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Functional Centralization and the Division of Labor in Management

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Abstract: In contrast to the widely-held view that flatter hierarchies are associated with the delegation of decisions, this paper shows that the trend towards flattening in large US firms since the mid-80's has been accompanied by increased centralization of activities at the top of the organization. In particular, the number of functional managers (e.g., Chief Financial Officer or Chief Marketing Officer) reporting directly to the CEO has increased relative to the number of general managers. Using panel data on senior management positions in large US firms (1986-1999) and exploiting variation within firms over time and across position types, we document how the centralization of functional activities relates to the firm's IT investments and business diversification. Centralization increases with IT intensity for "administrative" functions (e.g., finance, law, HR); yet, the same relationship only holds for "product" functions (e.g., marketing, R&D) in firms with related businesses. Firms in related businesses are more likely to centralize product functions, but we find no relationship with administrative functions. We also document how pay changes with firm organizational structure for the different types of managers. These findings suggest that the nature of the information associated with the different functions and the degree of business diversification are important forces driving the centralization decision.

Key words: communication, organizational design, functions, centralization, M-form, hierarchy, top management team, information technology, activities.

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I. Introduction

“We learned from experience that work of higher quality could be obtained by utilizing, corporation-wide, the highly developed talents of the [functional] specialists. “

Alfred P. Sloan, Jr. “My Years with General Motors” (1963)

Modern corporations are run by a team of executives that go beyond the Chief Executive Officer (CEO). It is by now a well established fact that the size of the CEO’s executive team—as defined by the managers that report directly to the CEO—has increased dramatically in recent decades (Rajan and Wulf, 2006).¹ Yet we know little about the composition of this team, even though it is the governing body that sets firm strategy and allocates resources—decisions that are critical to firm performance. We also know little about how changes in the executive team relate to decision making inside the firm, and whether firms are becoming more or less centralized. Much of the existing research on managers in economics and finance focuses on *general managers* (i.e., CEOs and business unit managers) who are responsible for a broad range of activities and typically have profit and loss responsibility. However, this focus overlooks the importance of *functional managers* as highlighted in the Sloan quote above: positions that perform corporate-wide activities of their specialized function (e.g., finance, legal, marketing, R&D). Using a panel of about 300 large US firms, this paper characterizes and documents the changes in the composition of the executive team over two decades and investigates the drivers of these changes. In contrast to the widely-held view that flatter hierarchies are associated with the delegation of decisions, we show that the trend towards flattening in large US firms since the mid-80’s has been accompanied by increased centralization of activities at the top of the organization. Our analysis captures what is happening inside the headquarters of corporations, how the changes in the composition of executive teams relate to changes

¹ In this paper, we define the executive team as the positions that report directly to the CEO in the organizational hierarchy (or the executives who are the CEO’s direct subordinates). This is commonly referred to as the CEO’s span of control and represents the second level in the management hierarchy with the CEO being at the first level. Rajan and Wulf, 2006 show that firms have flattened their hierarchies over the past several decades—and one measure of this is the broadening of the CEO’s span of control (or the increase in the size of the executive team).

in the centralization of decision making, and how the relative importance of different types of information inside the firm shape organizational choices.

Firm choices about which functions to centralize at corporate headquarters are critical to current theories of firm organization (e.g., Hart and Moore, 2005; Cremer, Garicano and Prat, 2007; Dessein, Garicano and Gertner, 2010) and shed light on choices about organizational form, in particular their decision to structure themselves as an M-form or U-form organization (Chandler, 1962; Williamson, 1975, 1985). The relevant tradeoff for firms is whether to assign activities to corporate executives responsible for specialized functions to exploit synergies (e.g., Chief Marketing Officer and marketing activities) versus assigning activities to general managers responsible for business units who may have better information or incentives (e.g., General Manager of a business unit). This paper presents new evidence establishing a shift over the past two decades in the composition of the executive team toward more functional managers and greater centralization of functions at the top of the organization. In fact, while the CEO's span of control doubles, approximately three quarters of the 5 position increase is attributed to functional managers. Two important trends may be relevant to the shift toward functional managers: (i) firms have increased investments in information technology (IT), and (ii) firms have become less diversified. In this paper, we systematically investigate simultaneous changes in the importance of functional executives in corporate hierarchies (centralized functions) and changes in firm diversification and investments in information technology over time. This allows us not just to provide a more complete picture of the changes taking place at headquarters, but also to interpret how decision making has changed at the top of organizations. Our results show that distinguishing between both general and functional managers, and between types of functional managers, is important in a world that is richer than current theories.²

² While existing research shows that the identity of select executives have an effect on firm policies (e.g., Bertrand and Schoar, 2003; Carpenter, Geletkanycz, and Sanders, 2004; Hambrick, 2007), we are focused on the composition of the types of positions instead of the executives filling them.

For our analysis, we use a unique panel dataset rich in details of managerial job descriptions, reporting relationships and compensation structures for senior management positions in large US firms (1986-1999). We identify all our effects by exploiting not only differences within firm and positions over time, but also differences between types of positions within firms. This helps to ensure that our results are not confounded by unobserved firm heterogeneity and that we are capturing distinct economic phenomena and not just a spurious trend. These advantages—panel data and variation by position type within firms—mean that we don't rely on cross-sectional variation to identify effects which is advantageous relative to other datasets on organizations. As such, our analysis produces a set of robust within-firm correlations showing how firms simultaneously adjust different dimensions of their organization.³ The dataset is also unique in that it allows us to precisely identify the reporting relationships of senior management positions thereby allowing a precise definition of the executive team (i.e., CEO's span of control) and how this changes over time.

One simple view explaining the trends that we document is that the size of a CEO's executive team (or span of control) increases as firms increase investments in information technology. Put simply, the capacity of the CEO to manage more subordinates increases because it is easier to communicate and share information (e.g., Garicano, 2000). However, we find no simple relationship between IT investments and CEO's span of control. Instead, our results suggest that IT is correlated with the *composition* of the team: the number of functional managers is increasing in IT, while the number of general managers is (weakly) decreasing. Another widely-held view based on a classic synergy explanation is that firm scope is an important determinant of the composition of the executive team: firms in related businesses are more likely to centralize functions to exploit synergies, and hence should have more functional managers in the headquarters executive team. Again, we do not find this in the data. In contrast to simple explanations,

³ There are some clear exogenous forces driving some of these variables. For example, IT adoption was determined in this period by the falling costs of IT and the availability of new IT products; the fall in diversification was partly driven by increasing competition and international trade (Guadalupe and Wulf, 2010). However, it is difficult to find instruments for these variables that vary over time and by firms/industries. This is a common problem in this kind of work. Here, we rely on the richness of the panel variation to identify our results.

and of potentially greater interest, we find that the link between the composition of the executive team and both IT and firm scope varies by *type of functional manager*.

In particular, and in line with the common parlance exemplified in Chandler (1991),⁴ we distinguish between two types of headquarter functions: (i) “product” or front-end functions (e.g., marketing, R&D) that are closer to both customers and product markets and that require information that is relatively product-specific and (ii) “administrative” or back-end functions (e.g., finance, legal, human resources) where relevant information is less product-specific. Our most novel set of results is that we find a different relationship between information technology, the diversification of the firm, and the presence of these two types of functional managers in the executive team. First, the number of administrative functional managers (e.g., Chief Financial Officer) reporting directly to the CEO increases with IT-intensity. However, for product functional managers (e.g., Chief Marketing Officer), the same relationship only holds in firms with related businesses. So, the firm’s decision to centralize a function as it invests more in IT varies by the nature of information that is used to perform functional activities: the degree to which the information is product-specific. Second, while we find no relationship between administrative functional managers and firm scope, we do find that the number of product functional managers is increasing in business relatedness. So, the classic synergy explanation of centralized functions applies to functions that are closer to products and rely more on product-specific information (marketing and R&D), but not to traditional administrative functions (finance, legal, human resources).

To understand more fully the role of functional managers as members of the executive team and shed light on decision-making in headquarters, we analyze pay of functional managers and general managers. Using position-level regressions, first we find that functional manager pay increases as the position joins

⁴Chandler (1991) makes a distinction between two types of functions of the headquarters unit in multi-business firms: entrepreneurial (value-creation) and administrative (loss prevention). In the strategy literature, Porter (1985) distinguishes between two types of activities within functions: support (finance, HR, systems) and primary (manufacturing, inbound and outbound logistics, sales, after-sales support). Another set of classifications based on functional tracks of executive development comes from the management literature and is summarized in Hambrick and Mason (1984): output functions (marketing, sales, and product R&D); throughput functions (production, process-engineering, and accounting); and peripheral functions (finance and law).

the executive team (or moves to reporting directly to the CEO). Second, division manager pay (general managers) declines with the number of functional managers that report directly to the CEO. Notably, this relationship is driven by the number of *product* functional managers, not administrative functional managers. While we do not observe directly the allocation of activities in our data, one possible explanation of our findings on pay and reporting relationships is that the role of the functional manager changes as the position joins the executive team and that functional managers serve as substitutes for general or division managers in product functions, but not in administrative functions.

