round of data collection to discuss the accuracy of our interpretations. The interviews lasted between 30 and 90 minutes, and were held face-to-face in the presence of both co-authors. Unfortunately, most of our informants were not comfortable with being recorded during the interviews. This resulted in most of the interviews being conducted more informally. For these interviews, we took notes and transcribed the key points made by the informant immediately following the meeting, for a total of 11 pages of notes. For the two interviews we were able to record, we have a total of 63 minutes of recording and 20 single-spaced pages of transcripts. Finally, we spent two days at CERN in Geneva (Switzerland) to visit LHC, spend time with our informants during their work day, observe interactions in the offices as well as over lunch breaks, and hang out with them after work. During the two days spent at CERN, we collected 13 pages of fieldnotes.

Despite the absence of interview transcripts substantially limited our ability to analyze interview data through an iterative content-analysis process (Glaser and Strauss 1967, Miles and Huberman 1994), we tried to replicate a similar process with interview notes.[6] We relied on all interviews from Phase 2, as well as the four interviews conducted in Phase 1 with members of ATLAS and CMS. We began by writing short descriptions of each interview to highlight key points and identify recurring patterns. We then linked each interview to a set of first-order categories (Gioia and Chittipeddi 1991, Locke 2001), capturing the elements each informant brought to our understanding of knowledge disclosure. By iterating between data and theory, we were able to re-code our first-order categories into theoretically grounded second-order categories (Strauss and Corbin 1998). Fieldnotes from our observation in Switzerland, together with the archival material we had collected, were also used to guide our interpretation (Jick 1979). In this process, we repeatedly updated and revised the emerging framework based on new evidence collected through our interviews. We discussed to resolve occasional discrepancies in interpretations. In line with methodological prescriptions (Hirschman 1986, Lincoln and Guba 1985), we reviewed our interpretations with spokespersons from both experiments to ensure their accuracy. By the beginning of 2018, we believed we had a good understanding of how ATLAS and CMS differed, and with what effect on the tendency of their members to disclose proprietary knowledge across organizational boundaries. We were also able to link such understanding to the findings from prior research, and hence established to have reached theoretical saturation (Locke 2001).

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[6] We have chosen not to report such data structure in the paper because we believe that the fact that it was generated based mainly on interview notes, rather than interview transcripts, reduced its objectivity compared to methodological standards. Still, we found the exercise of generating it useful, as it helped us make sense of our data and identify the emerging patterns.

Main insights. As soon as we started to know ATLAS and CMS better, we realized our intuition about these organizations being very different had some merit. As one informant from ATLAS put it (*Informant #19*), the two experiments have indeed different *'genetic traits.'* Members of the two organizations continuously hinted at the differences while discussing about their relationship with employees of the other organization. For instance, one ATLAS informant explained to us that the two experiments are to be seen as two '*twin sisters*' with '*differences'* and '*interdependencies*.' When asked to characterize the '*personalities'* of the two organizations, this informant described ATLAS as '*calm'* and '*rigorous'* and CMS as '*pushy'* and '*aggressive*' (*Informant #12*). Similarly, another ATLAS informant (*Informant #13*) described ATLAS as '*less organized*,' but '*more strict and a perfectionist*,' and CMS as '*more top-down and efficient*' but with a tendency for '*risk-taking*' and '*laissez-faire*' when it comes to potential discoveries. Another interviewee (*Informant #19*) further insisted on the idea of leadership being more '*democratic'* and oriented towards '*consensus'* at ATLAS, to the point of being criticized by some as '*not as strong*.' Differences between the two experiments were also emphasized by our CMS informants, as the following quote from one of them exemplifies:

> *Well, it's clear that each collaboration [ATLAS and CMS] has its own history and its way of being, which are quite different. For instance, with respect to the extent to which the spokesperson has power, what are the procedures for approving publications and so on. (Informant #14)*

The juxtaposition between the two organizations became very visible once we visited the headquarters in Geneva (Switzerland). The main offices of both experiments are co-located in the same building, called Building 40 (see Figure 1). Hosting more than 300 offices, this building is composed of four towers: ATLAS offices are located in two adjacent towers (C and D), right across those of CMS (towers A and B). The towers are connected at the ground floor level, where employees gather to buy food from the coffee shop thereby located, and sit at the nearby tables, equally split between the two sides of the building.

- Insert Figure 1 about here -

The divide that physically materialized in the organization of the workspace was also tangible when talking to members of the two organizations. A first relevant dimension along which the organizations differed was related to the extent to which their members identify with them. Employees at ATLAS tended to constantly adopt the point of view of the organization as a whole, and explicitly referred to being part of a group anytime we asked any question about their choices as individuals. For instance, one informant described the process leading to the publication of results as a collective one, where individual scientists act for the collective goals of the organization, as shown in the quote below:

> *You have a problem that you might easily solve alone in your room, but still you sit with others and try to solve it collectively. In this way, everyone can give his contribution. You write a lot of collective reports that then lead you to the final result. Probably, you could have solved the problem in less time by working alone but, by sharing with others, you create common practices and hope that others will do the same in the future. (Informant #5)*

On the other hand, CMS employees seemed much more self-centered. The quote below, taken from an email exchange with a CMS informant, exemplifies such tendency to adopt an individual perspective:

> *At a researcher level, the aim is to have better results (earlier/more precise/more complete) compared to the other experiment. This can help you when applying for academic positions later in your career. Put it different: the existence of a competitor, with similar capabilities and working on an almost identical scientific program, sets a benchmark and, for you to gain credibility as a researcher, you can't allow your results to be too far from that benchmark. (Informant #17)*

Given the tendency we had started to identify, it hence came as no surprise when a more senior informant at CMS explicitly characterized the lack of organizational identification as an 'issue' with junior scientists:

> *The identification with the experiment was much stronger twenty years ago compared to now. The feeling of 'being a family' was stronger, since we were only a few people and we knew each other well. Now, the experiment is so big that, especially for young people who are new to it, that aspect of identification is lower and experienced in a completely different way with respect to how we experienced it back then. (Informant #13)*

Another relevant dimension along which ATLAS and CMS seemed to differ was related to the extent to which members of the two organizations reported feeling in competition with their colleagues. ATLAS employees described a collaborative culture, where competition is not as strong as one could imagine:

> *On paper it looks like there is a 'culture of fear', as in a cold war, where you always have to be in competition with others. But, in reality, there is no competition. This whole idea of competition is a bit weird to us. (Informant #3)*

Overall, CMS scientists seemed much more aware of the boundaries existing among colleagues in the organization, and of the fact that they were in competition with their peers. For instance, one of our CMS informants recalled a potential discovery that emerged few months before (and not confirmed later), and explained that she would have never 'dared' to talk about it even with a peer she works closely with:

> *If this potential bump in the data was in the analysis of my colleague working besides me, I would have never dared to ask him something about it, you see? (Informant #4)*

Another informant pushed the argument further, by arguing for the need for his experiment (CMS) to keep up with, if not outperform, the other:

> *ATLAS and CMS are the only experiments in the world that can pursue and achieve the physics results they are producing. This means that being ahead of your competitor automatically makes you the best in the world. [...] I think that what would create considerable damage to an experiment would be to become known as the*

'second best' experiment at CERN. This negative image, on the long term, would affect the power of the experiment to attract funding. (Informant #17)

A final notable difference between the two organizations emerged when talking about the management of organizational knowledge. The spokespersons of both organizations explained that no information about potential new discoveries should be shared, under any condition, with members of the competing organization. The rationale is not to create any possible bias that may invalidate results, as well as to avoid that the other organization exploits these insights. As one of our CMS informants explained:

> *It is all based on the professional honesty of scientists working at the analysis. It is in our own interest that there are no knowledge leakages. We want to make sure that the analyses of the two experiments are independent, because only then one experiment can confirm the results of the other. If there is an interaction between the two experiments, the risk is that they both start taking the same research avenue, because they talked to each other. So, it is in our own interest that knowledge leakages are minimal, in order to guarantee the quality of our work. (Informant #14)*

Members of ATLAS seemed to share this vision, and were adamant in stating that organizational knowledge should not be disclosed to members of the other organization before priority was made clear:

