Communication within Firms: Evidence from CEO Turnovers

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Abstract. This paper uses novel, firm-level measures derived from communications metadata before and after a CEO transition in 101 firms to study if CEO turnover impacts employees' communication flows. We find that CEO turnover leads to an initial decrease in intra-firm communication, followed by a significant increase approximately five months after the CEO change. The increase is driven primarily by vertical (i.e. manager to employee) communication. Greater increase in communication after CEO change are associated with greater increases in firm market returns.

Keywords: CEO change, communication

1. Introduction

Intra-firm communication enables firms to share knowledge, create organizational memory, and make decisions that are essential to developing and executing firms' strategies (Simon 1947, Arrow 1974). Internal communication flows have been extensively studied in the organizational economics literature, primarily from a theoretical perspective. More efficient and effective communication can reduce transaction costs in decisions to internalize aspects of operations (Williamson 1979), overcome the cognitive limitations of employees (Simon 1947), increase the ability for firms to analyze and understand information (Arrow 1974), make "sense" out of changes in firm strategy (Weick 1995), and is one of the main reasons why firms form (Coase 1937). In multi-divisional firms, employees use communication to coordinate decision-making across departments and align those decisions to local conditions to achieve the firm's goals (Alonso et al. 2008, Marshak & Radner 1972).

The ultimate drivers of internal communication patterns and their variation across firms and over time, however, are still largely unknown due to data limitations. Comparable observational data on firm-level communication for large samples of firms are hard to find (Impink, Prat & Sadun 2020), and longitudinal data following the evolution of communication patterns over time within firms has not, to our knowledge, been available to researchers. As a consequence, though prior research in organizational economics has provided many theoretical models of intra-firm communication flows from both a static and dynamic perspective, these predictions have not yet been tested empirically.

This paper provides one of the first empirical examinations of internal communication patterns across a large sample of firms. We leverage unique meeting and email metadata from 101 firms to study the effects of specific organizational shocks—CEO turnover, a pivotal event impacting a firm's strategy and performance (Bertrand & Schoar 2003)—on internal communication patterns. Guided by a canonical model of intra-firm communication (Alonso et al. 2008, Rantakari 2008), we examine whether and how CEO turnover impacts employee's formal, internal communication patterns (as measured by intra-firm

emails and meetings), with an event study research design that examines communication flows from six months before the transition to 14 months after the transition.

The model formalizes the idea that directly following a CEO change, confusion around the firm's changing goals and management's expectations (Srivastava 2015) increases ambiguity around the firm's objectives, reducing the formal communication needed to coordinate decision-making. However, as the new CEO sets expectations, redefines priorities, and then shares this new strategy with the firm, uncertainty is reduced. As uncertainty diminishes, employees within the firm communicate more to coordinate decisions. CEOs who are better leaders can restore coordination more quickly (Kotter 1995, Schein 1994) and to a higher point than previously attained.

The empirical findings are largely supportive of the model's predictions. Namely, we find that CEO change leads to an initial decrease in intra-firm communication, followed by a significant increase in intra-firm communication approximately four months after the transition. Second, vertical communication (i.e. managers to employees and vice-versa) increases more than horizontal communication (managers with managers and employees with employees) across hierarchical peers starting about four months after the CEO transition. Finally, though we cannot observe the CEO type directly, we observe that increased medium-term communication, starting four months after the transition, is positively correlated with cumulative, firm-level French-Fama returns one year after the transition.

This study innovates on the prior literature on four fronts. First, we are among the first studies to use communications metadata at scale across many firms (Polzer et al. 2016, Polzer & DeFilippis 2020, DeFilippis, Impink, Singell, Polzer & Sadun 2020). Communications metadata have been used in prior research to analyze employee coordination (Kleinbaum et al. 2008, Kleinbaum & Stuart 2013) and the implementation of corporate strategies (Kleinbaum & Stuart 2014). These studies have pioneered the idea that these metadata contain valuable insight into information flows within firms and that changes to these information flows have important decision-making implications. However, they usually only observe a single organization rather than a large cross-section of firms.

Second, we are the first study to use longitudinal firm-level communications metadata to analyze the impact of an organizational change across many firms. Our research design allows us to examine the dynamics of intra-firm communication patterns before and after a CEO transition. To our knowledge, only one other paper, Srivastava et al. (2015), shows the impact of an organizational event on communication patterns, yet only focuses on a single firm.

Third, our findings contribute to the literature dedicated to understanding the impact that CEOs have on the "softer," less quantifiable aspects of firms that are typically hard to observe (Gibbons & Henderson 2012, Bloom, Sadun, et al. 2012, 2016) and their contribution to performance variation across firms (Syverson 2011).

Lastly, this paper related to a rich literature in organizational economics that focuses on the importance of intra-firm communication as a proxy for information flow and knowledge sharing to support effective coordination (Hart and Holmstrom 2002, Dessein & Santos 2006, Cremer et al. 2007, Alonso et al. 2008, Rantakari 2008, Calvó-Armengol et al. 2015, Dessein et al. 2016). This literature has emphasized the importance of intra-firm communication as a proxy for information flow and knowledge sharing needed to support effective coordination. Additionally, the literature has identified the existence of tradeoffs between the benefits of increased coordination and employees acting independently. Managers often have strategically important, private information (i.e. asymmetric awareness) about a decision's fit with the external environment. Increased coordination, synchronizing decisions across departments, may make it harder for managers to use their understanding of the environment to adapt resulting decisions to local conditions (Alonso et al. 2008). Others highlight issues that arise with increased coordination, such as employees engaging in non-productive or "wasteful" activities to influence decision-making (Milgrom & Roberts 1990, Milgrom 1988, Powell 2015). Our contribution is to take to the data an established model in the literature (Alonso et al. 2008) and to study the extent to which its main predictions are empirically supported.

The paper proceeds as follows. Section 2 describes the related theory and discusses a stylized model of information flows between parties in a multi-divisional firm. This model provides us with testable predictions in the context of a CEO change. Section 3 describes the communications metadata and the measures we developed to test the model's predictions. Next, Section 4 details the event study and performance research designs. Section 5 describes the main results and additional findings correlating communication changes with firm performance. Section 6 concludes.

2. Theory

This short section builds a highly stylized model of intra-firm communication and uses it to make predictions on the evolution of communication patterns around a CEO transition. Subsection 2.A introduces a simplified version of the canonical organizational economics model of intra-firm communication and revisits two of its main results. Subsection 2.B adapts the canonical model to include the possibility of CEO transitions. Subsection 2.C derives four predictions on communication dynamics around CEO transition by making three assumptions on the short- and medium-term effects of a change in leadership.