How do we interpret our broad set of results? While existing theoretical models do consider the relationship between information technology, firm scope and organizational form, no theory explains our key findings about the differences across types of managerial positions. We interpret these findings as being broadly consistent with different types of functional managers performing activities that vary in the nature of the information they use: the relative importance of product-specific information. In administrative functions where information is less product-specific (e.g., finance), IT favors functional managers (e.g., CFO)⁵ and centralization because it reduces the cost of acquiring and communicating information from business units to corporate-wide functional managers. The centralization of administrative functions does not depend on the relatedness of businesses since the relevant information is generally not product-specific. On the other hand, in product functions where information is product-specific (e.g., marketing), firms operating in related businesses favor functional managers (e.g., Chief Marketing Officers) who can exploit synergies in information acquisition and communication. IT can further exploit synergies between business units with similar products, but the effect of IT is diminished for firms with unrelated businesses.

⁵ Chandler's (1991) description of the finance function is consistent with this view: "Its functions were somewhat less product-specific. Its tasks were to coordinate the flow of funds through the enterprise's many units and to provide a steady flow of information to enable top management to monitor performance and allocate resources" (Pg. 33).

In sum, our findings suggest that firms are shifting away from the classic M-form-hailed by Williamson (1975, 1985) and documented by Chandler (1962)-and adopting aspects of the U-form; firms have become more centralized at the top of the organization as more functional managers within the executive team perform corporate-wide activities. This is in stark contrast to the widely-held view that firms have flattened their hierarchies to decentralize decision-making and empower lower level employees. We also demonstrate that the “devil is in the details” in understanding changes in organizational structure. There is a significant gap between existing formal models on organizational design and what we observe about the structure of the senior executive team at corporate headquarters. To bridge the gap, one needs to recognize differences in the nature of information that is used across functions within multi-business firms. These new results on the shifting division of labor among members of arguably a firm’s most influential group highlight the importance of distinguishing between types of managerial positions in the study of changes in firm organization. Only allowing for these differences can one understand the relation between decision-making and the structure of the hierarchy at the top of the organization. Ignoring these differences hides important subtleties of organizational change.

On the empirical side, our paper contributes to a number of different literatures. While we relate to the literature linking organizational structure and information technology (e.g., Bresnahan, Brynjolfsson and Hitt, 2002; Baker & Hubbard, 2003, 2004; Bartel, Ichniowski, Shaw, 2007; Caroli and Van Reenen, 2001; Bloom, Garicano, Sadun, and Van Reenen, 2010), our focus is at the top of the hierarchy. We explicitly document how the presence of functional managers in the executive team changes with increased IT investment and the reduction in information and communication costs. Moreover, we distinguish between types of functions in their response to IT, depending on the importance of product-specific information for that function. We also contribute to the analysis of the determinants of hierarchical structures (e.g., Baker, Gibbs, and Holmstrom, 1994; Whittington, Pettigrew, Peck, Fenton, & Conyon 1999; Rajan and Wulf, 2006; Guadalupe and Wulf, 2010). We focus on one particular aspect of the hierarchy, that has received little attention to date, namely the composition of the span of control of

the CEO or the executive team. To our knowledge, this is the first paper to analyze these questions empirically. Finally, we contribute to the management literature on top management teams (TMT) (e.g., Hambrick & Mason, 1984; Carpenter, Geletkanycz, & Sanders, 2004) and the more recent literature focusing on specific functional TMT members and corporate headquarters (e.g., Collis, Young and Goold, 2007; Menz, 2011).⁶

On the theoretical side, our findings and story are related to a number of issues on the internal organization of firms. Our explanation for our results focuses on (i) the effect of communication on the organization of activities, (ii) in a setting where the relevant organizational choice is whether to centralize functional activities. Specifically, we argue that functional centralization allows the firm to exploit synergies and that IT augments the ability of functional managers to exploit synergies. Moreover, the effect of IT on synergistic activities depends on the nature of these synergies. With respect to (i), various papers have studied the economics of communication in organizations in a variety of settings (Cremer, Garicano and Prat, 2007, Garicano, 2000, Dessein and Santos 2007). These papers also analyze the impact of communication technology on organizational form; in particular, how improvements in IT may advantage or disadvantage centralization. Both sets of issues are addressed in our paper, and our proposed explanation for our results will draw from some of the ideas developed in this literature, and apply them to a setting where functional centralization is the key organizational choice. With respect to (ii), our paper's focus on functional centralization is related to the literature that analyzes the role of the functional manager in multi-business organizations. These papers take various approaches to the issue, and consider (amongst other things) how the centralization decision is affected by the importance of incentivizing managers (Dessein, Garicano and Gertner, 2010), monitoring workers (Rotemberg, 1999), and experimentation and learning (Qian, Roland and Xu, 2006). This literature emphasizes the point that the centralization decision depends on the ability to exploit synergies in various forms; in this vein, our paper

⁶ Much of the empirical research in management on top management teams (TMT) focuses on the characteristics of the individual manager (e.g., tenure, education, experience). While more recent research in management has analyzed individual TMT positions (e.g., CFO, COO, CMO, CIO), there is no evidence on functional TMT members as a group (see Menz, 2011 for a review of the literature).

focuses on the importance of communication and the nature of relevant information in exploiting synergies.

The rest of the paper is organized as follows. Section II presents the definition and trends related to different types of positions in the data and a simple framework to interpret our findings. Section III describes the data/ empirical specification and Section IV presents the empirical results. Section V concludes.

II: Increasing Functional Centralization in Management Positions

II.A: Definitions and General Trends

Let us begin by defining the senior executive team (also known as the top management team) of an organization as the CEO and the managers that report directly to him. The executives that are direct subordinates to the CEO can be classified into two broad types of positions: functional managers and general managers. Functional managers are responsible for the activities of their specialized function (e.g., finance, legal, marketing, R&D), which have been centralized at the firm level (commonly referred to as “staff” positions). In contrast, general managers are concerned with a range of functional activities within their business units (and typically have profit and loss responsibility and are commonly referred to as “line” positions). In other words, the top executive team includes “specialists” in one particular function (functional managers) as well as “generalists” (general managers).

We know that, as documented elsewhere, the span of control of the CEO has increased substantially over the past two decades.⁷ However, little is known about the changes in the composition of the top executive team represented by the positions included in the CEO’s span of control. The novel systematic trend uncovered in this paper is that the mix of management positions reporting to the CEO in large U.S. firms has shifted toward more functional centralization. That is, while the CEO’s span of

⁷ E.g. Rajan and Wulf (2006), show that the CEO’s span of control increased from 4.4 in 1986 to 8.2 in 1998 in a sample of Fortune 500 firms. Using data from The Conference Board for a subset of firms, we document that this trend continues through the mid-2000s (2004-2008) to a span of control of 9.6.

control doubles from five to ten, on average, approximately three quarters of the five position increase is attributed to functional managers.

Functional managers can be further classified into two relevant categories depending on how close to the product their function is (Chandler, 1991): “Product” or front-end functions (e.g., marketing, sales, R&D) that are heavily reliant on product information and closer to both customers and product markets; and “Administrative” or back-end functions (e.g., finance, legal, human resources) that rely on information that is less product-specific.

To make these conceptual categories concrete, take for instance IBM in 1994 (Figure 1). At the time, Lou Gerstner, the CEO, had nine functional managers reporting directly to him. These included six Administrative positions (e.g., including the Chief Financial Officer, the General Counsel, the Chief Human Resource Officer) and three Product positions (e.g. the heads of Research and Development, Marketing and Sales). He also had five general managers in the top executive team, including the business unit managers of the personal computer business (General Manager --Personal Systems) and the mainframe business (General Manager --Systems), among others.

Figure 2 shows that, in our data, the average number of functional managers reporting directly to the CEO increased from 3.1 in the late 1980s to 6.7 in the mid 2000s—an increase of 3.6 positions.⁸ This is significantly larger than the 1.3 position increase in general manager positions (from 1.6 to 2.9). So, approximately three quarters of the 5 position increase in the CEO’s span of control over the past two decades is attributed to functional managers.^{9, 10}

⁸To minimize bias from using an unbalanced panel, the figures documenting trends are based on the sample of firms that appear for at least 10 years over the sample period. The first three time periods in figure 2 use data from the larger sample of firms (290), while the last time period (2004-2008) is based on smaller sample (43 firms). If we limit the sample to only the 43 firms for which we have data in the later period, the pattern over the 20 years is qualitatively similar.

⁹Our measures may understate functional centralization. As mentioned, there may be corporate-level functional managers that don’t report directly to the CEO. Plus, if anything, the survey probably understates functional managers because they are less standard positions and Hewitt’s survey focuses on standardized positions.

To give a better sense of the details behind these averages, in Figure 3 we plot the fraction of the sample for which the position reports directly to the CEO, for each functional position over time. Figure 3-A shows that CEOs in our sample had, on average, an increasing number of administrative functions (especially finance, legal, HR, CIO) reporting to them over the period. For example they had, on average, 0.66 CFOs and 0.36 HR heads reporting in 1986. By 1999, CEOs had 0.87 CFOs and 0.67 HR heads reporting to them on average. Figure 3-B shows that CEOs in our sample had a smaller number of product functions reporting to them on average, but that these also increased over the sample period. For example, CEOs had, on average, 0.11 R&D heads reporting in 1986 and 0.24 in 1999.