> *My friends who are theoretical physicists send me emails, messages in the internal chat, and so on, but I don't answer. If they contact me, it means that the situation is already critical, because it means that they might already know about potential new discoveries we are working on. The thing is: if the other experiment is seeing something in the data and I become aware of it, then I might be biased. Specifically, I could 'suddenly' see the same thing in the data, or try to find it, look for it. Not with a malevolent intention, but just because I have been triggered by the other experiment. And this is not the best scientific method to have an independent confirmation of results. (Informant #5)*

This strict adherence to rules was sometimes described as an impediment to information flows that could have benefited the organization, as explained by this ATLAS informant recalling a specific episode:

> *We had to grant access to the internal data at the basis of one analysis to one of our theoretical physicists in* [an Italian city hosting a national laboratory of physics]. *The bureaucracy at Atlas was so burdensome that, if one was to follow all the procedures, the access would have been granted after the analysis was published. So, we simply decided not to grant access, as it would have been useless. (Informant #3)*

On the other hand, CMS informants tended to question the rationale behind the norm, and joked about their need to be reminded not to disclose sensitive information to the competing organization:

> *At the start of each meeting, there was this precautionary dressing-down of the spokesperson, who used to say: "Please remember that what I am about to tell you will remain here; and please remember that you are not supposed to discuss this with your besties at ATLAS." (Informant #4)*

Others emphasized how knowledge disclosure, despite being harmful to the organization, could lead to personal returns for the individual. Below we report a conversation between two CMS informants, recalling a case where a scientist's individual goals conflicted with the ones of the organization:

> *Informant #14: A physicist can also decide to focus on things that will bring personal returns for his career.*

> *Informant #13: Yes, for example, some time ago, someone within the experiment knew about a result that was about to be published. He collaborated with some theoretical physicists and, as soon as that result was out, he published another paper on his own, together with these theoretical physicists. This is not okay, because he had the advantage of knowing about the result before others. He exploited a specific situation.*

Of course, we also noticed some commonalities across the two organizations. For instance, when pushed further to articulate the drivers of their choice of transferring proprietary knowledge to a colleague, most of our informants tended to agree about the fact that knowledge transfers more easily when they can trust the colleague, either because they know her '*personally, as in the case of someone you have worked with before*' (*Informant #15*), or because she is highly reputed:

> *Of course, if you have two full professors from the two experiments* [ATLAS and CMS] *who know each other and trust each other, they will share knowledge. But if some random person from ATLAS goes to a full professor at CMS, or vice-versa, he will never get the information he is looking for. (Informant #3)*

Similarly, they reported being more willing to transfer knowledge that is not of strategic importance to the organization. For instance, one informant at ATLAS (*Informant #12*) explained to us that there is no problem in sharing information that is not *'hot'*; moreover, sharing this information is also very useful, since it might help with cross-checking preliminary results. Another informant from ATLAS effectively summarized this point in the following quote:

> *Well, there might be two typologies of knowledge sharing: technical information, for example information about some tools that we use. People from the other experiment might want the code behind them, so that they can use the same one. This is not problematic. Well, let's say that there is no copyright on this type of information, I believe. So, it can be shared via email or during a coffee break without problems. Then you have sharing of knowledge concerning physics results. This information should be shared only at the managerial level but, even at lower levels, we often exchange comments on results that are about to be published. So, we often know the results that the other experiment is about to present. However, sharing this kind of information is different. Let's put it this way: if you share, you don't want that your name is mentioned as a source. (Informant #3)*

Discussion. Our qualitative investigation revealed interesting differences between ATLAS and CMS. In particular, we observed that at ATLAS, where members identify more with the organization and feel less in competition with each other, our informants displayed a stronger tendency keep proprietary knowledge within organizational boundaries. On the other hand, at CMS, where physicists feel more in competition and identify less with the organization, we noticed a higher propensity to disclose knowledge to members of the competing organization. We believe extant literature is in line with our intuitions.

According to our qualitative examination, a first antecedent to knowledge disclosure is organizational identification – that is, the extent to which members of an organization perceive themselves as an integral part of it (Ashforth and Mael 1989, Mael and Ashforth 1992). Previous literature discusses the role of organizational identification in increasing job and organizational satisfaction (van Dick et al. 2004) as well as organizational commitment and loyalty (Adler and Adler 1988, Foreman and Whetten 2002, Riketta and Van Dick 2005), thus reducing turnover (Conroy et al. 2017, O'Reilly and Chatman 1986) and positively contributing to the success of an organization (Jones and Volpe 2011, Pratt 1998). Organizational identification has also been shown to shield organizational members from environmental pressures by increasing certainty and focusing attention (Schilke 2018). Results from our qualitative investigation suggest that organizational identification could also come with the benefit of reducing the propensity of an organizational member to disclose a firm's proprietary knowledge.

Another factor that surfaced in our qualitative investigation is related to the feeling of being in competition with coworkers. We connect this to motivational climate, which refers to how members of an organization perceive the organizational practices to evaluate them and determine success or failure (Ames 1992a, 1992b). Motivational climate is a relatively understudied driver of knowledge flows. A notable exception is constituted by the work of Černe and colleagues (2014, 2017), who examine the effect of the interplay between knowledge sharing and motivational climate on innovative behavior. In particular, they discuss how motivational climate can moderate the relationship between the lack of knowledge sharing and creativity (Černe et al. 2014). The authors contend that creativity suffers when colleagues withhold knowledge from one another, and more so if the motivational climate is oriented towards performance, which rewards employees who 'outperform' coworkers (Ames and Archer 1988, Pensgaard and Roberts 2002). Our qualitative examination further suggests that motivational climate can directly influence the choice of disclosing proprietary knowledge across organizational boundaries. In particular, we observed that in a competitive climate –where individual achievements are recognized and only best performers are rewarded –, coworkers may prefer disclosing knowledge to colleagues of a different organization rather than sharing it with their own colleagues, who they view as their direct competitors.

Results from our qualitative investigation also suggest that differences between ATLAS and CMS dissolved when talking to individuals holding positions of responsibility, as all the spokespersons with whom we interacted mentioned strict and explicit rules about knowledge disclosure. This intuition is consistent with literature on organizational interest alignment (Gottschalg and Zollo 2007), according to which organizations can influence the extent to which their members are motivated to behave in line with organizational goals by acting, among the others, on job design. In the case of ATLAS and CMS, the tasks of the spokespersons and the rules they have to follow are indeed made explicit by CERN. According to Gottschalg and Zollo (2007), another relevant lever organizations can act upon is constituted by an employee' socialization regime. This brings us to speculate that the tendency to disclose should be weaker for those members of CMS who are located in the headquarter, and hence have the possibility to interact with their colleagues on a regular basis, thus turning them from 'competitors' to 'colleagues.'

Finally, an observation common to members of both experiments is that knowledge transfers more easily: (i) when they can trust the colleague, either because they know her directly, or because she is highly reputed; or (ii) if the knowledge involved is not of strategic importance to the organization. This resonates with prior literature according to which the threat of expropriation is lower and knowledge transfers more easily with trustworthy counterparts (Bradach and Eccles 1989, Dyer and Nobeoka 2000, Kale et al. 2000) and less valuable knowledge (Hernandez et al. 2015, Liebeskind 1997, Wadhwa et al. 2017).

EMPIRICAL EXAMINATION: SCENARIO-BASED FIELD EXPERIMENT AND FOLLOW-UP INTERVIEWS (2018)

We have discussed how our qualitative investigation revealed interesting differences between ATLAS and CMS. We next leveraged the insights generated during the first two phases of our field study to design an experiment aimed at providing evidence for the patterns previously identified. In particular, we opted for a scenario-based experiment (Florey and Harrison 2000, Gomez et al. 2000, Schminke et al. 1997) carried out '*in the wild*' (Di Stefano et al 2015, p. 907), i.e. involving all physicists working at ATLAS and CMS. We chose such a method because our theory required us to explore individual-level processes within a broader organizational context (Smith and Rand 2017), and we aimed at combining the inference power of an experiment with the external validity of a field study (Di Stefano et al. 2015). The experiment was administered through a survey that was initially circulated among representatives of ATLAS and CMS (through phone calls and email exchanges). We took advantage of our visit at CERN in February 2018 to pre-test the instrument with 8 physicists from ATLAS and CMS who were not part of the management team. In addition, before the official launch of the experiment, we emailed the instrument to other ten physicists, in order to further refine it before distributing it to the entire community of ATLAS and CMS scientists. This pre-test phase allowed us to improve the wording of the questions, making sure that questions were understandable and scientific terms were correctly used. The experiment was then presented in two internal meetings of ATLAS and CMS and finally administered between the end of February and the end of April 2018. This third phase of our data collection was followed by a fourth and final phase, which took place in the second half of 2018, during which we visited CERN again and conducted a number of interviews to discuss the results, share our interpretations with key informants, and collect their feedback.