2.A. A Simple Model of Intra-Firm Communication

We develop a simplified version of a widely used model of intra-firm communication (Alonso et al. 2008, Rantakari 2008), and we report some existing results that will be useful later for the empirical analysis.

Definitions. A highly stylized firm is modeled as a game with three players: the Center and two Agents. Each Agent i has a local payoff:

$$\pi_i = K_i - (d_i - \theta_i)^2 - \delta(d_i - d_{-i})^2$$

where K_i is a constant, d_i is Agent i's decision, and θ_i is the local state observed by i. The θ_i's are normally distributed with mean zero and variance one, and mutually independent. Besides the constant, the payoff depends on two components:

(1) Adaptation cost, $(d_i - \theta_i)^2$: how well the Agent's decision fits the local state of the world that she faces.

(2) Coordination cost, $(d_i - d_{-i})^2$: how well the Agent's decision fits with the decision taken by the other Agent.

The parameter δ measures the relative importance of coordination versus adaptation. It plays a central role in our analysis, and we refer to this variable as the *need for coordination*. If the need for coordination is high, the Agent's payoff depends more heavily on how her decision fits the other Agent's decision. Each Agent cares both about her functional unit's payoff and the other Agent's payoff. She maximizes:

$$\pi_i + \alpha\pi_{-i},$$

where α represents the *degree of alignment* of the Agent with the rest of the organization. When $\alpha = 0$, alignment is minimal, and the Agent only cares about her unit's payoff. When $\alpha = 1$, alignment is maximal, and the Agent cares about the whole organization's payoff $\pi_i + \pi_{-i}$.

Communication Modes. In Alonso et al. (2008), there are two possible modes of organization and communication. *Horizontal communication* occurs when the two Agents communicate with each other and then make decisions independently. Namely, first, each Agent observes the value of her local state. Second, Agent 1 sends a non-verifiable signal to Agent 2, and Agent 2 sends a non-verifiable signal to Agent 1. Third, each Agent makes a local decision. *Vertical communication* occurs when the two Agents communicate with the Center, who then makes decisions for both Agents (or tells them what decision to

take).[1] Namely, after each state observes her local states, she sends a non-verifiable signal to the Center, who then selects both d_1 and d_2.

In both communication modes, each Agent faces a tension between communicating the true value of her signal, who will help the other player – be it the Agent or the Center –make a correct decision, and exaggerating her own signal in order to induce the decision-maker to make a decision that is closer to the Agent's preference. For instance, if θ_i is positive, Agent i knows that her signal is likely to be higher than the other Agent's signal. If signals were taken at face value, Agent i would have an incentive to communicate a signal higher than θ_i to induce the other Agent or the Center to select a higher action. This effect is related to the one present in the celebrated cheap talk game studied by Crawford and Sobel (1982).

As in Crawford and Sobel (1982), in equilibrium, Agents communicate a partitional signal. Although each Agent observes a continuous signal, she can only credibly communicate a coarser discrete signal with a finite number of realizations. Each realization informs the receiver that the true signal lies in a given interval. The residual variance after communication is a function of how coarse the partitional signal is. Therefore, in equilibrium, the partitional signal's fineness can be interpreted as a measure of the amount of information transmitted.[2]

While the incentive to exaggerate the Agent's own state is present both in horizontal and vertical communication, the two modes of communication differ in the relative importance decision-makers assign to local (i.e. functional unit) and global (i.e. firm-level) payoffs. As the Center always maximizes $\pi_1 + \pi_2$, we should expect her to assign more importance to achieve coordination gains.

Equilibrium. We next present two results borrowed from Alonso et al. (2008) that will form the basis of our predictions. The first links alignment and communication:

[1] There are also two hybrid configurations: (i) The Agents communicate horizontally and the Center makes (uninformed) decisions; (ii) The Agents communicate with the Center and then make decisions themselves (without getting a signal from the other Agent). However, they are obviously suboptimal.
[2] A partitional equilibrium with n intervals would require transmitting approximately $log\ n$ bits of information.

Proposition 1*: For both modes of communication, an increase in the degree of alignment α increases the amount of information transmitted.*[3]

The intuition for this result is that more aligned Agents face a lower incentive to misrepresent their information because they internalize a higher share of the cost of misleading the other Agent or the Center. When the degree for alignment α is higher, the partitional message becomes finer and more information is transmitted. This proposition captures the basic idea that alignment breeds trust, and we communicate more and better when we trust each other.

The second result links the need for coordination with the relative value of the two communication modes:

Proposition 2*: Holding α constant, an increase in the need for coordination δ makes it more likely that vertical communication is more efficient than horizontal communication.*[4]

2.B. CEO Transition

Equipped with our intra-firm communication theory, we explore the effects of CEO transition on the intensity and mode (i.e. horizontal versus vertical) of intra-firm communication. We distinguish between four stages of the transition: the steady-state (when the prior CEO still runs the firm), the short-term transition (the first weeks of the transition), medium-term transition (the first months of the transition, excluding the very first weeks), and the new steady-state.

We make three assumptions on the evolution of our two key parameters: α and δ. First, the initial weeks of the transition are characterized by a certain degree of confusion in the organization and a lack of clarity over the implicit and explicit incentive structure. In the short-term, alignment suffers, and each Agent becomes more protective of her turf. Following a large organizational change, increased ambiguity creates numerous, conflicting interpretations of the same situation (Weick 1995, Weick et al. 2005). This ambiguity

[3] Proof: See Proposition 3(iii) in ADM (noting that our α is related to their λ according to α=λ/(1-λ)).
[4] Proof: See Proposition 5 of ADM.

persists until the new CEO effectively communicates a singular path forward, dispelling any possible misunderstandings regarding the firm's mission or strategy and reducing uncertainty. Thus, we make the following assumption.

> ***Assumption A****: In the short-term, the degree of alignment falls from the pre-transition level* α_0 *to* α_{ST}*, where* $\alpha_{ST} < \alpha_0$.

In the medium-term, the new CEO takes control of the firm, selects new leaders, and sets the firm's strategic vision. A new leader may change the firm's shared frame (Gibbons et al 2020). Planned organizational changes require increased coordination, yet inertial pressures constrain the firm's ability to adapt (Gargiulo & Benassi 2000, Maurer & Ebers 2006). Prior structural rigidities (Leonard-Barton 1992) are challenging to overcome, and the repositioning costs of changing firm strategy further reduce flexibility (Menon & Yao 2017). The communication of the strategic visions ripples through the firm when information sharing is lower, requiring employees to update themselves and their teams on the updated strategies. Subsets of the firm begin to coordinate their decisions based on the shared strategy, reducing uncertainty and increasing the need to coordinate. So, we assume:

> ***Assumption B****: In the medium-term, the need for coordination increases from the pre-transition level* δ_0 *to* δ_{MT}*, where* $\delta_{MT} < \delta_0$.