II.B: IT, Diversification and Increasing Functional Centralization in Management Positions

In this sub-section we provide a simple framework to explain our findings on the firm's organizational choices in terms of which functions to centralize. A key point that we emphasize throughout this section is that the decision to centralize certain activities depends crucially on the nature of the information required to perform these activities. This is why, as we will see, the effect of IT and firm diversification on functional centralization differs across functions: because of differences in the nature of the relevant information across functions.

Firms perform activities associated with various functions (marketing, sales, finance, etc), each of which requires information from one or more business units. When a functional manager (who is a member of the executive group) performs the activities associated with a function, we say that the function is centralized;¹¹ the alternative is to perform these activities in their respective business units.

¹⁰ Clearly, there are various reasons why functional manager positions have become more important over time with some reasons being quite idiosyncratic to the function. For example, the rise of the CFO position is partially explained by the increasing complexity of financial markets and changes in accounting rules (Zorn, 2004). Or, as companies become more customer-focused and marketing techniques grow in sophistication, Chief Marketing Officers (CMOs) play a more important role in senior management. CEOs may also signal greater strategic importance of certain functions both inside the organization and to key external constituents through their choice of direct reports. While reasons for the movement of functional positions to the top may have an idiosyncratic component, our objective in this paper is to investigate the general forces that drive functional centralization.

¹¹ Dessein, Garicano and Gertner (2010) and earlier papers (e.g., Lawrence and Lorsch, 1967) would define this as integration.

The organizational design choice is which functions should be centralized, and which should remain at the business-unit level. In what follows we discuss how the nature of the information associated with the different functions can be one force driving the centralization decision.

When deciding which functions to centralize, the firm needs to take into account the information required to efficiently perform functional activities. The downside of centralizing a function is that some local information from the business units is necessary for all functions and this information may be imperfectly communicated from the business unit to the functional manager (whereas a general manager, who is closer to the business unit, would suffer less from communication problems). The advantage of centralizing the activities of a function is that synergies can be achieved more efficiently under centralization (there are various reasons for this – for example, economies of scale or the fact that functional managers may have better incentives to perform synergistic activities, as in Dessein, Garicano and Gertner, 2010). This advantage may be mitigated if it is difficult for the functional manager to acquire (either directly, or via communication with the business unit) relevant information, or if the relevant information is difficult to standardize and analyze.

We argue that functions differ in the nature of information required to perform the functional activities. In particular, they differ in the extent to which the necessary information is product-specific (this distinction between types of functions is similar to that in Porter, 1985, Hambrick and Mason, 1984, and Chandler, 1991). The activities associated with some functions are heavily reliant on product-specific information. We call these product functions. In contrast, other functions rely relatively more on information that is not product-specific and is easier to standardize. We call such functions administrative functions. For example, the marketing function (a product function) in a firm like IBM relies on the

detailed knowledge of the product, market and competitors to a much greater extent than the finance function (an administrative function).¹²

Classifying functions in this way allows us to consider the relationship between centralization and IT investments. One characteristic feature of IT investments is that they reduce the costs of acquiring, communicating and analyzing information. IT can increase the returns to centralizing functions to the extent that it makes it easier for the functional manager to acquire, communicate and analyze information from various business units in performing activities. But, most importantly, it is activities where there is a potential for synergies that should more readily be centralized as the firm invests in IT (because IT allows standardized information to be easily processed). For example, IT helps with the aggregation and analysis of financial performance of various business units, and thus improves capital allocation decisions. In contrast, when the relevant information is not comparable across products, or difficult to aggregate, standardize or communicate (as in the marketing function), IT investments will have relatively little effect on the ability to organize and utilize marketing information from various business units to realize synergies.

Which functions are more likely to be centralized in this setting? The returns to centralization should depend on the degree to which information from the various business units can be utilized to exploit synergies. This is easier for functions whose activities are fairly similar across business units – such as administrative functions, where the relevant information is relatively non-product-specific and easy to standardize. An increase in IT should, by improving the acquisition, communication and analysis of relevant information, increase the returns to allocating activities to the functional manager of administrative functions and thus should be accompanied by an increase in centralization. This would be the case, for example, for the finance function which empirically is the most frequently centralized along with the legal function.

¹² Other terminology consistent with our distinction of type of function is “front-end” for product functions and “back-end” for administrative functions.

In contrast, synergies are harder to exploit in product functions where the relevant information and activities are highly product or market specific, such as marketing or R&D. For these functions, there are fewer potential synergies and they are harder to realize; thus IT has less of an effect on the returns to centralizing product functions. IT should only be associated with the centralization of product functions in firms where products are similar (with low diversification).

The decision to centralize functions also depends on the degree of firm diversification. The strength of this relationship differs across functions. Product functions in less diversified firms with more similar products will be more readily centralized. In contrast, for functions where information is not product-specific (administrative functions), the choice to centralize should be less strongly related to the scope of the firm.

The following examples illustrate these forces. In a conglomerate that produces both aircraft engines and household appliances (e.g., General Electric), marketing-relevant information produced by the engine business unit is qualitatively different from marketing-relevant information produced by the household appliances unit. In this example, since products are different, we expect IT to have little impact on the centralization of the marketing function and other product functions. However, when products are fairly similar across business units, we expect IT to favor centralization of product functions. For example, in 1994 IBM produced similar products that were all technology-related and the common brand was applied to PCs and mainframes alike. Marketing and Sales were centralized functions because of the value of synergistic marketing and sales activities across business units.

It is useful to compare the effect of IT on organization in this framework to the effect of IT in existing theories of organizational form. In the Garicano (2000) and Bloom, Garicano, Sadun & Van Reenen (2010) models of hierarchical communication, improvements in communication technology allow activities to be moved from informed parties to uninformed parties, because of the greater ease of communication. This is consistent with our results and our explanation that moving activities from the

(informed) business unit to an (initially uninformed) functional manager becomes more attractive as communication technology improves.

In another related paper, Dessein and Santos (2006) consider a model of horizontal communication where improvements in communication technology ease the disaggregation of activities between multiple parties. In our setting, this suggests that, to the extent that synergistic activities may be performed directly by collaborating business units, improvements in communication technology may sometimes favor decentralization. However, our empirical finding that centralization is generally increasing in IT implies that this effect is less relevant in our setting; synergistic activities are difficult to decentralize and have to be consolidated under a single party (the functional manager). Consequently, our explanation focuses on the role of the functional manager in performing synergistic activities.

We emphasize the role of IT in standardizing and analyzing information. Our discussion partly draws from Cremer, Garicano and Prat (2007), where improvements in IT make it easier to standardize information across an organization. In their model, improvements in IT may decrease centralization by allowing business units to standardize and thus communicate directly with each other rather than through headquarters. Our results suggest that, in our setting, the effect of IT is not to allow decentralized communication via standardization but instead, by standardizing, to enhance the ability of headquarters to analyze information so as to exploit synergies; consequently, IT encourages rather than inhibits centralization, but only to the extent that the relevant information can be standardized and analyzed. In particular, the effect of IT depends on the nature of relevant information; that is, how easy it is to standardize information for synergistic activities.

Finally, our paper considers a setting where activities may be centralized under a functional manager. Dessein, Garicano and Gertner (2010) study the incentive trade-offs involved in centralizing activities under a functional manager. Qian, Roland and Xu (2006) study learning under M-form versus U-form organization. Rotemberg (1999) studies how the centralization decision affects the ability of

managers to monitor subordinates. In general, these papers argue that functional centralization occurs when there are more synergies (broadly construed) to be exploited across business units, which is consistent with our results. However, our results, and thus our explanation for our results, focus on the effect of IT in exploiting these synergies.

III. Data Sources and Description

In order to analyze the drivers of the observed patterns of increased functional centralization at the top of the firm described in Section II.A, we draw on a number of different datasets. First, our main dataset is based on a confidential compensation survey conducted by Hewitt Associates, a leading human resources consulting firm specializing in executive compensation and benefits. This dataset allows us to identify how the number and type of positions that report directly to the CEO change over time. The dataset records information on managerial positions at the top of the organization, their compensation, their title/job description and who the individual reports to. Notice that the title/job description is categorized by Hewitt in order to make positions comparable across firms. That is, even if the same position has different titles in two different firms, Hewitt will group them into positions that share job descriptions and responsibilities. This is essential for our study, since it implies that we can easily compare positions and their evolution across firms over time. Appendix I contains a detailed description of all the relevant positions covered by Hewitt. With this dataset we are able to define how many positions report directly to the CEO (span of control or the members of the executive team) and observe what positions those are.