Phase 3

Experimental procedure. On Monday, February 26, 2018, the secretary of ATLAS sent an email to all 2,777 physicists affiliated with the organization. An email from CMS secretary followed on Thursday, April 26, 2018, targeting all 2,955 physicists affiliated with the experiment. Both emails had been announced during meetings of the management team, as well as meetings of research teams whose members we previously interviewed. The emails distributing the experiment included a brief introduction and a direct link to the survey through which we administered our experiment (see Appendix 1).[7] The experiment put the participant in front of a hypothetical scenario describing another scientist with whom (s)he might interact. The scenario was followed by a series of questions aimed at capturing the likelihood of observing information flows between the participant and this hypothetical colleague, whose characteristics we manipulated in the scenario. In particular, our experimental design was a 2 (affiliation: same or different) X 2 (direct tie: yes or no) X 2 (reputation: high or low) factorial design, generating a total of eight different combinations of treatments, each corresponding to one potential scenario the participant may face. The follow-up questions further differentiated between types of knowledge involved (strategic importance: high or low). Table 2 reports the exact formulation for the four variables of interest, while a copy of the survey through which we administered our experiment is included in Appendix 2.

- Insert Table 2 about here -

[7] Despite we gave both organizations the same sample email, they decided to slightly modify it to better fit their style. It is interesting to note how ATLAS adopted a more hands-off approach by 'inviting' members to reply, and providing our emails for any question or comment. On the other hand, CMS 'strongly encouraged' their members to take part to the experiment, and centralized the collection of feedback by asking potential respondents to contact the management to get in touch with us.

The scenario was introduced by a disclaimer, explaining that the characteristics of the fictitious colleague were selected randomly, and were not meant to identify a specific colleague. We further explained that there were no right or wrong answers, that we had no way to trace back any response to his or her author, and that only aggregated results were going to be shared with the management of ATLAS and CMS – thus not putting our participants at risk of being identified and reducing concerns about social desirability. We assigned two scenarios per participant and randomized assignment both within and between subjects, so to allow for within-participant comparisons. Given that each participant received two randomly assigned scenarios, we can use subject-level fixed effects in the analysis. This allows us to observe how changes in characteristics of a counterpart affect knowledge flows *above and beyond* the average propensity of an individual to engage in such knowledge flows.

Participants. Out of the 5,732 physicists contacted, 518 (ATLAS: 274; CMS: 244) took part to our experiment. Our overall response rate was equal to 9% (ATLAS: 9.9%; CMS: 8.3%), in line with previous studies vehiculated through surveys (e.g., 8.3% in Wilden et al. 2013). Such participation rate was also in line with the expectations of ATLAS and CMS management, as previously expressed by one spokesperson who explicitly warned us: "*Based on our experience when we conducted surveys within the experiment, you should not expect to receive 3,000 responses, but rather few hundreds.*" Broadly speaking, our respondents are mainly male (73% for ATLAS and 75% for CMS), with an average age of 41 (minimum 23, maximum 79), and at different stages of their career; including physicists in the management team (20% for ATLAS and 14% for CMS) and PhD students (40% for ATLAS and 28% for CMS).

In order to understand whether our sample was different compared to the population, we asked the management of both experiments for some summary data about the list of recipients of the original email. Table 3 shows a comparison between our population and sample based on gender, organizational rank, and stage of career. A closer look reveals an overrepresentation of physicists in the management team (ATLAS: $M_{Participants}$=0.238 vs. $M_{Recipients}$=0.050; CMS: $M_{Participants}$=0.119 vs. $M_{Recipients}$=0.060), which can be explained by the fact that the management of both organizations had been involved with validating the experiment and organizing its distribution. To further explore any difference between ATLAS and CMS, we also conducted a series of t-tests based on the same criteria. Results show that, compared to CMS, our ATLAS sample over-represents both PhD students and physicists in the management team. The difference is not big in size (as per Cohen's d). Still, we suggest caution in making any inference, as only 152 of the 274 ATLAS participants answered to our demographic questions.

- Insert Table 3 about here -

Variables. Our interest in this paper is that to understand an individual's propensity to disclose proprietary knowledge to members of a competing organization. To this end, we asked our participants to imagine that the fictitious colleague described in the scenario would come to them looking for unpublished information that is internal to the collaboration. We then asked them to indicate the likelihood (on a scale from 1 to 7) that they would provide such information (*propensity to disclose*).[8] In order to capture whether the knowledge was disclosed across or within the organizational boundaries, we manipulated the affiliation of the colleague described in the scenario, by characterizing him/her as 'affiliated with ATLAS' or 'affiliated with CMS,' while at the same time collecting information about the participant's own affiliation. Hence, depending on who the participant was, the same colleague could have been perceived as affiliated to the same or the other experiment. We chose a concrete statement of facts for our manipulation so to limit demand effects: by describing a colleague as affiliated to a 'competing' experiment, we would have risked prompting the participants to avoid any type of contact.

We also included other variables that, according to our qualitative informants, could explain one's propensity to disclose proprietary knowledge across the organizational boundaries. In line with what we heard on the field, knowledge should in fact flow more easily when the counterpart is trustworthy or when the knowledge itself has less value. At the advice of our informants, we capture trustworthiness by looking at the existence of a direct tie with the colleague asking for information, as well as his/her reputation. We manipulated the existence of a *direct tie* between the participant and the fictitious colleague by characterizing the colleague described in the scenario as 'linked to you through personal relationships, e.g. you work or have worked together, you know each other directly' (direct tie: yes) or 'NOT linked to you through personal relationships, e.g. you have never worked together, you do not know each other

[8] We collected information about other five dependent variables, so to have a clearer idea of the full flow of information. In particular, we asked our participants to estimate the likelihood that they would *receive* such a request from the colleague described in the scenario, as well as their expectation of *reciprocity* (the extent to which they expected the colleague described in the scenario to provide similar information to them in the future). We also asked our participants to imagine the *opposite* situation, in which they would have been the ones asking for information to the colleague in the scenario. We then asked the same three questions about their propensity to ask and to reciprocate, and the expected propensity of the colleague to pass them the information they asked for. We do not report results for these variables in this paper, given that they are not central to our research question.

directly' (direct tie: no). We manipulated the *reputation* of the fictitious colleague by characterizing the colleague described in the scenario as 'known to be a good physicist in the CERN/experiment community' (reputation: high) or 'known to be a mediocre physicist in the CERN/experiment community' (reputation: low). Given that all our manipulations were concrete statements of facts, we did not insert any manipulation checks (Perdue and Summers 1986). Finally, in order to measure the *strategic importance* of the information disclosed, we asked our question about *propensity to disclose* twice, with reference to two types of information. In particular, at the advice of our informants, we distinguished between 'information about an unexpected peak in the data' (strategic importance: high) and 'information about a standard model measurement' (strategic importance: low). Following each scenario, we measured the propensity to disclose each of these two types of information. We marked responses to the two different types of information with dummy variables, and focused our analyses on information of high strategic importance, as compared to the omitted dummy for information of low strategic importance.