Finally, in the medium term, the CEO affects alignment. The CEO has an unobservable type that determines her ability to create the right organizational culture and implement effective incentive mechanisms. The CEO's type is $\theta \in \{bad, good\}$. The quality of management is important in multi-divisional, decentralized firms (Sah & Stiglitz 1991), and aspects of CEO behavior and fit with the firm are related to increased firm performance (Bandiera et al. 2015, 2020). Good managers reduce employee turnover (Hoffman & Tadelis, forthcoming). Good managers can communicate their plans more effectively, reducing greater ambiguity (Kotter 1995, Schein 1994). This reduction in ambiguity facilitates communication. We make one last assumption:

***Assumption C**: In the medium-term, a good CEO increases alignment relatively more than a bad CEO: $\alpha_{good} > \alpha_{bad}$.*

2.C. Predictions

These three assumptions lead to a set of testable predictions.

***Prediction 1**: In the short-term transition, the amount of information transmitted falls.*

The first prediction is an immediate consequence of Proposition 1 and Assumption A. The reduction in the degree of alignment leads to less intense equilibrium communication. The ambiguity accompanying the new CEO's transition reduces communication between employees, and this reduction is more apparent amongst formal network ties, such as employees in the same department (Srivastava 2015).

***Prediction 2**: In the medium-term transition, the ratio between the amount of vertical communication to the amount of horizontal communication increases.*

The second prediction derives from the assumption that the need for coordination increased after a CEO transition together with Proposition 2. The increased need for coordination makes vertical communication relatively more efficient. In other words, to develop a "new" organization, the CEO requires more centralization. Furthermore, we expect that employees communicate more vertically within their departments to coordinate decision-making around the new strategy.

***Prediction 3**: A greater increase in communication in the medium-term determines a higher steady-state performance.*

The third prediction is slightly more elaborate than the previous two, focused on the connection among CEO types, increased communication, and firm performance. By Assumption C combined with Proposition 1, a good CEO increases the degree of alignment and, hence, medium-term communication more than a bad CEO. However, the increase in the degree of alignment also translates into a higher level

of firm performance ($\pi_1 + \pi_2$ in the model). We do not know the CEO type, but we observe changes in communication intensity and firm performance. The model predicts that the former will predict the latter.

3. Data

In this section, we describe the data employed in the empirical analysis. We start by describing how we constructed the sample of firms experiencing a CEO transition event (3.A). We then describe the communication variables proxying for internal communication flows (3.B) and French-Fama cumulative returns as stock market performance measures (3.C). Lastly, we discuss some limitations of using communications metadata (3.D).

3.A. Identifying CEO turnover events

We obtained metadata on meeting and communication flows thanks to a partnership with a large email provider. The provider allowed us to analyze firm-level aggregates based on meeting and email metadata, under the condition that the firms used in the sample could not be identified (by other external researchers or us). To identify a suitable sample for the analysis, the provider gave us a sense of the time period and geographies for which email and meeting metadata had been captured and retained (approximately three years of data). We then identified all based public firms experiencing a CEO transition within a three-month window within the time period with usable communications meta-data using Execucomp,[5] Boardex,[6] and Orbis.[7] This broader sample consisted of 338 firms, for which we collected additional firm-level data from multiple databases, including information on the number of employees, industry, CHQ location from Dun & Bradstreet,[8] and revenue data from Orbis. We manually coded why the CEO transition occurred (e.g., fired for performance issues, retirement, death, an internal transition to another role, merger, hired by

[5] Execucomp is a data base of executive compensation for S&P 1000 firms from 1992 to present, and includes base salary, bonus and stock option data as well as company financial data from Compustat. Provided through WRDS.
[6] Boardex is a database that provides information on the relationships between firms and their executives.
[7] Orbis is a database that provides firm-level data from 365M firms worldwide.
[8] Dun & Bradstreet is a company that provides commercial data, analytics, and insights for businesses.

another firm, or left to start an entrepreneurial venture) from press releases. This dataset was sent to the email provider to be anonymously matched to firms in its database.

This process led to a sample of 101 firms with communication data before and after a CEO turnover event. The sample includes firms located in 22 different countries, though 39% of the firms are located in the United States. More than half of the firms (52%) replaced their CEO with an internal manager from within the firm. The majority of the firms in the sample are in the manufacturing (20%), services[9] (30%), or trade (9%) industries. The CEOs left for various reasons, including being fired for performance reasons (14%), retirement (26%), and transfer to another firm (37%).

3.B. Describing Communication Measures

Once the sample was identified, we asked the email provider to build month-level, firm-specific aggregated communication measures, from email and meeting metadata, measured before and after the CEO transition. Our primary analysis is based on variables measuring meetings and email flows at the firm-month level. We were also able to obtain information on communication flows for different subsets of each firm, such as employees by hierarchical levels (e.g., senior managers, other managers, and individual contributors) based on each firm's organogram.[10] In addition to total meeting and email communications, we also received measures of meeting and email communications within and across functional departments (89 firms) and measures of meeting communications across similar managerial hierarchy levels (i.e. horizontal communication) and upward with management (i.e. vertical communication) (91 firms). In the main analysis, we use firm-level aggregates for 101 firms.

Meetings. We received data on average number of meetings per employee, average duration of meetings, average number of attendees per meeting for 17 months. Table 1a shows basic summary statistics for the meeting data. Employees attended, on average, 40 (Standard Deviation 32) internal meetings per month.

[9] Includes financial and insurance services.

[10] Firms' organograms are derived from the firms' listing of formal reporting relationships, which are self-recorded by the firm when the email provider onboards a firm's employees to the platform. Through this pairing, we can distinguish between employees that are individual contributors, managers, and managers of managers.

These meetings lasted about 118 minutes (SD 326) and included 44 attendees (SD 63).[11] In total, employees were scheduled to attend around 80 hours a month in meetings.