The sample spans the 1986-1999 period and includes around 300 firms of which 69% are in manufacturing, and 31% are in services. The firms are typically leaders in their sector and representative of the Fortune 500 firms (see Rajan and Wulf, 2006 for a detailed sample description).¹³ Hewitt also records detailed compensation information for all positions, but we were able to obtain the detailed

¹³ Rajan and Wulf (2006) describes the sample representativeness relative to Compustat firms, discusses concerns about selection, and potential misreporting in the survey. It concludes that the sample is representative of large, Fortune 500 firms that are leaders in their sectors.

compensation only for a subset of positions. These include the CEO, Division Managers, the CFO, General Counsel and the Chief Human Resources Officer. For those positions, we have information on the level of salary, bonus and long-term compensation (this includes the Black-Scholes value of stock options grants, restricted stock and other long-term incentives). Using the Hewitt dataset we are also able to construct a number of important variables such as firm depth (as measured by the average number of reporting positions/distance between the division manager and the CEO).

This unique dataset allows us to characterize the composition of the top executive team, as defined by the positions that report directly to the CEO, and analyze how the composition changes over 14 years. This is not possible in any of the existing datasets we are aware of. However, in spite of its richness, our dataset has some limitations. First, functional positions may exist in other places of the organization, and not report directly to the CEO (in that case, because we focus on top executive team positions, we would under-estimate the extent of centralization of functions). Second, we cannot definitively answer the question of whether the increase in functional positions at the top comes from newly created or existing positions. For some functions (finance, law and HR), we know whether the position exists and the reporting level of the position; but, we don't have this information for all functional positions. Finally, while we think that the number of functional managers that report directly to the CEO captures some notion of centralization and the allocation of more activities to the functional manager (and away from division or business unit managers), we do not observe anything about the allocation of activities.

We also obtain information on IT investment at the firm-year level from the Harte-Hanks database (see details in Bresnahan, Brynjolfsson and Hitt, 2002). The database reports the number of personal computers in use at the firms in a given year, so that we can define IT-intensity of the firm as the number of PCs per employee. Since our sample covers the 1986-1999 period, this variable is particularly meaningful, given that this is the period where PC prices were falling and firms started adopting the new technology (Dunne et al, 2004). We exploit the panel nature of our dataset and the differential rate of adoption by different firms. In our use of this variable, we expect to capture the overall IT-intensity

within the firm, including not just PCs themselves, but also other aspects of IT that are correlated with hardware, such as software, Enterprise Resource Planning (ERP) or different types of technologies that improve communication. As a result we are not able to distinguish between investments in hardware, software or communication technology. A more detailed dataset would be necessary for that.¹⁴

Next, we constructed a set of variables that measure the degree of diversification within firms. The first variable uses Compustat Segment data to measure firm entropy as defined in Palepu (1985). Intuitively, firm entropy measures the extent of diversification as captured by the different 2-digit SIC segments the firm operates in. It is a transformation of a Herfindahl index (sum of squared shares of segment sales to firm sales) across different two-digit SIC segments reported by the firm that captures the extent of relatedness of the businesses the firm operates in. The higher the value, the more diversified the firm is (see data appendix for exact definition and formulae). The second set of diversification variables, measure the degree of diversification/relatedness not just by whether two firm segments are close as defined by the SIC code, but by whether they use products that are related in Input-Output tables. Fan & Lang (2000) calculate inter-industry relatedness coefficients using input-output commodity flow tables and construct two basic measures of relatedness: vertical and complementarity. The vertical relatedness measure captures the extent to which the segments the firm operates in are inputs to one another, as defined in the Input-Output tables. The higher the vertical relatedness value the more related the firm's businesses, along the production chain. For example, since semiconductors are an important input into personal computers, firms that operate in both sectors would score high on the vertical relatedness measure. The complementarity measure, in turn, captures whether the businesses the firm operates in are all inputs into the same, common industry, or alternatively whether they source their products from the same common industry (see data appendix for details and formulae). For example, a firm that operates in both semiconductors and plasma screens would score high on the complementarity measure since these

¹⁴ Bloom, et al, (2010) also uses Harte-Hanks data for a cross-section of firms in 2006. In that period Harte-Hanks collected information on the types of software adopted such that the authors are able to distinguish between information technology and communications technology. Unfortunately such information is not available in our time period (a 14 year panel).

are both inputs into personal computers. The higher the complementarity value, the more related the firm's businesses.

Finally, we obtained accounting information on all firms in our sample from Compustat.

IV. Results: Functional Centralization, IT and Diversification

The empirical analysis in what follows relies on the panel nature of our dataset for identification. We observe firms for up to 14 years, and we have information on changes in the structure of the executive team (who reports to the CEO) along with measures for IT-intensity and firm diversification. We also have detailed pay information for a subset of positions inside the firm. Unfortunately, we cannot argue that the relevant independent variables of interest (IT or the degree of firm diversification) are purely exogenous.¹⁵ In fact, we think that firms are making scope, IT investments and organizational decisions simultaneously. Our goal is to see how these decisions correlate with one another. Notice however that we are able to improve on much of the existing organizational literature because we are able to control for unobserved firm heterogeneity and do not have to rely on cross-sectional relationships to identify our results. Furthermore, in much of our analysis, we compare changes between different types of positions within firms over time, which further offsets the concern that our results are simply a spurious correlation.

A- Understanding Changes to the Executive Team through Changes in Pay

Before turning to the analysis of how the composition of the senior executive team has changed over time with changes in IT and diversification, we would like to shed light on what it means when a firm adds a functional manager to the executive team; or more generally, how centralizing one function at the top affects other positions in the organization. One advantage of our dataset is that, for some positions

¹⁵ As mentioned in footnote 4, there are some clear exogenous forces driving some of these variables. However, it is difficult to find instruments that vary over time and by firms/industries. And even if we had such instruments, it would be hard to argue that they satisfy the exclusion restriction (that they only affect organizational choices through the instrumented variable). This is a common problem in this kind of work. For a reduced form analysis, with exogenous variation and arguably causal results on the effect of competition on organizational structure see Guadalupe and Wulf (2010).

(Division Managers, CFO, General Counsel, and Chief HR Officer and CEO), we have information on pay and reporting levels, even if the position is not directly reporting to the CEO.¹⁶ Exploring how pay for these different positions changes with the composition of the executive team is a useful exercise: It allows us to interpret the relationships we uncover in the next subsections, but also more generally, it uncovers some new facts about how different positions relate to each other. To do so, we analyze how pay for our different types of managers (general managers, functional managers and the CEO) changes as their position in the hierarchy (e.g., their reporting level) and the composition of the senior executive team changes.

All regressions in Table 2 have a position-year as the basic unit of observation, and have the following structure:

$$\ln(W_{pit}) = \alpha + \beta O_{pit} + \delta F_{it} + X_{it}'\theta + d_t + d_{pi} + \varepsilon$$

The dependent variable $\ln(W_{pit})$, is either the logarithm of base compensation (salary) or total compensation (salary, bonus and long-term incentives) of position p in firm i , in year t . We analyze separately the correlates of pay for three types of positions: general managers (division managers), functional managers, and the CEO. The independent variables include variables that characterize the position itself (O_{pit}) such as whether the position reports to the CEO, and firm characteristics (F_{it}) such as how many functional manager and general managers report to the CEO, and the types of functional managers (i.e., product or administrative). All regressions include a set of controls X_{it} for firm sales, the number of segments the firm operates in and the extent of diversification. All regressions include firm-specific position fixed effects and time dummies such that all the effects are identified within a firm and position as they change over time.

¹⁶ In our firm-level data, for each firm-year, we know which positions report directly to the CEO. For a select group of positions, we know, conditional on the existence of the position, whether it reports directly to the CEO or not. In most cases, for this subset of positions, functional managers report directly to the CEO (72%), but in 28% of the cases they do not.

We start describing pay for functional managers, in Columns 1 and 2. As mentioned, the only functional managers we have pay information for are the CFO, the General Counsel and the Chief Human Resources Officer (Administrative functions in our terminology). The variable “Reports to the CEO” is a dummy variable that equals one if the position reports directly to the CEO. We find that there is an 11 percent increase in base compensation and a 15 percent increase in total compensation when the position joins the executive team by reporting directly to the CEO. This could be driven by a number of factors. One might argue that reporting to the CEO does not mean much, that it is simply a box on a chart with no real consequences. At the very least, our evidence indicates that reporting to the CEO has practical consequences in terms of pay. We interpret this pay increase to suggest that the level of responsibility and authority of the manager is greater when the position becomes part of the executive team.¹⁷

Columns 3 to 6, report pay changes for general (division) managers. Here again, we find that reporting directly to the CEO increases base pay (8 percent) and total compensation (13 percent) for these managers. But even more interestingly, we find strong evidence that division manager pay decreases as more functional managers report directly to the CEO (Columns 3 and 4). This is consistent with centralization of the functions: as functional managers move closer to the CEO, they perform some of the activities that division managers were responsible for and division manager compensation declines as responsibilities are reduced. In Columns 5 and 6 we distinguish between two types of functional managers: administrative and product. We find that the increase in the number of product functional managers is strongly associated with a decrease in division manager’s pay: one more product functional manager reporting to the CEO is associated with a 2.9 percent lower salary and 6.3 percent lower total compensation for division managers. In contrast, we find no correlation between administrative functional managers and division manager pay.