The next set of variables we measured was aimed at capturing those factors that according to our qualitative examination, triangulated with extant literature, may affect one's propensity to transfer proprietary information across organizational boundaries. We measured *organizational identification* using the six-item scale of Jones and Volpe (2011), where we asked participant to express their agreement with six statements about their experiment on a scale from 1 (strongly disagree) to 7 (strongly agree). Examples include: 'This experiment's successes are my successes,' or 'When someone criticizes/praises the experiment, it feels like a personal insult/compliment.' The high Cronbach's alpha ($\alpha = 0.82$) supports the aggregation into a single measure. We measured *performance-oriented motivational climate* using the eight-item scale in Nerstad et al. (2013), where we asked our participants to express their agreement with eight statements about their experiment on a scale from 1 (strongly disagree) to 7 (strongly agree). Examples include: 'Internal competition is encouraged to attain the best possible results,' or 'Work accomplishments are measured based on comparisons with the accomplishments of colleagues.' The high Cronbach's alpha ($\alpha = 0.73$) supports the choice of combining the eight measures into one. At the advice of our informants, we further assessed whether participants held a position of responsibility by asking them about whether they were currently holding a position of responsibility or coordination within the experiment. The dummy *position of responsibility* equals to 1 if a participant responded affirmatively to this question. Finally, location in the headquarter was assessed by asking about the percentage of time participants spent at CERN during a year. At the advice of our informants, we created a dummy *located in headquarter* equal to 1 if a participant indicated a percentage equal or above 80%. Finally, we collected a series of control variables, such as gender, age, nationality, career stage, and seniority with the experiment. The list of all variables is provided in Table 4, while Table 5 shows descriptive statistics and correlations.

- Insert Table 4 and Table 5about here -

Model specification. The use of a randomized experimental design ensured that treatments were orthogonal to attributes of the respondents. As such, we could estimate unbiased coefficients for the treated variables. Still, in order to better isolate the effect of our independent variables on the individual's propensity to transfer proprietary knowledge, we provided each participant with two scenarios, thus allowing us to analyze the data by means of an OLS regression with fixed effects and robust standard errors clustered at the level of the participant. Such a specification allows us to control for all individual level characteristics, as the estimation produced is based on the differences between the two scenarios, taking aside the baseline propensity of each participant to transfer information. We use this more conservative specification throughout all the analyses presented in the paper. This does not allow to estimate the impact of control variables (as all individual-invariant characteristics are included in the fixed effects), which comes with the advantage that we could use all the responses provided by our participants, including those where participants did not provide demographic information. We also ran a series of robustness test, using a GLS regression with random instead of fixed effects, as well as an ordered probit instead of an OLS. Results are consistent with those presented here.

Results. Our qualitative examination suggested that members of ATLAS and CMS had a different attitude when it came to disclosing valuable proprietary knowledge to members of the competing experiment. In particular, we noticed that members of ATLAS seemed much more cautious about knowledge disclosure compared to their CMS counterpart. The first analysis we hence run on our data is aimed at understanding whether results from the experiment confirmed this intuition. Table 6 shows the impact that *same affiliation* has on the *propensity to disclose*. In particular, model 1 includes all responses, while models 2 and 4 include only responses from ATLAS and models 3 and 5 only responses from CMS. Model 1 gives us an idea of the main drivers of knowledge sharing across both experiments. Results show that physicists are overall more likely to disclose knowledge to colleagues they know directly, and less likely to disclose knowledge of strategic importance. Neither same affiliation nor reputation seem to have any effect on one's propensity to answer to requests for knowledge. If we then split the data, however, and look at the behavior of the two experiments separately, interesting differences emerge, as predicted by our qualitative examination. First, and foremost, the coefficient of *same affiliation* has opposite signs across model 2 and model 3: at ATLAS, our participants reported being more likely to pass proprietary, unprotected information to scientists affiliated to the same experiment (β=1.807, p-value=0.000, CI: 1.564, 2.050). On the contrary, at CMS participants reported being more likely to pass proprietary, unprotected information to scientists affiliated to the other (competing) experiment (β=-1.306, p-value=0.000, CI: -1.526, -1.086). The effects are big in size, as they represent, respectively a 50.96% increase and 34.64% decrease to the average propensity to disclose in the two experiments (M_{ATLAS}=3.546; M_{CMS}=3.771). This finding lends support to the main intuition emerging from Phase 1 and Phase 2 of our field study. We also observe how participants from CMS seem to be less affected by the trustworthiness of their counterpart when thinking about sharing: neither direct tie nor reputation seem to be particularly effective in increasing their propensity to disclose information. In models 4 and 5, we push the comparison even further and look at how affiliation may further affect the behavior of scientists at ATLAS and CMS. To this end, we interact *same affiliation* with the other three independent variables, to see whether being part of the same organization has any effect on how the trustworthiness of the counterpart (*direct tie*, *reputation*) and the value of information (*strategic importance*) affect sharing behavior. It is interesting to observe that at ATLAS *same affiliation* reverts the result on *strategic importance*: our ATLAS participants reported being more likely to pass proprietary, unprotected information of high strategic importance if the colleague asking for it is affiliated to their same experiment (β=0.151, p-value=0.026, CI: 0.018, 0.283).

- Insert Table 6 about here -

Once we established the existence of this difference across ATLAS and CMS, we started to look for evidence of the mechanisms previously identified. Our qualitative examination suggested that at the organizational level ATLAS is characterized by higher levels of identification with the organization and a motivational climate less oriented towards competition – two characteristics that, we argued, explain their higher propensity to keep the knowledge inside organizational boundaries. The opposite holds true for CMS – which may explain the higher propensity of CMS scientists to transfer knowledge to their competitors rather than pass it to their proximate colleagues. Our main claim is that ATLAS and CMS significantly differ along these two organizational dimensions – a claim we can substantiate through a simple mean comparison. However, we can only speculate that this is the reason why the two organizations exhibit opposite sharing tendencies – our qualitative analysis is what brings us to speculate this is the case, but our experimental design does not allow us to test such claim. To do so, we would have needed to treat organizational identification and motivational climate and then observe changes in the propensity to transfer knowledge to a competitor. This however proved unfeasible in the field: given how ingrained these organizational characteristics seemed to be based on our qualitative examination, we felt that any manipulation would have not been strong enough, and, more importantly, our informants suggested they would have come at the expense of the realism of our experiment. As a result, we chose not to manipulate these organizational characteristics, and simply provide evidence of the existence of a difference across ATLAS and CMS. Results from the mean comparisons show in Table 7 confirm that participants from ATLAS reported higher levels of organizational identification compared to participants from CMS (β_{ATLAS}=4.812 vs. β_{CMS}=4.531, t=3.178, p=0.002, d=0.278). On the other hand, participants from CMS reported to be in a more performance-oriented motivational climate compared to their ATLAS counterparts (β_{ATLAS}=4.272 vs. β_{CMS}=4.466, t=-2.849, p=0.005, d=0.249). This is in line with our observation according to which the two experiments differed along these two dimensions.

- Insert Table 7 about here -

Until now, our analyses have shown that at ATLAS, where organizational identification is higher, and the motivational climate is less oriented towards outperforming coworkers, knowledge tends to remain within organizational boundaries. On the other hand, at CMS, where organizational identification is lower, and the motivational climate is more oriented towards outperforming coworkers, knowledge is more easily disclosed outside organizational boundaries. We next examine whether the threat of knowledge disclosure can be mitigated by acting upon the individual employee. To this end, we study the moderating effect of job design (in our case: holding a position of responsibility) and socialization regime (in our case: being based in the headquarter). Table 8 shows the results of our analyses. In models 1 and 2, we interact *same* *affiliation* with *position of responsibility*, respectively for ATLAS and CMS. What we observe is that, in both cases, scientists who hold a position of responsibility are more likely to pass proprietary, unprotected information if the colleague asking for it is affiliated to their same experiment. The effect, which represents a 3.10% increase of the average propensity to disclose at CMS (M_{CMS}=3.771), is not particularly strong based on traditional indicators of statistical significance (β=0.176, p-value=0.134, CI: -0.055, 0.406). Still, in line with recent literature (Wasserstein et al. 2019), and in the light of our qualitative findings, we believe there is some merit to this finding, and it may be worth to further explore it in future studies, especially since at CMS the main effect of same affiliation has the opposite sign (β=-1.372, p-value=0.000, CI: -1.603, -1.141). Next, in models 3 and 4, we interact *same affiliation* with *located in headquarter*, respectively for ATLAS and CMS. What we find particularly interesting is that, once again, in the case of CMS, where the main effect of same affiliation is strongly negative, scientists located in the headquarters reported being more likely to pass proprietary, unprotected information if the colleague asking for it was affiliated to their same experiment (β=0.385, p-value=0.082, CI: -0.049, 0.819). The effect is not very strong, but big in size, as it represents a 10.21% increase of the average propensity to disclose at CMS (M=3.771). We conclude that results from these analyses offer at least partial support to our intuition that CMS scientists in positions of responsibility or located in the headquarter exhibit opposite tendencies compared to their colleagues, and tend to keep knowledge inside their organization.