We also show aggregated meeting data along the firm hierarchy, across similar managerial hierarchy levels (i.e. horizontal communication between Agents) and across different hierarchical levels between ICs and managers (i.e. vertical communication with the Center) to proxy for the different communication modes discussed in the model. We report these summary statistics and results in Table 1b. Meetings vary along the hierarchy: senior managers have more meetings and send more emails than lower-ranked managers and individual contributors (61 meetings/month SD 37 for senior managers, 46 meetings/month SD 28 for other managers, and 20 meetings/month SD 15 for ICs; senior managers send 335 emails/month SD 164, other managers: 267 emails/month SD 129, ICs: 164 emails/month SD 240). Even though more senior managers attend more meetings, these meetings are on average shorter (92 minutes/meeting SD 69) than those attended by other managers (103 minutes/meeting SD 133) or ICs (153 minutes/meeting SD 516). We use t-tests to confirm that the differences between the means of these subgroups are different from zero. For these groups, the only measure in which the means are not significantly different is the number of attendees present at a meeting. For vertical and horizontal communication flows, there are an average of 14,155 (SD 38,127) horizontal meetings and 8,722 (SD 29,357) vertical meetings per month at the firm-level (96 firms). This roughly equates to two vertical and five horizontal meetings per user per firm per month.[12] We report these details in Table 1c and summarize the data available and provided in the Appendix in Table A2.

Emails. For email measures, we received aggregated average number of internal emails, number of recipients, and the percent of same department only emails for 22 months. We further broke down these

[11] The meeting data could capture all-hands meetings and training events. To help manage this issue, before commuting the meeting aggregates the data provider excluded meetings that lasted longer than eight hours. The data provider also removed all-day meetings and multi-day meetings, which employees often use to block time for trips or events. Additionally, the data provided does not include meetings that were declined by an employee in their calendar meta-data

[12] This measure does not map back to our other data set because these are distinct meetings. For example, even if 100 employees attended an all-hands meeting, then it would still only count as one meeting.

aggregates into the average number of different department emails and the mix of different-same department emails within each firm. On average, employees sent around 249 (SD 200) internal emails per month. We report these summary statistics in Table 1a, under Emails.

3.C. French-Fama Returns

To measure performance before and after the CEO transition, we collected monthly stock market measures from Orbis. We combined these data with measures of the Fama-French three-factor model from Ken French's website, including the value-weighted market index, the difference between a portfolio of small stocks and a portfolio of big stocks, and the difference between a portfolio of high book-to-market stocks and a portfolio of low book-to-market stocks (Fama & French 1993, 2015).[13] We measured medium-run performance using the change in the Fama-French adjusted stock returns from the transition date to twelve months after the transition date. We report the histogram of this measure in the Appendix in Figure A4. On average, CAR is +2.1%, SD 0.17.

3.D. Limitation of Communications Metadata.

There are numerous limitations in the metadata aggregates used in the analysis. First, these measures do not capture all interactions, including informal communications on mobile phones or other consumer-focused software platforms. Our data only capture formal communications on the email provider's platform and do not capture any forms of informal communications (e.g., instant messenger, personal email, consumer messaging applications, SMS, and many more). Furthermore, employees that deal with highly-sensitive information may opt for an ad hoc phone call or in-person meeting to avoid sharing the information in a legally discoverable manner.

Next, it is unclear if meetings represent what employees actually do or simply what they write in their digital calendars. For instance, employees could use their calendar inconsistently or may not attend

[13]The monthly French-Fama data was downloaded from the following website: http://mba.tuck.dartmouth.edu /pages/faculty/ken.french/.

meetings that they accept in their calendars. We do not know if employees attend the meeting; we only know that they have not "declined" the meeting. The types of communications, both meetings and email, could vary drastically. Similarly, we do not know if an individual exerted a lot of effort writing an email or quickly sent a message. Our data is limited in that we do not have access to the content or subject lines of emails and meeting requests, which could provide us with more insight into the interaction and the exertion of effort. For example, a one on one meeting with your manager is very different from a team-building event or monthly all-hands. An email used to update management is very different from an email used to coordinate firm strategy. Also, meetings could be set up to work on a single task or many different tasks.

Lastly, we do not have any network measures. Instead, we use firm-level aggregates with some network connotations (i.e. same versus different departments, horizontal versus vertical communication, management hierarchy, etc.). Given the nature of these data, the network approach where every person is a "node" would not adequately anonymize in our sample, and a panel containing every communication for the ten million employees in our sample would have been difficult and exceedingly costly to analyze.[14]

4. Research Design

4. A. Event Study Regressions

We exploit the CEO transition's timing by using an event study specification to analyze the change in email and meeting measures over different months before and after the CEO transition. All data are aggregated at the firm level. We create user-weighted averages of the measures at the bi-monthly level to smooth out monthly variations. The CEO transition occurs in month 0, and combined with the first month after the transition, is denoted "Period 0" in the tables and figures. The base period for these regressions is the bi-monthly period before the CEO transition (i.e. month -1 and -2, denoted as "Period -1" in the tables and figures). We include firm-level fixed effects in all specifications, such that the coefficients represent

[14] The data underlying the meeting and email data contains about 15 petabytes of communication data.

changes in communication patterns within the same firm over time. We cluster all standard errors at the firm level.

$$ln\,(y_{i,t}) = \beta_0 + \sum_{\tau=-3}^{-2} \beta_t^L \times D\tau_t + \sum_{\tau=0}^{6} \beta_t^L \times D\tau_t + \gamma_i + \mu_{i,t}$$

Where

$y_{i,t} = bimonthly_t\ and\ firm\ level_i\ communications\ data$

$\tau_t = bimonthly\ indicator\ variable,$ *relative to the transition event (Period 0)*

$\gamma_i = firm\ fixed\ effects$

In terms of identification, given that CEO changes are, to some degree, endogenous, there could be unobserved heterogeneity that affects communication patterns and are correlated with a CEO transition. The limited number of purely exogenous transitions in our sample—i.e. sudden CEO death—does not allow us to entirely rule out that the variation in communication patterns happening around the time of a CEO transition may be driven by other unobservable and time-varying firm-level factors (since we control for time-invariant factors with firm-level fixed effects).