¹⁷ In addition, it is well-known that managers at the top of the hierarchy have extensive visibility (both internal and external) and have direct access and interaction with the CEO, arguably the scarcest and most valuable human capital resource (Bandiera, Prat, Sadun and Wulf, 2011). Managers reporting directly to the CEO often comprise the Executive Committee which is the most influential decision-making body in large organizations. According to CEOs, managers that report directly to the CEO tend to “have a seat at the table” which means that they are important and influential members of the senior management team (Wulf, 2011).

While we do not observe the tasks/activities/decisions performed by each of our managers directly, one interpretation of these results is that when more activities/decisions are centralized (allocated to the functional manager), division manager pay declines. And this effect is particularly strong for product-related activities (relative to administrative activities), that typically are a more substantial component of the division manager's job. So, the role of the functional manager changes as the functional position joins the executive team since their pay increases. Moreover, since division manager pay declines when there are more product functional managers at the top, functional managers serve as substitutes for division managers in product functions, but not in administrative functions.

Finally, we studied how CEO pay evolves with the size and composition of the executive team. The results are presented in Columns 7 and 8. We find some weak evidence that CEO pay, and in particular base pay, declines with the size of the executive team, however the coefficients on the number of general managers and the number of functional managers are never statistically significant. Although the results are weak, the negative correlation is consistent with CEOs sharing responsibilities when they have larger executive teams.

Using pay and reporting relationships, we have documented two relevant facts that illustrate what occurs inside the firm as the composition of the CEO's direct reports changes: (i) functional manager and general manager (division manager) pay increases when the position moves closer to the CEO and (ii) division manager pay decreases when more product functional managers report directly to the CEO. While we do not observe the allocation of activities directly, these findings are consistent with the common view that functional managers centralize functions that previously resided with the business unit or division managers. This is particularly true for product functions, and less so for administrative functions.

These results support the idea that the secular increase in span of control of the CEO, that takes mainly the form of more functional managers reporting directly to the CEO, is reflecting an increase in

centralization of decision making at the headquarters of the organization. We are not suggesting that the CEO is more involved in decision-making, but instead that the shift in the composition of the second layer of managers is consistent with a trend toward centralization of functions at the top of the organization.

In the next section, we turn to investigating the relationship between changes in the composition of the executive team and other firm characteristics, namely IT and the extent of firm diversification. This will allow us to better understand the fundamental economic drivers behind the observed centralization/decentralization decision, and the relationship to the CEO span of control.

B- Information Technology and Functional Centralization

To study the correlates of executive team composition, we exploit the firm panel dataset. The basic structure of our empirical specification will be as follows:

$$Y_{it} = \alpha + \beta IT_{it} + \delta DIVERSIF_{it} + X_{it}'\theta + d_t + d_i + \varepsilon$$

Where the dependent variable Y_{it} will typically be the number of functional managers reporting to the CEO in firm i , at time t . IT_{it} and $DIVERSIF_{it}$ are the IT-intensity and diversification measures respectively, X_{it} are control variables (e.g., firm size, the number of general managers or the number of segments the firm operates in), d_t are year dummies and d_i are firm fixed effects. We also estimate several position-level regressions of pay and reporting level that include position fixed effects.

Table 3 explores the relationship between the presence of functional managers in the executive team and IT investments at the firm level. The dependent variable in Columns 1 to 4 is the number of functional manager positions that report directly to the CEO. It includes the following corporate-level functional heads: Chief Financial Officer (CFO), General Counsel, Human Resources (CHRO), Chief Information Officer (CIO), Planning & Business Development (Strategy), Public Relations, Chief Marketing Officer (CMO), Sales, Research & Development, Manufacturing, and the Chief Administrative

Officer (CAO). Table 3 shows the relationship between the number of functional managers and the level of IT within the firm as measured by the number of personal computers (PCs) per employee. Column 1 is our base specification. It includes firm fixed effects, and a control for firm size. It shows that as firms increase their IT-intensity, the number of functional managers within the firm increases. A one standard deviation increase in IT-intensity is associated with a 0.14 position increase in the number of functional manager positions at the top of the organization, which is around 20% of the overall increase in the number of functional managers during this period.

Columns 2, 3 and 4 include a number of firm controls that could potentially affect some of the main results. To control for the fact that firms are increasing not only the number of functional manager positions but also the number of general managers, Columns 2 to 4 control for the number of general managers reporting directly to the CEO (which includes division managers, group managers and the presence of a COO). We find that the number of functional managers is positively correlated with the number of general managers, suggesting that firms increase both types of positions at the same time. However, adding these controls hardly affects our estimate of the effect of IT adoption on the number of managers. Also, it certainly could be the case that both IT and the number of functional managers may be related to the portfolio of businesses within the firm. To address this, in Column 3, we control for the number of segments that the firm operates in as well as the degree of diversification as captured by entropy. This hardly changes the main correlation identified in Column 1. Next, in Column 4 we control for whether the firm has a COO and whether it has a CAO. Over our sample period, firms have been eliminating these positions, and our result could just be reflecting the presence or absence of these positions. Controlling for these positions explicitly (Column 4) hardly changes our main coefficient of interest.

Column 5 uses the share of functional managers in overall CEO span of control as a dependent variable rather than the number of functional managers. It confirms the results in earlier tables and shows that not only the number, but also the share of functional managers is increasing in IT. Finally, we test for

the effect of IT on the size of the executive team. As mentioned earlier, a simple explanation that IT increases the CEO's ability to manage more subordinates would suggest a positive relationship between IT and span of control. Yet, we find weak support for this explanation. In Column 6, the dependent variable is the total number of positions reporting directly to the CEO (CEO span of control), and even though we find a significant positive coefficient on the IT variable, it is insignificant. Hence, the effect of IT on span of control is concentrated on the number of functional managers, rather than general managers, with a weak overall effect on total span. That is, IT-intensity is correlated with the *composition* of the executive team (both number and share of functional managers), but not with the size of the team.¹⁸ This reinforces the idea that when trying to analyze the allocation of decision making within organizations it is important to distinguish between types of positions, since they respond to different forces.

Table 4 performs a number of robustness checks on our main result. To ensure that the IT results identified using the PC per employee variables is driven by changes in PCs rather than employment, we control explicitly for the logarithm of employment in Column 1 with similar results to those in Table 2. Column 2 uses a count variable specification (Poisson with fixed effects) instead of OLS to identify our main effect, again with similar results. Next, it is often argued that a significant driver of changes inside organizations is a change in leadership –when the CEO is replaced with a new one. We therefore assess how much of the effect we identify occurs when there is a change in CEO, and how much occurs within a given CEO's tenure. For that purpose, Column 3 controls for CEO fixed effects, i.e., when the firm changes CEO we treat this, econometrically, as if it were a new firm. Relative to our baseline coefficient of 0.650, the within-CEO coefficient drops to 0.424. This reduction in the estimated coefficient implies that some of the effect we identified earlier occurs when CEOs change and simultaneously change IT and

¹⁸ Notice that the reason why total span does not change significantly as the number of functional managers goes up is that the number of general managers is actually going down as IT increases. So, we find opposite effects of IT on the reporting relationships of functional managers versus general managers. This result also highlights the importance of distinguishing between types of positions at the top of the firm, since these are very different in nature and can hence have a very different response to other firm changes.

the structure of their organizations. However, a substantial amount (two-thirds) of the overall change in the number of functional managers comes about “within CEOs”, i.e., during a given CEO’s tenure.

One concern with these regressions is that all we are capturing is a spurious correlation between two variables that are trending over time. However, if this were true, we also would expect to find a correlation between IT and CEO span of control, since the latter also strongly trends upwards over our sample period. The fact that we find qualitatively different effects for different types of managers alleviates the concern that we are just capturing a spurious relationship. Still, to saturate our model even further, we introduce industry-specific time trends (Column 4) and even firm-specific linear trends (Column 5). Our main result is still significant even in the highly demanding specification of Column 5.

Finally, we explored whether the relationship between IT and functional managers is different in manufacturing and non-manufacturing industries. Column 6 interacts the IT variable with a dummy for whether the firm reports a manufacturing industry as its primary SIC. The interaction is insignificant, suggesting there is no difference between types of industries based on this crude distinction.¹⁹

Overall, our results suggest that firms simultaneously increase their IT-intensity and the number of functional managers reporting to the CEO. This within firm correlation is very robust to a number of specifications. In contrast, we find no relationship between the increase in overall span of control and IT adoption within firms, even though overall span has also been increasing over our time period. Instead, it is certain types of managerial positions that are related to IT adoption. Specifically, the number of functional managers in the executive team is positively related to IT, while the number of general managers is not. One broad interpretation of these results is that the lower costs of communicating and acquiring information associated with IT led to higher returns to centralizing functions at the top of the organization. This result is consistent with the predictions in a number of models (e.g. Dessein and

¹⁹ We also tested and rejected the notion that the relationship between the number of functional managers and IT is just driven by the increasing importance of the Chief Information Officer (CIO) position. When we regress an indicator variable representing whether the CIO directly reports to the CEO on PC per employee and all of the controls in our specification in Column 4 of Table 3, we find a small and statistically insignificant coefficient on PC per employee (see Appendix Table III).

Santos, 2006). However, to date, there is little evidence showing empirically how centralization and IT adoption occur simultaneously at the top management levels of the firm (the evidence on Bloom et al, 2010, is for positions at much lower levels in the organization).