- Insert Table 8 about here -

Phase 4

Overview. During the previous phase of data collection, we gave participants multiple ways to get in touch with us. They could leave a written comment after participating in the experiment – which thirty-three participants from ATLAS and twenty-four from CMS did, for a total of 7 single-spaced pages. Alternatively, they could contact us directly via email – and indeed we received direct emails from eight participants from ATLAS and three from CMS. While many comments revolved around the content of our experiment, the emails were mostly focused on asking for additional details or sharing suggestions on the data collection. We replied to all emails and discussed about their content with the spokespersons of the two experiments.

At this point, we realized that a second visit on site would have been appropriate, not only to share some preliminary results with the management of the two experiments, but also to meet with some of our participants, and get a better understanding of their point of view about the experiment. In late May 2018, we hence arranged a two-day visit at CERN. During this time, we met with one spokesperson at ATLAS and one at CMS to discuss some preliminary results and share potential interpretations. We also arranged face-to-face interviews with nine ATLAS participants we never met before, as well as one ATLAS and two CMS informants from Phase 1 and Phase 2 who had expressed an interest in meeting with us while we were on site. The interviews lasted around 30 minutes and were not recorded at the request of our informants. Still, we took notes and transcribed the key points made by the informant immediately following the meeting, for a total of 5 single-spaced pages of notes. We completed one last interview via video-conferencing in June 2018 with a participant who was not at CERN during our visit but wanted to discuss his point of view with us (*Informant #29*). The interview lasted 39 minutes and generated 17 single-spaced pages of transcripts. Overall, these interviews with participants to the experiment helped us better understand their perspective and gather additional evidence in support of our findings. We speculate that the reason why only ATLAS participants expressed an interest in meeting us might have been related to the fact at ATLAS the management team encouraged organizational members to get in contact with us directly rather than to forward any request directly to them, as in the case of CMS (see Appendix 1).

Main insights. We leveraged the additional opportunity to interact with our participants in order to collect additional information on two findings that, we believe, needed further support, namely: (ii) the mediating role of organizational identification and motivational climate; and (ii) the moderating role of job design and socialization regime. About the first point, as we have previously explained, our research design allows us to show that ATLAS and CMS are substantially different in terms of organizational identification and motivational climate. What we cannot show is that it is *because* of these differences that they exhibit opposite tendencies when it comes to disclosing. We hence spent some time gathering additional evidence on this point. One informant reinforced the point that ATLAS scientists usually take more time before disclosing any result, so to be able to have a more refined understanding of what is going on. He emphasized that this usually results in CMS being faster (*Informant #23*). Another echoed this intuition (*Informant #29*): ATLAS physicists prefer to have better refined analyses and more precise results, even if this means waiting more time before discussing about their initial findings outside the boundaries of the organization. He argued that this behavior originates from them being more concerned with group objectives and less worried about competition. On the contrary, according to him, CMS scientists prefer to present less refined results, with the aim of being faster than ATLAS:

> *See, we don't really do this kind of head to head competition at ATLAS. We kind of try to make it more collaborative. And I think this also plays into why CMS is sometimes quicker. (Informant #29)*

The comments collected at the end of the experiment were also quite telling of the difference in motivational climate between the two organizations. Comments left by CMS participants hinted at a high level of competition and were focused on politics and fairness, as exemplified in the following comment:

> *Too often in the collaboration the decision-making process is absolutely not transparent. Only very few people participate to the decision process. (Comment #45)*

Same goes with the next one:

> *The serious issue in the experiments is 'politics.' People are not rewarded according to their skills or contributions. The information chain from working-groups or institutes to upper levels of management is effectively broken with plenty of conflicts of interests in the reporting chain. (Comment #50)*

In turn, comments from ATLAS participants tended to revolve around the importance of adhering to rules and not disclosing information. In addition, ATLAS participants highlighted that competition is not very relevant. The two aspects are exemplified in the comments that follow:

> *There must be a threshold of not distributing important news, it does not matter on a new particle or a relevant measurement, because the mutual independence is what assures the importance of the observation or correctness of the result. (Comment #8)*

Similarly, another participant noted:

> *In the survey, there are many questions about competition, but there is none about self-assessment and working hard just to be able to look back and feel proud or at least satisfied that I did my best. This is what guides most of my colleagues […], even those in the most competitive positions (post-docs). If it was only for competition, most of these people could go to industry and make much more money. (Comment #19)*

The idea of prioritizing organizational goals over personal ones because of the strong level of organizational identification also emerged in one interview, where an informant from ATLAS explained:

> *We're all going for the same goal. […] We all work under the umbrella of having one result. It's not like, it's my result, it's your result. Like, when that result is leaving one team and being presented outside, it's usually presented as, this is our work with everybody kind of contributing to it, even if there was a particular team behind it. (Informant #29)*

A second aspect we looked more closely at is related to the role of job design (in our case: holding a position of responsibility) and socialization regime (in our case: being based in the headquarter) as individual levers that organizations may act upon to mitigate the threat of knowledge disclosure. As discussed above, we find only partial support for this intuition with our experimental data, as the result about job design is not particularly strong. Our interviewees however provided additional evidence that there may be merit in this intuition. In particular, one informant from ATLAS (*Informant #29*) told us that: "*At the management level it's like: it's not my personal goals that I'm trying to achieve, it's like I'm trying to make this community achieve a whole set of goals.*" This point was raised also by other informants who explained that scientists in a position of responsibility internalize rules and try to enforce them within their team through emails and personal interactions (*Informant #22*), thus doing their best to prevent information leakages (*Informant #26*). It is in this spirit that another informant concluded that the level of competition in the experiment '*depends on them*' (*Informant #28*).

In a parallel fashion, other informants claimed that younger scientists might have an incentive to break the rules by looking for information from competitors that might help them in a getting an important result for the organization, thus gaining credibility and having higher chances to get a better position in the future. With respect to this, one interviewee affiliated with ATLAS (*Informant #21*) added that scientists in positions of responsibility can help younger scientists understand what is appropriate when it comes to disclosing information. She recalled an episode that happened before a conference. She wanted to present something quite technical that she was working on, something that had not gone through the approval process yet, but was not very sensitive in her opinion. So, she discussed about it with her superior, who agreed to include the technical result in the presentation; after the presentation, she removed the corresponding slides from the proceedings.

DISCUSSION AND CONCLUSIONS

How can firms prevent the disclosure of proprietary knowledge through their employees? In this paper, we examine the role of organizational climate as a powerful tool firms can act upon. The findings from an extensive field study carried out between 2016 and 2018 at CERN suggest that employees are less likely to disclose proprietary knowledge in organizations of which they feel an integral part, but more likely to disclose it if the motivational climate is oriented towards performance, with the organization encouraging them to outperform coworkers. Results from our analyses further support the intuition that, even in the presence of an unfavorable organizational climate, the threat of knowledge disclosure can be mitigated by acting upon individual levers, namely job design and socialization regime.

We believe our study makes several theoretical contributions. First, and foremost, it explores a fundamental issue of how organizations can retain strategic knowledge within their boundaries. We broaden extant literature, mainly focused on pecuniary incentives and legal barriers (Agarwal et al. 2009, Ganco et al. 2015, Kim and Marschke 2005), by uncovering the role of informal mechanisms such as organizational climate. Exploring the effectiveness of such *soft* tools is of great importance, especially for those contexts where knowledge cannot be effectively protected through formal mechanisms (Di Stefano et al. 2014, Flammer and Kacperczyk 2019). Future research could further explore the interplay between formal and informal protection mechanisms, in the attempt to understand, for instance, under which conditions they can complement or substitute each other.

For literature on interest alignment (e.g., Gottschalg and Zollo 2007, Mahoney et al. 2009), we show how organizations can better align the goals of their individual employees to their own by acting upon different levers at the organizational and individual level. Our context is that of a complex organization, where different actors with different goals co-exist and influence each other (Ethiraj and Levinthal 2009). In this respect, our case is characterized by: (i) individual scientists who want to advance their career, enhance their reputation, and find satisfaction in their job; (ii) two organizations (ATLAS and CMS) that want to advance science, secure access to resources, and gain recognition; and finally (iii) the overarching institution (CERN) directly reaching to the scientific community and society as a whole. Future research could further disentangle the complex interplay between these different goals. Within the context of our study, for instance, we have not explored the interactions between ATLAS and CMS on one side, and CERN as a separate organizational entity on the other.