4.B. French-Fama Returns Regressions

We correlate the change in performance measure, French-Fama returns for the year after the CEO transition, with the change in communication between four months and twelve months after the transition date, as a proxy for medium-term communication change after the immediate transition shock.

$$changeinCAR_i = \beta_0 + \beta_i changeincomm_i + \mu_i$$

Where:

$changeinCAR_i = change\ in\ the\ cumulative\ average\ stock\ return\ for\ firm\ i$
$between\ 0\ and\ 12\ months\ after\ the\ CEO\ transition$

$changeincomm_i = change\ in\ the\ communication\ measure\ \ for\ firm\ i$
$between\ 4\ and\ 12\ months\ after\ the\ CEO\ transition$

5. Results

Main Results. We show the event study results in Table 2 and graph these bimonthly coefficients in Figure 1. Email and meeting measures do not display evidence of a pre-trend in months before the base period, Period -1, two months before the CEO transition month. Supporting Prediction 1, meeting counts and emails decrease for four months immediately after the CEO transition (meetings: P0 -33.8%, SD 0.1, P1 -26.8%, SD 0.1; emails: P0 -20.7%, SD 0.08, P1 -15.4% SD 0.05). Starting in Period 2 (i.e. four and five months after the CEO change month), meetings and emails increase significantly from the base period and stabilize through Period 6, starting 12 months after the CEO change month (meeting stabilize ~+30% from base and emails stabilize at ~+10%). The duration of meetings and the number of attendees also vary over time, but the changes are small and insignificant.

Vertical and Horizontal Communication Interactions. The email provider calculated vertical (i.e. meetings with the Center) and horizontal communication (i.e. meetings amongst peer Agents) metadata for meetings in 88 firms from six months before until eight months after the CEO transition.[15] We show these results in Table 3 and graph these coefficients in Figure 2. Similar to the main results, both vertical and horizontal meeting interactions increase starting in Period 2, four months after the CEO change. We analyze the change in the ratio of vertical to horizontal meetings over time (i.e. horizontal meeting count divided by vertical meeting counts) to determine if the mix of intra-firm meeting interaction types changed. Supporting Prediction 2, this ratio significantly increases (P2 +3.8% SD 0.12, P3 +6.5% SD 0.14).

Robustness Checks. We performed several robustness checks on the results discussed so far, which we report in Table 5. First, we were concerned that the data might systematically miss informal interactions that are not routinely reported in calendars. The extent to which misreporting varies over time (for example, perhaps more informal interactions happen around the CEO transition event) could affect the event study results. To allay this concern, we built the meeting variables exclusively from meetings across employees

[15] Due to large gaps in the email meta-data from GDPR compliance, the email provider built these measures from meeting meta-data only.

of different functional departments,[16] under the assumption that these interactions are more likely to be logged on employees' calendars. Reassuringly, the results are virtually identical when we use this subsample of interactions (column 3).

A second robustness check relates to the unbalanced nature of the sample used in the analysis. This is because some firms only have meeting metadata after the CEO transition (data availability depends on when firms opted into the email provider's services). All firms have balanced email data; however, only 55 firms have balanced meeting data, including the transition month. When we re-run the main event study for the balanced sample of firms with data before and after the transition, we obtain similar coefficients, though less precisely estimated (column 5).

Finally, we investigated whether the changes in communication flows were driven by the timing of the actual CEO transition or by its mere announcement. We were able to examine the reaction to the announcement of the CEO transition separately from that of the actual transition for 30 firms, for which the announcement occurred earlier than a month before the actual CEO transition. Though the point estimates on Periods 0 and 1 dummies are large and negative (columns 8 and 10), they are not precisely estimated (whereas the coefficient on the dummies denoting months after the actual transition are negative and significant (columns 7 and 9) even in this small subsample of firms.

In unreported analysis, we analyzed whether the coefficients on the period dummies varied across small and large firms, for different types of reasons driving to a CEO transition (CEO death, firing, promotion, move to a different firm or retirement), and for different types of incoming CEOs (internal, i.e. hired from within the firm, or external CEO. We do not find strong evidence for heterogeneity, though we note that our sample may be too small to estimate these differences properly.

Communication and Performance. Finally, we investigate the relationship between communication and French-Fama cumulative excess return changes 12 months after the CEO transition, shown in Table 4. We could run this analysis only on a very small sample of firms (36 firms); hence this analysis should be

[16] This data was only available for 89 firms of the 101 firms in the sample

interpreted cautiously. Supporting Prediction 3, and despite the smaller sample size, we find a positive correlation between medium-term communication intensity change measures and firm-level French-Fama market returns measured 12 months after the CEO transition.

6. Conclusion

We use email and meeting metadata on 101 firms to study how internal communication patterns evolve after a meaningful organizational change—a CEO transition. To our knowledge, this is the first time that longitudinal measures of intra-firm communication could be analyzed and linked to meaningful organizational events across multiple firms and longitudinally.

Using an event study research design centered on these CEO transitions, we find that CEO changes are associated with large changes in communication within firms. During the first three months after the CEO transition email and meetings intensity drop significantly. Around four months after the CEO transition, there is a large increase in email and meeting communications, which more than compensates for the initial drop. The increase in communication is mostly driven by vertical (i.e. manager to employees) relative to horizontal (i.e. peer to peer) communication flows. These results are robust to a number of robustness checks. Finally, we find increases in medium-term communication are positively correlated with increases in French-Fama market returns a year after the change.

We see this paper as a first step in the use of email and meeting metadata to study the impact of significant organizational events, such as CEO change, on internal communications patterns. Much more could be done with that are even richer than ours: for example, understanding with greater precision the structure of internal communication networks rather than broader aggregate metrics, or using text to identify topics of discussion. In spite of these limitations, we see promise in the use of email and meeting metadata—typically passively collected by firms—to study typically unobserved aspects of the inner workings of organizations. We hope that our study can provide a possible blueprint to advance the exploration of these data, while at the same preserving the confidentiality of employees and firms.

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Table 1a - Summary of Communications Data

	Total			
	Mean	SD	Min	Max
Meetings				
Count (avg/month)	40	32	1	377
Duration (minutes/meeting)	118	326	5	24344
Attendees (avg invited/meeting)	44	63	2	1470
Emails				
Count (avg/month)	249	200	1	46927
Recipients (avg employees/email)	3	4	1	491

Notes: Means are user weighted by average monthly email and meeting users provided by the email provider at the firm-month level for the 101 firms in the main effect analysis. Meeting count, duration, and attendees are based on calendar invites that include at least one other individual.