C- Types of Functional Managers, Information Technology and Diversification

In this Sub-section, we study whether the relationship between IT and functional centralization varies by type of functional manager. As discussed earlier, we classify functional managers into two broad groups depending on the relative importance of product-specific information (see Section II). Administrative functions, which rely relatively less on product-specific information, include Finance, Legal, Human Resources, Planning, Information Technology, and Public Relations. In contrast, product functions that use more product-specific information include Marketing, Sales, Research & Development and Manufacturing. Clearly, classifying functions into these categories is subjective. However, as we show below, our empirical results are consistent with our ex-ante subjective classification of functions.

Columns 1 and 4 of Table 5 replicate the basic specification of Column 4 in Table 2, with a different dependent variable. Column 1 uses the total number of administrative functional managers reporting to the CEO –i.e., managers performing activities in functions that use relatively less product-specific information. Column 4 uses the total number of product functional managers reporting to the CEO –i.e., managers performing activities in functions that use relatively more product information. We find that IT adoption is positively correlated with the number of administrative functional managers, but not with the number of product functional managers. In contrast, if we focus on the diversification variable, we find that while diversification (as measured by entropy) is negatively related with the product functional managers (Column 4), it is uncorrelated with administrative functional managers (Column 1). A one standard deviation increase in diversification is associated with a decrease of 0.13 product functional managers, or 40% of the standard deviation in the number of product functional managers. More focused (less diversified) firms are more likely to centralize product functions at the corporate level.

Columns 2, 3, 5 and 6 reproduce these results with two alternative measures of firm diversification. Using both measures of vertical relatedness (Columns 2 and 5) and of complementarity (Columns 3 and 6), we find that more focused (less diversified) firms have more product functional managers reporting directly to the CEO. Yet, for administrative functional managers, we find the opposite sign although it is never statistically significant.

That less diversification (related businesses or more homogeneous products) is associated with more specialized functions at the top may not be so surprising: a classic synergy argument suggests that economies of scope are greater in firms operating in related businesses leading to gains from centralized functions. So, centralizing the marketing function and assigning activities to a Chief Marketing Officer makes sense when businesses are related (or equivalently, when a firm's product line is homogenous). Empirically, we find mixed support for the synergy argument. The classic synergy argument should apply to *all* functions, yet we find that it only applies to product functions. One could hypothesize that this should be a stronger relationship for product functions, and that administrative functions might be less affected by the relatedness of the firm's businesses, since the latter are less dependent on product-specific information. Indeed, there is no relation between firm relatedness and administrative positions. This is a new result, and one that confirms the need to distinguish between types of managerial positions when we think about changing span of control and the optimal organization of the firm. We need to distinguish not only between functional managers and general managers, but also between types of functions.

Finally, in Table 6, we study the interaction between IT and the degree of diversification. A priori, it seems that IT should reduce communication and information acquisition costs for all functional positions. We find that for product functions, while IT has little effect on average, it is positively related to the number of functional managers in firms with similar businesses (Columns 4 to 6) (or negatively related in diversified firms). In contrast, this interaction is not significant in regressions analyzing the number of administrative functional managers (Columns 1 to 3). These results also hold for our different measures of diversification—with stronger statistical significance for vertical relatedness and entropy measures.

We have shown that changes in the functional centralization of senior management in response to changes in information technology and firm scope vary by type of functional manager.²⁰ The different results for types of functions allow us to shed light on the role of information in the decision to centralize decision-making. Different functions use different types of information. We distinguish between two types: information that is product-specific and information that is relatively similar across products. IT allows the firm to centralize functions where information is relatively similar across products (administrative functions), and the degree of diversification is not relevant in the centralization of such functions. In contrast, functions where product information is important are centralized only when products are relatively similar (such that there is scope to realize synergies).

D- Reporting to the CEO, Pay and Information Technology: Position-Level Evidence

The last two sub-sections showed how IT and diversification related to the number and type of functional managers that report directly to the CEO. All regressions shown were at the firm level. Now we provide further evidence of those changes using the subset of positions for which we have information on pay and reporting levels, even if the position is not directly reporting to the CEO positions (Division Managers, CFO, General Counsel and Chief HR Officer).²¹ The advantage of doing the analysis at the position level, rather than at the firm level, is that we can control for position level fixed effects and hence for any unobserved heterogeneity or permanent unobserved variables that may affect reporting relationships. For example, firms may restructure and combine business units and move managers of the larger combined unit closer to the top. By following the same position over time, we address this concern

²⁰ In Appendix III, we show the effect of IT and diversification on the probability that each individual position reports directly to the CEO. The results for the separate positions are noisier, but overall they paint a consistent picture: We find that Administrative positions are more strongly related to IT (all are positively related to PC per employee, with generally large coefficients). In contrast, Product functions are more strongly related to diversification (all product functions are negatively related to diversification, whereas for administrative functions the relationship is less systematic and quantitatively weaker).

²¹ In our firm-level data, for each firm-year, we know which positions report directly to the CEO. For this select group of positions, we know, conditional on the existence of the position, whether it reports directly to the CEO or not. In most cases, for this subset of positions, functional specialists report directly to the CEO (72%), but in 28% of the cases they do not.

and can directly test whether the reporting level of the position changes over time. The disadvantages are that we only have detailed position information for a subset of positions, and that this analysis does not capture newly-created positions that report directly to the CEO.

Using the individual position data, we investigate changes in both reporting levels and pay and the relationship to changes in information technology. We investigate whether IT adoption is associated with changes in reporting level of the functional manager and/or changes in pay (as proxies for a broader job scope and performance of more activities). As mentioned, we only have detailed information on individual positions that do not report directly to the CEO for a subset of administrative functional managers. For those, we run a regression where the unit of observation is again the position, and the dependent variable is whether the position reports directly to the CEO. Since these are position-level fixed effects regressions, we identify our results from positions that changed their reporting status over time. Column 1 in Table 7 presents the results. It shows that increases in IT investment are positively correlated with the administrative functional managers moving closer to the CEO. This is consistent with the results in Tables 3 to 6, but is based on a different type of identification. We also find that in diversifying firms, administrative managers are more likely to move closer to the CEO—a similar result to that found in Table 5, but here the coefficient is statistically significant. In contrast, in Table 5, we found the opposite relationship between product functional managers and diversification. In diversifying firms, we found fewer product functional managers reporting to the CEO reflecting that the benefits to centralize product functions are reduced when products are different across businesses (unfortunately we do not have position-level data for product functional managers to test whether narrowing business scope is associated with changes in reporting relationships).

Next, Columns 2 and 3 in Table 7 investigate directly the relationship between total compensation for functional managers and IT. The dependent variable is the logarithm of total compensation for the three positions mentioned earlier. Column 2 shows that pay is positively correlated with IT. A one standard deviation in PCs per employee is associated with a 1.1% increase in pay for these positions. However, the

coefficient on IT becomes insignificant in Column 3, when we include a control for whether the position reports directly to the CEO. This suggests that the correlation between IT and pay is mainly attributed to moving closer to the CEO. When we hold the reporting level constant, there is no clear significant association between IT and pay. Finally, Columns 4 and 5 replicate the analysis of Columns 1 and 2 for division (general) managers. When we restrict the sample to division managers only, we find that increases in IT are uncorrelated with the probability of reporting directly to the CEO (Column 4). In fact, if anything, the relationship is negative. Column 5 uses the logarithm of total pay for division managers as the dependent variable and we find that it is uncorrelated with our measure of IT intensity. Although insignificant, the coefficient on PC per employee is also negative in Column 5.

Overall, our findings suggest that IT is associated with higher pay for administrative functional managers, but mainly because IT makes them more likely to report directly to the CEO. Conditional on reporting directly, the relationship between IT and functional manager pay is more tenuous. In contrast, we find no effect of IT on the reporting relationship or the pay of division managers. This evidence is consistent with our earlier evidence on firms simultaneously adopting IT and changing the composition of top management positions as they centralize functions and reallocate activities away from division or business unit managers and toward functional managers.

One obvious concern with all of our results is that we are simply capturing a spurious correlation, since functional centralization and investments in IT are both trending up over time. There is significant evidence to address this concern. First, the correlation between organizational change and investments in IT are identified from both within firm and within position variation. Secondly, we show that the relationship between reporting position and IT varies by type of managerial position: there is a different relationship between functional managers and IT and general managers and IT, as well as between types of functional managers (administrative vs. product) and IT. If the correlation was simply spurious, we shouldn't see these differences given that all types of positions increasingly report directly to the CEO over time.

E- Alternative Explanations

One potential alternative explanation is that increased investments in IT enable better monitoring of managers. General managers have profit and loss (P&L) responsibility and since there is no simple performance measure for functional managers, it is harder for the CEO to monitor and incentivize functional managers. IT, by improving information flow between manager and CEO, mitigates the difficulty of monitoring functional managers, and thus makes functional centralization more attractive. Such a story is consistent with the overall positive relationship between functional centralization and IT, but does not explain differences in this relationship between types of functions.