This observation about the multiplicity of goals uncovers another contribution of our work. By examining individual and organizational goals, and explaining individual behavior as the result of both firm- and individual-level characteristics, we contribute to literature exploring the complex interplay between micro and macro levels of analysis (Di Stefano and Gutierrez 2019, Felin et al. 2015, Lee et al. 2016). This is particularly important in the context of knowledge disclosure, where previous studies have underlined the need to put knowledge exchanges 'in context' (Černe et al. 2014, p. 186, Johns 2006), so to avoid considering individuals as detached from the environment in which they interact with their counterparts, when deciding whether or not to share their knowledge with them.

From a practical standpoint, we believe our study provides clear and actionable recommendations for managers. Our findings suggest that an unfavorable organizational climate may be tempered by acting on the individual employees. This suggests the possibility of acting at the individual level in the short run, in order to counterbalance the effects of the unfavorable climate. In the long run, managers can also put in place more complex interventions aimed at creating an organizational climate that promotes the identification of individual members with the organization and motivates them in a way that does not goes against the interests of the organization as a whole. Another takeaway for managers, in particular those of complex organizations, is that, despite being very similar on paper, different units are likely to develop very different organizational traits. Think about ATLAS and CMS, who "*are like close sisters, the best of friends and competitors all at once.*" The most direct consequence is the need to adapt interventions to the specific '*personality*' of each unit. Finally, we observed that awareness about the existence of codified norms varied considerably across individuals and organizations, as did the way in which the same norms were interpreted. This suggests a need to prioritize the creation of an organizational climate that is favorable to the enforcement of norms over their codification. The latter may not be very effective without the former.

We acknowledge that our study is not without limitations, most of which we have explicitly pointed at when presenting our empirical strategy and results. An important concern that we have not discussed until now may be related to the generalizability of our findings beyond a science-based organization. Our choice of this particular empirical setting was driven by the need to find a context where we could observe the behavior of employees who have the opportunity and incentive to disclose organizational knowledge, despite the harm it generates for the organizations they belong to. Studying ATLAS and CMS proved ideal in this respect. Future research could expand our work to organizations working in different contexts. Still, we would like to emphasize that the organizations we are studying are characterized by many features that are common to contemporary organizations. At ATLAS and CMS employees work across geographical boundaries through a mix of digital and physical interactions, and hierarchical structures are quite flat and leave room for personal initiatives. We think this makes the two organizations that are object of our investigation more typical than one would think.

To conclude, we believe our study provides a fascinating account of how organizational climate can act as a protection mechanism against knowledge disclosure, or on the contrary favor leakages that might be harmful to the organization as a whole. We further uncover how, even in the presence of an unfavorable organizational climate, the tendency to disclose may be reverted by acting upon the intrinsic motivation of the single employee through job design and socialization regime. The combination of these organizational and individual factors contributes to better align individual to organizational goals, thus mitigating the threat of disclosure, and, going back to our title, turning 'lions' into 'lambs.'

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TABLES AND FIGURES

TABLE 1. Overview of four phases of field study

Phase	Time	Data	Brief description	Main purpose of data collection
Phase 1	January - March 2016	Desk Research	CERN website and press releases; Academic literature discussing CERN - mostly in management, philosophy of science, and sociology; Books and monographs on the history and achievements of CERN	Familiarize with the context of CERN and scientific collaboration more in general
	January - October 2016	Interviews	11 interviews with: 8 physicists working at LHC (ATLAS, CMS, LHCb, TOTEM), 2 theoretical physicists (not affiliated with any experiment) and 1 physicist affiliated to one experiment outside LHC	Develop an overall understanding of knowledge flows across experiments at CERN
Phase 2	January - March 2017	Desk Research	Re-examination of sources previously consulted with a more specific focus on ATLAS and CMS	Become knowledgeable about the history and specificities of ATLAS and CMS
	September 2017 - February 2018	Interviews	13 interviews with 5 informants from ATLAS and 5 informants from CMS. We interviewed one of the spokespersons from ATLAS and the two spokespersons from CMS twice, one at the beginning and one at the end of this round of data collection	Understand along which dimensions ATLAS and CMS differ, and with what effect on the tendency of their members to disclose proprietary knowledge across organizational boundaries
	February 2018	Observations	Two days at CERN, spending time with informants during their work day, observing interactions in the offices as well as in the cafeteria and canteen	Triangulate archival and interview data with observational data, so to help the development of our theoretical framework
Phase 3	February - April 2018	Field Experiment	Scenario-based experiment administered through a survey directed to all members of ATLAS and CMS	Test the theoretical framework emerged from our qualitative examination
Phase 4	April 2018	Desk Research	57 comments left at the end of the experiment from 33 participants from ATLAS and 24 participants from CMS. 11 emails exchanges with 8 participants from ATLAS and 3 participants from CMS	Understand the motives and feelings of our participants
	May 2018	Observations	Two days at CERN, meeting with representatives from ATLAS and CMS, and participating to their activities	Debrief with participants and management
	May-June 2018	Interviews	13 interviews with 10 new informants from ATLAS, as well as, respectively, 1 and 2 former informants from ATLAS and CMS	Develop potential interpretations of results

TABLE 2. Manipulated variables and corresponding treatments

		High	Low
Colleague	Same affiliation	Affiliated with <*name of same experiment*>	Affiliated with <*name of other experiment*>
	Direct tie	Linked to you through personal relationships *e.g. you work or have worked together, you know each other directly*	NOT linked to you through personal relationships *e.g. you have never worked together, you do not know each other directly*
	Reputation	Known to be a good physicist in the CERN/ experiment community	Known to be a mediocre physicist in the CERN/ experiment community
Knowledge	Strategic importance	Information about an unexpected peak in the data	Information about a standard model measurement

TABLE 3. Characteristics of respondents

	ATLAS: Recipients (n=2,777)	**CMS: Recipients** (n=2,955)	**ATLAS: Participants** (n=152)*		**CMS: Participants** (n=244)		**T-test**		**Cohen's D**
	Mean	Mean	Mean	S.D.	Mean	S.D.	t	p-value	D
Gender	0.804	0.808	0.736	0.442	0.747	0.436	-0.212	0.832	0.025
PhD student	0.274	0.401	0.375	0.486	0.176	0.382	4.530	0.000	0.455
Management team	0.050	0.060	0.238	0.427	0.119	0.324	3.145	0.002	0.314

* Only 152 of our 274 ATLAS participants responded to all demographic questions. Numbers below are based on available responses.

TABLE 4. Variables and measures

Variable	Measure	Operationalization
Propensity to disclose	Participant's propensity to provide unpublished information that is internal to the collaboration	7-point scale, from very unlikely (1) to very likely (7)
Same affiliation	The colleague described in the scenario is affiliated with the same experiment	Experimentally Manipulated; Same = 1, Other = -1
Direct tie	The colleague described in the scenario is linked to the respondent through a personal relationship (e.g., work or have worked together, know each other directly)	Experimentally Manipulated; Yes = 1, No = -1
Reputation	The colleague described in the scenario is known to be a good physicist in the community	Experimentally Manipulated; High = 1, Low = -1
Strategic importance	The colleague described in the scenario has asked for information of strategic importance (i.e. an unexpected peak in the data)	Experimentally Manipulated; High = 1, Low = -1
Organizational identification	Extent to which participant feels an integral part of the organization (s)he belongs to (ATLAS vs. CMS)	Based on Jones and Volpe (2011): 6-item scale, from strongly disagree (1) to strongly agree (7); α= 0.82
Performance-oriented climate	Extent to which participant perceives the organization to reward employees who outperform coworkers	Based on Nerstad et al. (2013): 8-item scale, from strongly disagree (1) to strongly agree (7); α = 0.73
Position of responsibility	Participant currently holds a position of responsibility or coordination in the experiment	Yes =1; -1 otherwise
Located in headquarter	Participant's work activity is primarily (≥80% of working time) located at CERN in Geneva	Yes =1; -1 otherwise
Respondent_ATLAS	Affiliation of respondent to ATLAS (vis-à-vis CMS)	ATLAS= 1, CMS=-1