Table 1b - Summary of Management Hierarchy

	Individual Contributors		Other Managers		Senior Managers		T-Test (p-value)	
	Mean	SD	Mean	SD	Mean	SD	IC/ Ot. Man	Ot. Man/ Sr. Man
Meetings								
Count (avg/month)	20	15	46	28	61	37	0.00	0.00
Duration (minutes/meeting)	153	516	103	133	92	69	0.00	0.00
Attendees (avg invited/meeting)	39	51	47	68	49	68	0.06	0.96
Emails								
Count (avg/month)	164	240	267	129	335	164	0.00	0.00
Recipients (avg employees/email)	4	6	3	2	3	1	0.00	0.00

Notes: Management hierarchy is based on the firm's self-reported employee reporting structure: ICs have no direct reports, Other Managers only manage ICs, and Senior Managers manage at least one manager. Groups not included in the firm's formal reporting hierarchy, tagged as "no hierarchy" by the Email Provider, are dropped. Sample is the 101 firms of the main effect analysis. Two-sided t-test with equal variances: the null hypothesis is that the means are equal. IC/Ot. Man: 615 matched observations by id, period. Ot. Man/Sr. Man 564 matched observations by id, period.

Table 1c - Summary of Meeting Interactions

	Total		Vertical		Horizontal		Some External	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Meetings								
Count (avg/month)	7	5	2	2	5	4	0.3	0.3
Duration (minutes/meeting)			59	17	58	11		
Data N/A								

Notes: Meeting counts and duration provided at the firm level for 88 firms (353 observations) over seven bi-monthly periods (collapsed from 17 month of data). For these observations we have matched firm-period observations in the main analysis. These are distinct meetings and do not include any information on the number of attendees. The means calculated above are based on the average number of meeting users per firm. Vertical meetings include an IC and a Manager (and no external or "no hierarchy" employees). Horizontal meetings are the sum of two groups: manager only meetings and IC only meetings. The Email Provider did not share separate details on manager type (i.e. other managers, senior managers) in this dataset; they are combined. Duration of meetings provided only for IC/Man, Man/Man, and IC/IC interactions.

Table 2 - Firm-level Event Study Regressions of Meeting and Email Measures

	(1)	(2)	(3)	(4)	(5)
	MEETINGS			**EMAILS**	
Dependent Variable is log of:	Meetings (count)	Avg. Duration (minutes)	Avg. Participants (people)	Emails (count)	Avg. Recipients (people)
Period -3	0.051	0.247***	0.182*	0.030	-0.055**
	(0.073)	(0.081)	(0.102)	(0.036)	(0.026)
Period -2	-0.061	0.041	0.030	-0.124	-0.034*
	(0.073)	(0.041)	(0.120)	(0.075)	(0.018)
Period -1 (Base Period)					
Period 0	-0.338***	0.118	0.118	-0.207**	-0.025
	(0.107)	(0.072)	(0.086)	(0.079)	(0.030)
Period 1	-0.268***	0.163**	0.080	-0.154***	-0.011
	(0.090)	(0.082)	(0.086)	(0.054)	(0.030)
Period 2	0.245***	0.092	0.350***	0.125***	-0.000
	(0.075)	(0.061)	(0.085)	(0.047)	(0.030)
Period 3	0.232***	0.225***	0.558***	0.156***	0.022
	(0.076)	(0.081)	(0.092)	(0.048)	(0.032)
Period 4	0.149*	0.337***	0.575***	0.141***	0.024
	(0.077)	(0.094)	(0.102)	(0.051)	(0.034)
Period 5	0.281***	0.310***	0.431***	0.146***	0.026
	(0.076)	(0.084)	(0.104)	(0.053)	(0.038)
Period 6	0.312***	0.287***	0.384***	0.083	0.016
	(0.085)	(0.084)	(0.102)	(0.089)	(0.047)
Observations	706	706	706	706	706
Firms	101	101	101	101	101

Notes: * p<0.1, ** p<0.05, *** p<0.01. All columns estimated by OLS. Standard errors are clustered at the firm level, in parentheses under the coefficient. Firm-level fixed effects are included in all models. The transition occurs during the first month of bi-monthly Period 0. Period -1, the bi-monthly period before the CEO transition, is the base period for the regressions.

Table 3 - Firm-level Event Study Regressions of Meeting Interactions

	(1)	(2)	(3)	(4)
		MEETINGS		
Dependent Variable is log of:	Meetings (count)	Horizontal (count/user)	Vertical (count/user)	Ratio (Vertical/ Horizontal)
Period -3	0.062	0.126	0.080	-0.046
	(0.079)	(0.086)	(0.128)	(0.076)
Period -2	-0.056	0.108	0.034	-0.075
	(0.077)	(0.069)	(0.126)	(0.094)
Period -1 (Base Period)				
Period 0	-0.183*	-0.043	-0.097	-0.054
	(0.094)	(0.067)	(0.143)	(0.105)
Period 1	-0.056	0.071	0.078	0.007
	(0.096)	(0.073)	(0.151)	(0.112)
Period 2	0.418***	0.126*	0.662***	0.536***
	(0.087)	(0.075)	(0.152)	(0.112)
Period 3	0.576***	0.071	0.898***	0.827***
	(0.104)	(0.081)	(0.165)	(0.134)
Observations	353	353	353	353
Firms	88	88	88	88

Notes: * p<0.1, ** p<0.05, ***, p<0.01. All columns estimated by OLS. Standard errors are clustered at the firm level, in parentheses under the coefficient. Firm-level fixed effects are included in all models. The transition occurs during the first month of bi-monthly Period 0. Period -1, before the CEO transition, is the base period for the regressions. Regression (1) is the same measures as reported in Table 2 (1) but for the samples of matched observations/firms available in the meeting interactions data (353 firm-periods, 88 firms). Horizontal (1) is the mean of IC/IC and Man/Man meeting interactions. Vertical (2) is the IC/Manager meeting interactions. The ratio of vertical to horizontal meeting interactions (3) is vertical count divided by horizontal count at the firm-period level. The data underlying this table were limited to seven periods (Period -3 to Period 3).

Table 4 - French-Fama Returns Regressions

Dependent Variable is log of:	(1) French-Fama 1-Yr Return	(2) French-Fama 1-Yr Return
Log of Email Count Change from:		
4 to 12 mos. after the CEO transition	0.046*	
	(0.024)	
Log of Meeting Count Change from:		
4 to 12 mos. after the CEO transition		0.243
		(0.161)
Observations/Public Firms	36	36