A more nuanced view of the monitoring story may incorporate differences in the nature of information between functions. For example, in the spirit of Liberti and Mian (2009) and Stein (2002), it may be that administrative functions utilize hard, verifiable information while product functions utilize soft, non-verifiable information. As in our framework, IT may then improve the communication of hard information more than it does soft information; consequently, IT has a stronger positive effect on monitoring (and thus centralization) for administrative functions than for product functions. We view such a story as being complementary to, and augmenting, our explanation. Our explanation emphasizes how the decision to centralize functions is affected by the nature of relevant information; this information may be relevant for performing managerial activities, as in our framework, or for monitoring of managers, as in this alternative explanation.

Our framework focuses on the idea that IT may augment communication and analysis of information. An alternative view, from the literature on skill-biased technical change, suggests that IT may be complementary to certain managerial skills; to the extent that IT is complementary to the skills of functional managers but not to the skills of general managers, such a viewpoint may explain the positive relationship between functional centralization and IT. However, it is not clear why such a relationship may hold; further, it is not obvious why the relationship may differ across functions.

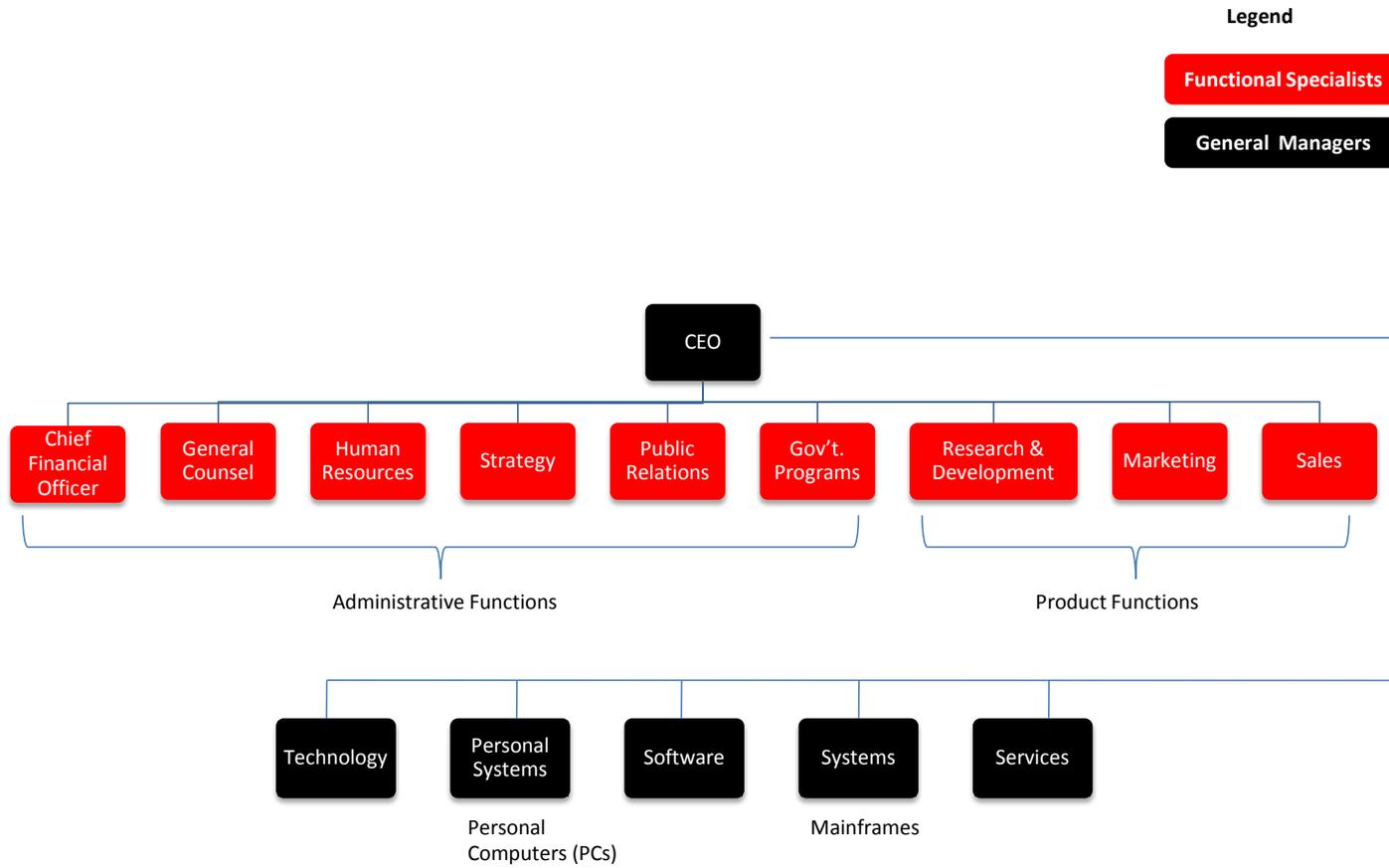
V. Conclusion

To our knowledge, we are the first to document the increase in the number of functional managers within the executive teams of large US firms over the past two decades. This shift suggests that firms are moving away from the classic M-form—hailed by Williamson (1975, 1985) and documented by Chandler (1962)—and adopting some aspects of the U-form in which functions are centralized at the top of the organization. This is in stark contrast to the widely-held view that firms have decentralized decision-making and empowered lower-level managers. In the paper, we investigate two possible drivers of these changes: reduction in the costs of information technology and the trends by firms in becoming less diversified by focusing on their core businesses. Our most novel set of results is that we find a different relationship between information technology, the diversification of the firm, and the centralization of two types of functions in the firm’s organization: administrative vs. product functions. Our empirical findings show that the “devil is in the details” and by ignoring the distinction between different types of managerial positions, we miss a critical piece to understanding organizational change. Existing theories explain some, but not all of our findings. We interpret our findings using a framework arguing that a firm’s decision to centralize functions depends on the nature of the information that is necessary to perform functional activities. Distinct from existing theory, we emphasize the importance of product-specific information in performing functional activities. We contribute to the set of empirical findings about changes in corporate hierarchies which will hopefully lead to more nuanced theories that capture the subtleties involved in organizational change.

This paper points to several directions and questions for future research, including: (i) What is the relationship between the composition of the executive team and centralization in headquarters and firm productivity? (ii) How does the increase in functional managers within the executive team square with the general trend toward greater emphasis on general manager skills? Do managers filling the functional positions at the top have more specialized or general skills? (iii) What is the role of the CEO in an

organization with more functional managers in the executive team? Are they more or less involved in decisions? We leave these questions for future work.

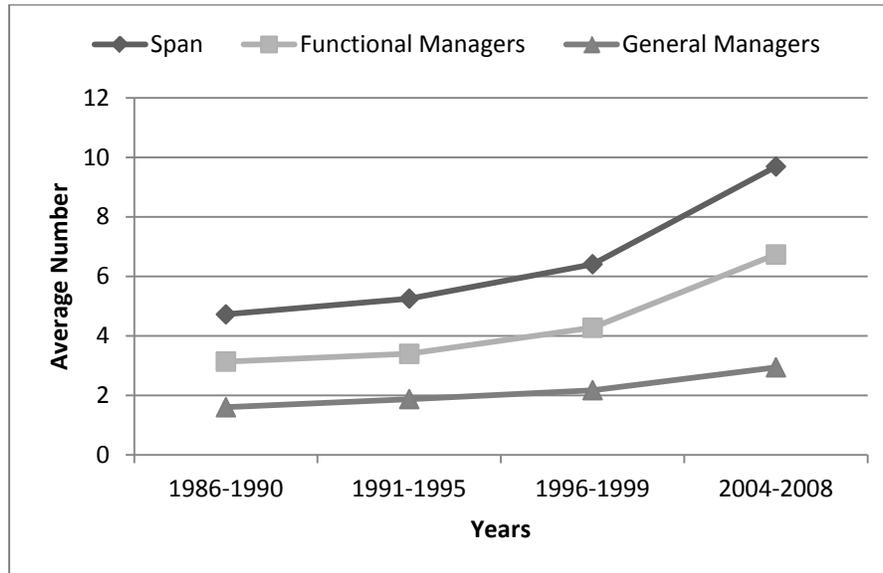
Figure 1: IBM Senior Executive Team, 1994



Source: IBM

Notes: Of the 14 that reported directly to the CEO, 5 were general managers and 9 were functional managers. The administrative functional managers are CFO, General Counsel, Human Resources, Strategy, Public Relations, and Gov't Programs. The product functional managers are Research & Development, Marketing, and Sales.

Figure 2: Span, Functional Managers and General Managers over Time (1986-2008)
(sample averages)



Note: To minimize bias from using an unbalanced panel, the figure above is based on the sample of firms that appear for at least 10 years over the sample period. The first three time periods use data from the larger sample of firms (290), while the last time period (2004-2008) is based on smaller sample (43 firms). If we limit the sample to only the 43 firms for which we have data in the later period, the pattern over the 20 years is qualitatively similar.