TABLE 5. Descriptive statistics and correlations

Variable	Mean	S.D.	Min	Max	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1. Propensity to disclose	3.665	2.407	1.000	7.000	1.000									
2. Same affiliation	-0.420	1.000	-1.000	1.000	-0.012	1.000								
3. Direct tie	0.030	1.000	-1.000	1.000	0.114	0.015	1.000							
4. Reputation	0.005	1.000	-1.000	1.000	0.069	0.002	-0.033	1.000						
5. Strategic importance	0.000	1.000	-1.000	1.000	-0.103	0.000	0.000	0.000	1.000					
6. Organizational identification	4.674	1.275	1.000	7.000	-0.051	-0.026	-0.094	-0.069	0.000	1.000				
7. Performance-oriented climate	4.371	0.984	1.000	6.625	0.037	-0.051	-0.051	-0.003	0.000	0.170	1.000			
8. Position of responsibility	-0.058	0.999	-1.000	1.000	0.001	-0.020	0.031	0.011	0.000	0.101	0.041	1.000		
9. Located in headquarter	-0.316	0.949	-1.000	1.000	0.077	-0.016	0.044	0.029	0.000	-0.141	-0.004	0.094	1.000	
10. Respondent_ATLAS	-0.058	0.999	-1.000	1.000	-0.047	-0.026	0.000	0.030	0.000	0.118	-0.103	0.051	0.134	1.000

TABLE 6. Likelihood to disclose proprietary unprotected information at ATLAS and CMS

	Model 1 All observations			Model 2 ATLAS			Model 3 CMS			Model 4 ATLAS			Model 5 CMS		
	coef	se	p-value	coef	se	p-value	coef	se	p-value	coef	se	p-value	coef	se	p-value
Same affiliation (SA)	0.027	0.140	0.846	1.807	0.123	0.000	-1.306	0.112	0.000	1.708	0.128	0.000	-1.269	0.118	0.000
Direct tie	0.326	0.099	0.001	0.284	0.104	0.007	0.145	0.088	0.098	0.295	0.103	0.004	0.146	0.088	0.095
Reputation	0.157	0.104	0.133	0.207	0.092	0.023	0.035	0.111	0.751	0.204	0.090	0.024	0.038	0.111	0.730
Strategic importance	-0.258	0.027	0.000	-0.198	0.034	0.000	-0.320	0.041	0.000	-0.193	0.034	0.000	-0.319	0.041	0.000
SA* Direct tie										0.161	0.109	0.138	-0.064	0.086	0.461
SA* Reputation										0.095	0.083	0.251	-0.073	0.092	0.431
SA* Strategic importance										0.151	0.067	0.026	-0.083	0.072	0.246
_cons	3.538	0.004	0.000	3.558	0.009	0.000	3.646	0.006	0.000	3.553	0.010	0.000	3.642	0.007	0.000
N		1.766			896			870			896			870	
F		27.028			71.632			59.590			44.547			34.369	
R^2 (ω)		0.051			0.534			0.426			0.542			0.428	

Note: N_{ATLAS}: 274 clusters (participants) with 2 to 4 observations (1 or 2 scenarios * 2 types of information transferred), N_{CMS}: 244 clusters. Within R^2 (ω) reported for all models.

TABLE 7. Differences in organizational identification and performance-oriented motivational climate across ATLAS and CMS

	ATLAS (n=274)		CMS (n=244)		T-test		Cohen's D
	Mean	S.D.	Mean	S.D.	T	p-value	D
Organizational identification	4.812	.870	4.531	1.134	3.178	0.002	0.278
Performance-oriented climate	4.272	.688	4.466	0.859	-2.849	0.005	0.249

TABLE 8. The role of job design and socialization regime

	Model 1 ATLAS			Model 2 CMS			Model 3 ATLAS			Model 4 CMS		
	coef	se	p-value	coef	se	p-value	coef	se	p-value	coef	se	p-value
Same affiliation (SA)	1.928	0.129	0.000	-1.372	0.117	0.000	1.864	0.187	0.000	-1.451	0.147	0.000
Direct tie	0.293	0.105	0.005	0.148	0.093	0.109	0.283	0.104	0.007	0.132	0.088	0.135
Reputation	0.191	0.084	0.023	0.069	0.112	0.535	0.212	0.089	0.018	0.038	0.109	0.727
Strategic importance	-0.170	0.038	0.000	-0.318	0.049	0.000	-0.198	0.034	0.000	-0.320	0.041	0.000
SA* Position of responsibility	0.227	0.126	0.072	0.176	0.117	0.133						
SA* Located in headquarter							-0.107	0.244	0.662	0.385	0.221	0.081
_cons	3.674	0.011	0.000	3.743	0.004	0.000	3.558	0.009	0.000	3.648	0.006	0.000
N		606			680			896			870	
F		79.359			43.785			57.445			47.457	
R^2 (ω)		0.641			0.465			0.535			0.433	

Note: For models 1 and 2: N_{ATLAS}=152 clusters (participants) with 2 to 4 observations (1 or 2 scenarios * 2 types of information transferred), N_{CMS}=170 clusters. For models 3 and 4: N_{ATLAS}=274 clusters, N_{CMS}=244 clusters. Within R^2 (ω) reported for all models.

FIGURE 1. ATLAS and CMS Headquarters, Building 40

APPENDICES

APPENDIX 1. Emails through which experiment was distributed

1. ATLAS, sent on February 26th 2018

Dear Colleagues,

The management of ATLAS has agreed to conduct a study on information transfer among colleagues at CERN.

This study is conducted by two researchers:
- Researcher #1: First name, Last name – Rank, Affiliation, Website
- Researcher #2: First name, Last name – Rank, Affiliation, Website

You are invited to reply to the survey, which takes **less than 10 minutes** to complete. The deadline is **March 9th, 2018**.

Please click: <direct link to survey>
If the link above does not work, please go to: <webpage>

Results from the survey will be presented in a web-cast event. You will also receive a detailed research report with all the main insights.

If you have any question or comment, please feel free to directly contact Researcher #1 (email) and Researcher #2 (email).

Thank you for your collaboration!

Names of spokespersons

2. CMS, sent on April 26th 2018

Dear Colleagues,

The management of CMS, with CERN support, has agreed to conduct a study on information transfer among physicists at CERN.

For this study, we are collaborating with two researchers:

- Researcher #1: First name, Last name – Rank, Affiliation, Website
- Researcher #2: First name, Last name – Rank, Affiliation, Website

You are strongly encouraged to reply to the survey, which takes **less than 10 minutes** to complete. The deadline is **May 8th, 2018**.

Please click: <direct link to survey>

Results from the survey will be presented in a web-cast event. We will also receive a detailed research report with all the main insights.

If you have any questions or comments, please pass them along to us and we will transmit them to the survey team leaders.

Thank you for your collaboration!

Names of spokespersons

APPENDIX 2. Survey through which experiment was administered
Example addressed to CMS physicist

Dear Colleague,

We are two researchers from [city] studying knowledge flows among physicists at CERN. You have received a link to fill in a survey that we are currently running with members of both the ATLAS and the CMS collaboration.

The survey is anonymous and is not meant to inform policy choices in the collaboration, or to be used as a tool for decision making by the management. Before sharing it with all of you, we have validated it with the management of both collaborations through more than 20 interviews that took place over the last 12 months. We have designed it because we understand that knowledge may flow differently within the collaboration rather than across collaborations. We understand that there are rules and norms. We simply want to measure them.

For your info, when you click on the link to access the survey, each of you is randomly assigned to colleagues with different characteristics (including the affiliation to a collaboration). We hope that by collecting many responses not only we will be able to provide you with a picture of what people think within your collaboration, but also of how potentially your collaboration is different from others (i.e. ATLAS).

Of course, the more answers we can collect, the more we can have a picture that is well representative of reality. If you think knowledge flows are not restricted and knowledge should flow freely, please reply to the questions, so that we can get your perspective. If you think knowledge flows are regulated very precisely and there are very specific situations under which they should be restricted, again please reply to the questions, so that we can get your perspective.

We plan to present the results of our research in a web-cast event. We will also distribute a detailed research report with all the main insights of our analysis.

Thanks a lot for helping us with our research!

SURVEY – KNOWLEDGE FLOWS IN SCIENCE

PART 1.