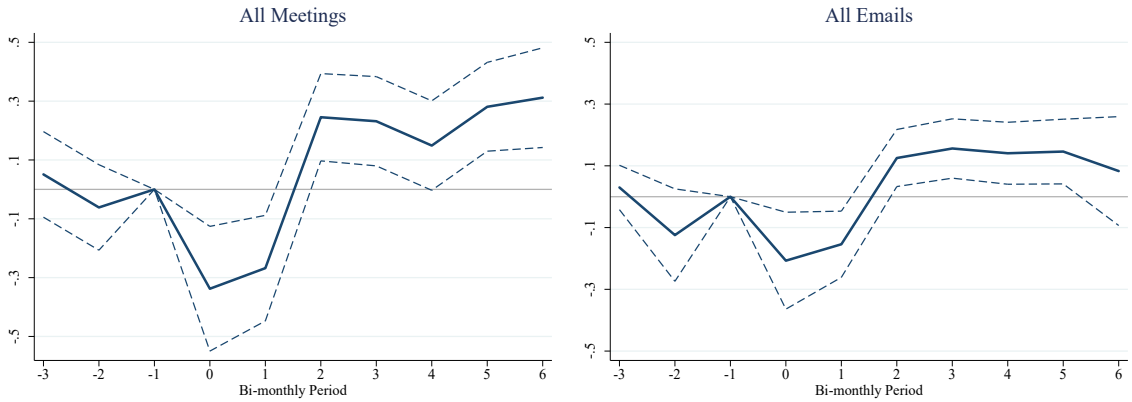
Notes: * p<0.1, ** p<0.05, *** p<0.01. All columns estimated by OLS, robust standard errors in parentheses under the coefficient, in parentheses under the coefficient. Monthly measures of French-Fama returns built from the 3-factor model (Fama & French 1993, 2015), data downloaded from http://mba.tuck.dartmouth.edu/pages/faculty /ken.french/. Stock market data from Orbis. The 4 to 12-month measures capture medium-term communication intensity change from meeting counts and email counts. Changes in communication built from the monthly, firm-level data (changes are winsorized at p5 and p95). Additional details are reported in Appendix A1.

Table 5 - Robustness Tests: Firm-level Event Study Regressions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Sample:	Total		Department Data		Balanced Data		Pre-Announcement			
Dependent Variable is log of:	Meetings (count)	Emails (count)	Meetings (count)	Emails (count)	Meetings (count)	Emails (count)	Meetings (count)		Emails (count)	
Timeline: Annoucement = P0 or Transition = P0	Trans	Trans	Trans	Trans	Trans	Trans	Trans	Ann	Trans	Ann
Period -3	0.051	0.030	0.049	0.022	0.051	0.030	0.054		0.028	
	(0.073)	(0.036)	(0.080)	(0.034)	(0.074)	(0.037)	(0.104)		(0.061)	
Period -2	-0.061	-0.124	-0.083	-0.120**	-0.061	-0.124	-0.011	0.105	0.020	0.031
	(0.073)	(0.075)	(0.079)	(0.058)	(0.074)	(0.076)	(0.037)	(0.133)	(0.064)	(0.053)
Period -1 (Base Period)										
Period 0	-0.338***	-0.207**	-0.217**	-0.039	-0.336***	-0.207**	-0.373**	-0.256	-0.168***	-0.120
	(0.107)	(0.079)	(0.103)	(0.052)	(0.108)	(0.080)	(0.141)	(0.175)	(0.054)	(0.088)
Period 1	-0.268***	-0.154***	-0.173*	-0.080	0.088	-0.059	-0.575***	-0.135	-0.299***	-0.252
	(0.090)	(0.054)	(0.092)	(0.053)	(0.075)	(0.054)	(0.129)	(0.100)	(0.078)	(0.166)
Period 2	0.245***	0.125***	0.302***	0.140***	0.251***	0.104**	0.093	-0.333**	-0.013	-0.170
	(0.075)	(0.047)	(0.080)	(0.047)	(0.075)	(0.044)	(0.061)	(0.142)	(0.032)	(0.101)
Period 3	0.232***	0.156***	0.281***	0.171***	0.090	0.140***	0.130	0.019	0.034	-0.048
	(0.076)	(0.048)	(0.084)	(0.050)	(0.077)	(0.048)	(0.077)	(0.073)	(0.040)	(0.094)
Period 4	0.149*	0.141***	0.186**	0.141***	0.093	0.122**	0.096	0.101	0.045	-0.021
	(0.077)	(0.051)	(0.084)	(0.051)	(0.075)	(0.052)	(0.062)	(0.087)	(0.043)	(0.090)
Period 5	0.281***	0.146***	0.328***	0.119**	0.176**	0.164***	0.146*	0.121	0.038	-0.009
	(0.076)	(0.053)	(0.099)	(0.054)	(0.077)	(0.053)	(0.074)	(0.078)	(0.043)	(0.090)
Period 6	0.312***	0.083			0.225**	0.002	0.194***	0.304***	0.031	0.038
	(0.085)	(0.089)			(0.100)	(0.140)	(0.065)	(0.084)	(0.044)	(0.097)
Observations	706	706	469	469	448	448	209	172	209	172
Firms	101	101	89	89	55	55	30	30	30	30

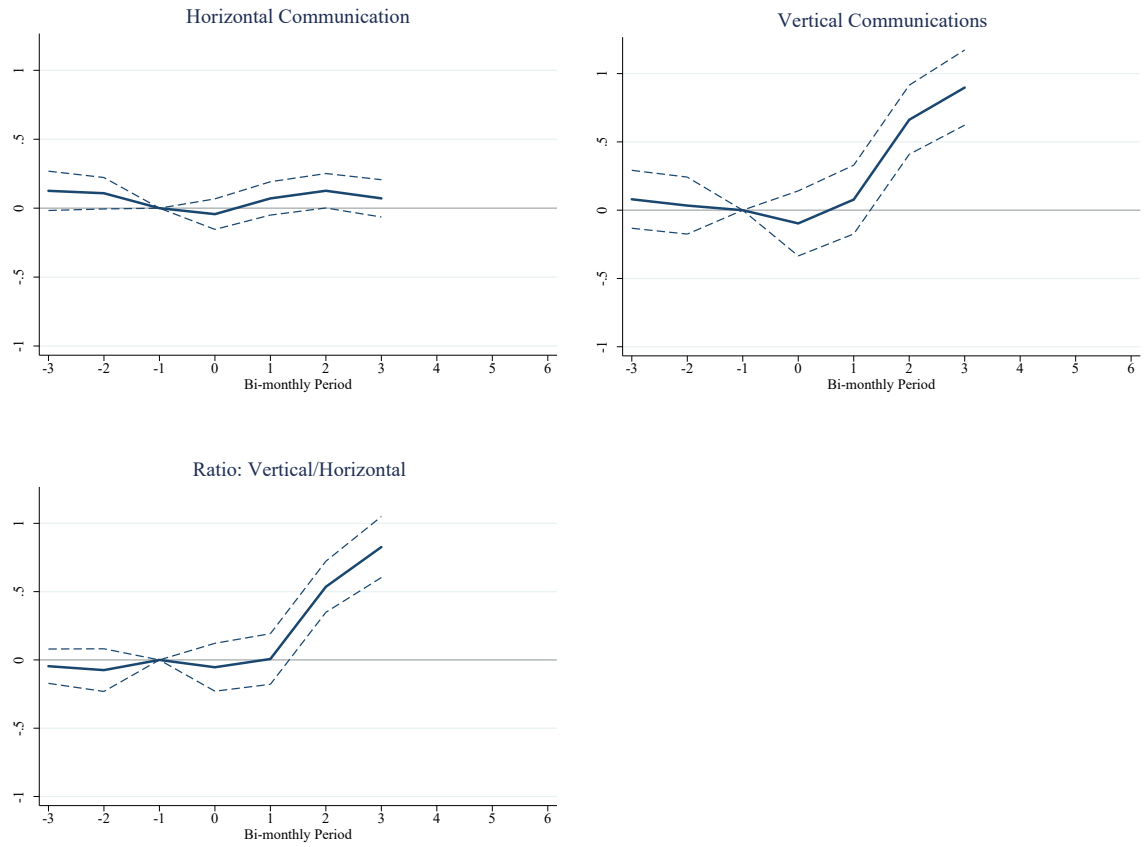
Notes: * p<0.1, ** p<0.05, *** p<0.01. Standard errors are clustered at the firm level. Firm-level fixed effects are included in all models. Regressions (1) and (2) are the main effect, mapping to Table 2 Regressions (1) and (4), respectively. Regressions (3) and (4) test the robustness of the main effect on the sample of 88 firms that have additional data on communication within and across functional departments within the firm. Regressions (5) and (6) test the robustness of the main effect on the sample of 55 firms that have balanced data, before and after the CEO transition event. Regressions (7) and (9) test the robustness of the main effect on the sample of 30 firms that have the announcement of the CEO change more than 1 month before the transition occurs, on the transition timeline (where the CEO transition event =Period 0 and the base = Period -1, one period before the CEO transition event), similar to the other regressions reported. Regressions (8) and (10) use the announcement timeline for this same sample of 30 firms (where the announcement of the pending CEO change= Period 0 and the base = Period -1, one period before the announcement.)

Figure 1: Event Study (Main Results)



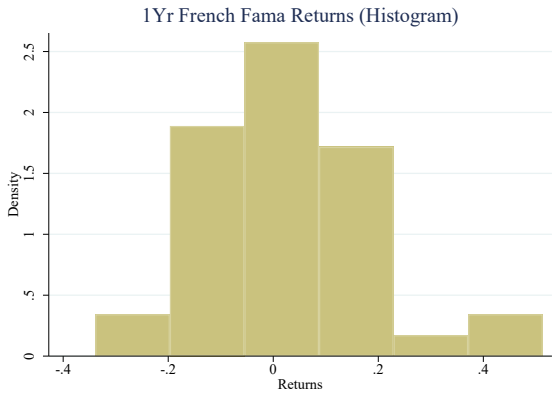
Notes: We plot the OLS regression coefficients from the main event regression specification on these two graphs, reporting in Table 2, across time for total meeting count (left) and email count (right) in the full sample of 101 firms. The CEO change occurs in Period 0. We use the period before the transition, Period -1, as the event study's base period. These results include firm-level fixed effects and standard errors clustered at the firm level.

Figure 2: Event Study (Meeting Interactions, Horizontal and Vertical Communication)



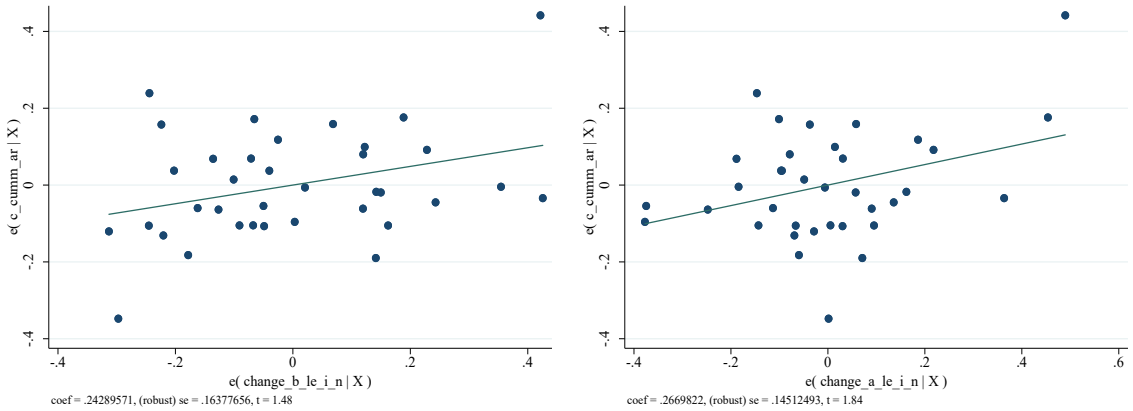
Notes: We plot the OLS regression coefficients from the meeting interaction specification across time for horizontal communication (top left), vertical communication (top right) on these graphs. Additionally, we look at the coefficients for the regression on the mix of vertical to horizontal meeting count (bottom left). These results are reported in Table 3, and the sample consists of 88 firms. We only have 17 months of data, equating to 7 periods, for these measures. The CEO change occurs in Period 0. We use the period before the transition, Period -1, as the event study's base period. These results include firm-level fixed effects and standard errors clustered at the firm level.

Figure A1: Performance



Notes: Histogram of the cumulative average French Fama one-year returns for the sample of firms included in the performance regressions.

Communications Change (4 to 12 months) and French-Fama cumulative returns (0 to 12 months)



Notes: These graphs show the scatter plots of the OLS regressions (robust standard errors) in Table 4 for meetings (left) and email (right). These regressions are for 36 firms at a single point of comparison (4 to12 months communication change, x-axis). French-Fama returns for the one-year period after the change (y-axis) are collected from Orbis.

Table A2- Meeting Interactions Data Availability

	External	IC	Manager	No Hierarchy
External		Some External	Some External	
IC	Some External	Horizontal	Vertical	
Manager	Some External	Vertical	Horizontal	
No Hierarchy				

Data N/A

Notes: Data summarized in Table 1c is based on data shared by the email provider. We do not have information on the following types of interactions by employees at the firm, as we only requested proxies for horizontal and vertical, intra-firm meeting interactions between employees with recorded hierarchy information. Email information was not provided.