In the following section, we will refer to a fictitious colleague with whom you might interact. The characteristics of this colleague have been selected randomly and are not intended to represent a specific colleague of yours. There is no "right" or "wrong" answer. Please select the one that works best for you.

Fictitious Colleague 1

Characteristics of colleague:	• Affiliated with ATLAS • Known to be a good physicist in the CERN/experiment community • Linked to you through personal relationships *e.g. you work or have worked together, you know each other directly, etc.*

Imagine this colleague comes to you looking for unpublished information that is internal to the collaboration:

		Very unlikely ... ***Very likely***
1	How likely is it that in the next year **this colleague** will **ask** to you:	
	Information about a standard model measurement	*1 2 3 4 5 6 7*
	Information about an unexpected peak in the data	*1 2 3 4 5 6 7*
2	If asked, how likely is it that **you** would **provide**:	
	Information about a standard model measurement	*1 2 3 4 5 6 7*
	Information about an unexpected peak in the data	*1 2 3 4 5 6 7*
3	Assuming you have provided the information, how likely is that **this colleague** will **provide** similar information to you in the future (if asked)?	
	Information about a standard model measurement	*1 2 3 4 5 6 7*
	Information about an unexpected peak in the data	*1 2 3 4 5 6 7*

Now, let's turn tables and imagine you go to this colleague looking for unpublished information that is internal to the collaboration:

		Very unlikely ... ***Very likely***
4	How likely is it that in the next year **you** will **ask** to this colleague:	
	Information about a standard model measurement	*1 2 3 4 5 6 7*
	Information about an unexpected peak in the data	*1 2 3 4 5 6 7*
5	If asked, how likely is it that **this colleague** would **provide**:	
	Information about a standard model measurement	*1 2 3 4 5 6 7*
	Information about an unexpected peak in the data	*1 2 3 4 5 6 7*
6	Assuming this colleague has provided the information, how likely is that **you** will **provide** similar information to this colleague in the future (if asked)?	
	Information about a standard model measurement	*1 2 3 4 5 6 7*
	Information about an unexpected peak in the data	*1 2 3 4 5 6 7*

PART 2.

The following section presents the same questions we had before, but with respect to a second fictitious colleague with some differing characteristics.

Fictitious Colleague 2

Characteristics of colleague:	• Affiliated with CMS • Known to be a mediocre physicist in the CERN/experiment community • NOT linked to you through personal relationships *e.g. you have never worked together, you do not know each other directly*

Imagine this colleague comes to you looking for unpublished information that is internal to the collaboration:

		Very unlikely ... ***Very likely***
7	How likely is it that in the next year **this colleague** will **ask** to you:	
	Information about a standard model measurement	*1 2 3 4 5 6 7*
	Information about an unexpected peak in the data	*1 2 3 4 5 6 7*
8	If asked, how likely is it that **you** would **provide**:	
	Information about a standard model measurement	*1 2 3 4 5 6 7*
	Information about an unexpected peak in the data	*1 2 3 4 5 6 7*
9	Assuming you have provided the information, how likely is that **this colleague** will **provide** similar information to you in the future (if asked)?	
	Information about a standard model measurement	*1 2 3 4 5 6 7*
	Information about an unexpected peak in the data	*1 2 3 4 5 6 7*

Now, let's turn tables and imagine you go to this colleague looking for unpublished information that is internal to the collaboration:

		Very unlikely ... ***Very likely***
10	How likely is it that in the next year **you** will **ask** to this colleague:	
	Information about a standard model measurement	*1 2 3 4 5 6 7*
	Information about an unexpected peak in the data	*1 2 3 4 5 6 7*
11	If asked, how likely is it that **this colleague** would **provide**:	
	Information about a standard model measurement	*1 2 3 4 5 6 7*
	Information about an unexpected peak in the data	*1 2 3 4 5 6 7*
12	Assuming this colleague has provided the information, how likely is that **you** will **provide** similar information to this colleague in the future (if asked)?	
	Information about a standard model measurement	*1 2 3 4 5 6 7*
	Information about an unexpected peak in the data	*1 2 3 4 5 6 7*

PART 3.

To conclude, we would like to ask you something about yourself.
Once again, <u>the information that you provide will be kept strictly confidential</u>. Only summary data drawn from the total responses will be used for the purpose of our research.

13. Your gender:
    a. Female
    b. Male
    c. Other
    d. Prefer not to answer

14. Your age: ______________________________

15. Your nationality: ______________________________

16. Percentage of time you spend at CERN during a year: ______________

17. Experiment you are affiliated with:
    a. ATLAS
    b. CMS
18. Affiliated with your current experiment since: ________________

19. Current position in the experiment (select all that apply):
    a. Management (L0/L1)
    b. Group coordinator / convener (L2)
    c. Detector operation
    d. Physics analysis
    e. Upgrade
    f. Other. Please specify: ______________________

20. To what extent do you agree (1: strongly disagree; 7: strongly agree) with the following statements <u>about the experiment</u> you are affiliated with:

An individual's accomplishments are compared with those of others	*1 2 3 4 5 6 7*
Cooperation and mutual exchange of knowledge are encouraged	*1 2 3 4 5 6 7*
Each individual's learning and development is emphasized	*1 2 3 4 5 6 7*
Colleagues are encouraged to try new solution/methods	*1 2 3 4 5 6 7*
Everybody has an important and clear task throughout the different processes	*1 2 3 4 5 6 7*
I am very interested in what others think about the experiment	*1 2 3 4 5 6 7*
If a story in the media criticized this experiment, I would feel embarrassed	*1 2 3 4 5 6 7*
Internal competition is encouraged to attain the best possible results	*1 2 3 4 5 6 7*
It is important to achieve better than others	*1 2 3 4 5 6 7*
One is encouraged to cooperate and exchange thoughts and ideas	*1 2 3 4 5 6 7*
One is encouraged to perform optimally to achieve rewards	*1 2 3 4 5 6 7*
One of the goals is to make each individual feel that he/she has an important role in the process	*1 2 3 4 5 6 7*
Only colleagues who achieve the best results are set up as examples	*1 2 3 4 5 6 7*
Rivalry between colleagues is encouraged	*1 2 3 4 5 6 7*
There exists a competitive rivalry among colleagues	*1 2 3 4 5 6 7*
This experiment's successes are my successes	*1 2 3 4 5 6 7*
When I talk about this experiment, I usually say "we" rather than "they"	*1 2 3 4 5 6 7*
When someone criticizes the experiment, it feels like a personal insult	*1 2 3 4 5 6 7*
When someone praises this experiment, it feels like a personal compliment	*1 2 3 4 5 6 7*
Work accomplishments are measured based on comparisons with the accomplishments of colleagues	*1 2 3 4 5 6 7*

21. Are you currently in a position of responsibility or coordination inside your experiment?
    a. YES
    b. NO

22. Have you previously been in a position of responsibility or coordination inside your experiment?
    a. YES
    b. NO

23. Have you been affiliated with any of the other experiments at CERN?
    a. YES
    b. NO

24. If yes, please provide a list of all the CERN experiments you worked at with an approximate indication of the time (e.g. 2015-2017):
    i. Experiment: ______________ ; Amount of time: ________________________
    ii. Experiment: ______________ ; Amount of time: ________________________
    iii. Experiment: ______________ ; Amount of time: ________________________

25. Institute you are affiliated with: ____
26. Affiliated with your current institute since: __________________________________

27. Current position in the institute:
    a. PhD student
    b. Postdoc
    c. Tenure-track
    d. Permanent position
    e. Other. Please specify: ____

28. To what extent do you agree (1: very weak; 7: very strong) with the following statements about the institute you are affiliated with:

When someone criticizes the institute, it feels like a personal insult	*1 2 3 4 5 6 7*
I am very interested in what others think about the institute	*1 2 3 4 5 6 7*
When I talk about this institute, I usually say "we" rather than "they"	*1 2 3 4 5 6 7*
This institute's successes are my successes	*1 2 3 4 5 6 7*
When someone praises this institute, it feels like a personal compliment	*1 2 3 4 5 6 7*
If a story in the media criticized this institute, I would feel embarrassed	*1 2 3 4 5 6 7*

Thank you for completing our survey!
If you wish, please use the space below to provide comments or suggestions.