Figure 3: Administrative & Product Functional Managers over Time (1986-1999)
(Fraction of Sample in which Position Reports Directly to CEO)

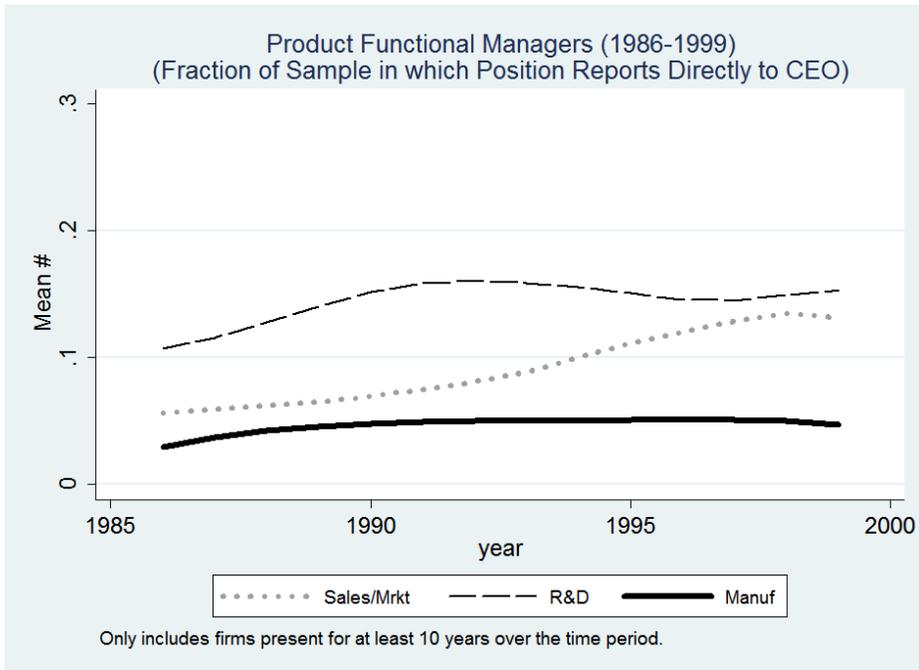
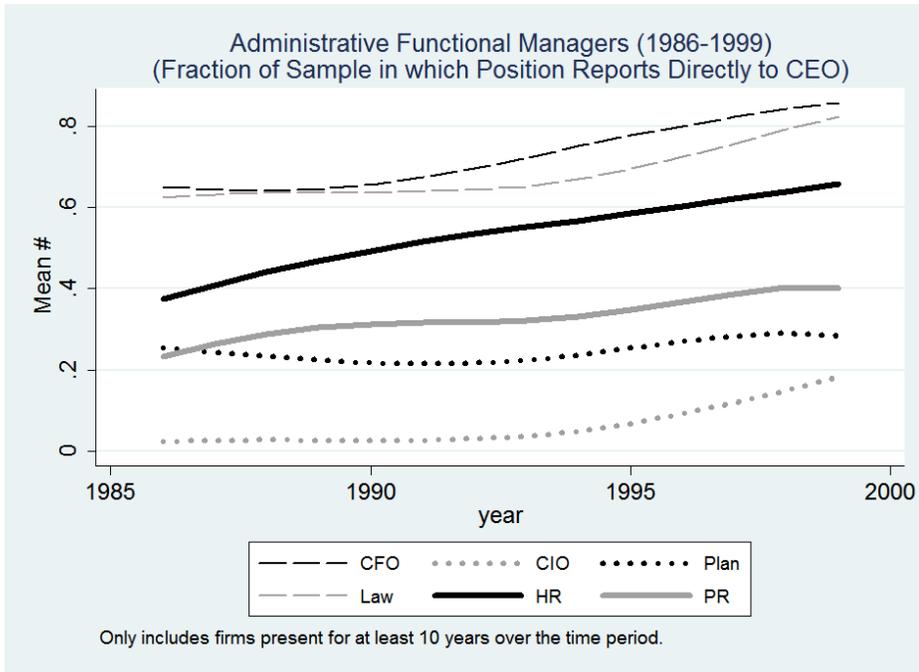


Table 1: Descriptive Statistics

	Mean	S.D.	# Observations
<i>Firm variables:</i>			
Sales (000s)	9267.44	16106.13	2321
Assets (000s)	10826.57	21852.34	2329
# of employees (000s)	48.28	81.36	2329
# of segments	2.76	1.66	2329
Functional Managers	3.19	1.53	2329
General Managers	1.79	1.52	2329
Span	4.98	2.34	2329
Administrative Functional Managers	2.55	1.41	2329
Product Functional Managers	0.32	0.60	2329
PCs per employee	0.22	0.21	2329
<i>Homogeneity variables:</i>			
Unrelated Diversif (entropy)	0.37	0.41	2329
Vertical Relatedness	0.02	0.04	1502
Complementarity	0.40	0.31	1502
<i>Compensation variables:</i>			
log CEO Total Compensation	14.64	0.75	2329
log CEO Base Compensation	13.48	0.44	2329
log Functional Managers Total Compensation	13.28	0.70	5337
log Functional Managers Base Compensation	12.43	0.38	5337
log Division Managers Total Compensation	12.75	0.65	8922
log Division Managers Base Compensation	12.05	0.41	8922

Notes: Firm sales, firm assets, and number of employees are measured in thousands. # of segments is the number of business segments. Functional manager is defined as the number of functional manager positions reporting directly to the CEO (including the CAO). Administrative functional managers include CFO, General Counsel, Human Resources, Public Relations, Planning, and Chief Information Officer. Product functional managers include heads of R&D, marketing, sales, sales & marketing, and manufacturing. General managers is defined the number of general managers reporting directly to the CEO. General managers include COO, group managers and division managers. Span is the total number of positions reporting directly to the CEO (i.e., the sum of functional managers and general managers). PCs per employee is PCs per 1000 employees. For unrelated diversification (entropy), suppose a firm has several segments operating in different 2-digit SICs. Unrelated diversification is the entropy measure used in Palepu (1985). Vertical Relatedness and Complementarity are based on measures using Input-Output tables. (Please see data appendix for detailed definitions.) Base Compensation is an employee's base salary, while Total Compensation includes base salary along with bonuses and long-term incentives.

Table 2: Base and Total Compensation for Functional Managers, General (Division) Managers, and CEOs (Position Fixed Effects)

	<i>Functional Only</i>	<i>Functional Only</i>	<i>Gen Only</i>	<i>Gen Only</i>	<i>Gen Only</i>	<i>Gen Only</i>	<i>CEO Only</i>	<i>CEO Only</i>
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Ln(Base Comp)	Ln(Total Comp)	Ln(Base Comp)	Ln(Total Comp)	Ln(Base Comp)	Ln(Total Comp)	Ln (Base Comp)	Ln (Total Comp)
Functional Mgrs.	-0.0153*** (0.0034)	-0.00377 (0.00726)	-0.0092** (0.0034)	-0.0113* (0.00626)			-0.0047 (0.0040)	-0.0060 (0.0117)
General Mgrs.							-0.0053 (0.0040)	-0.0035 (0.0071)
Admin. Functional Mgrs.					-0.0046 (0.0038)	0.00278 (0.00823)		
Product Functional Mgrs.					-0.0291** (0.0104)	-0.0629*** (0.0187)		
Division Depth			-0.0613*** (0.0103)	-0.0972*** (0.0164)	-0.0618*** (0.0103)	-0.0981*** (0.0163)		
Reports to CEO	0.1090*** (0.0128)	0.146*** (0.0254)	0.0743*** (0.0216)	0.128*** (0.0414)	0.0750*** (0.0210)	0.131*** (0.0401)		
Unrelated Diversif (entropy)	-0.0102 (0.0278)	-0.0647 (0.0719)	-0.0242 (0.0297)	-0.0292 (0.0572)	-0.0286 (0.0297)	-0.0426 (0.0573)	0.0626 (0.0720)	-0.1886** (0.0680)
# of segments	0.0026 (0.0056)	-6.13e-05 (0.0148)	-0.0019 (0.0056)	-0.00396 (0.0138)	-0.0011 (0.0056)	-0.00169 (0.0136)	0.0019 (0.0078)	0.0060 (0.0130)
Ln(Sales)	0.1352*** (0.0187)	0.279*** (0.0372)	0.0968*** (0.0257)	0.219*** (0.0517)	0.0983*** (0.0253)	0.224*** (0.0497)	0.0854 (0.0472)	0.4142*** (0.0909)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Position FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5337	5337	8922	8922	8922	8922	2348	2348
R-squared	0.5776	0.584	0.6399	0.540	0.6409	0.543	0.4018	0.5864

Notes: ***, **, and * represent statistical significances at 1%, 5%, and 10% levels respectively. Standard errors are clustered by firm. Columns 1 and 2 are for functional managers only (CFO, General Counsel, and Human Resources). Columns 3 through 6 are for general managers only (division managers). Columns 7 and 8 are for CEOs only. Administrative functional managers include CFO, General Counsel, Human Resources, Public Relations, Planning, and Chief Information Officer. Product functional managers include heads of R&D, marketing, sales, sales & marketing, and manufacturing. Base Compensation is an employee's base salary, while Total Compensation includes base salary along with bonuses and long-term incentives.

Table 3: Technology's Effect on Functional Centralization

	(1)	(2)	(3)	(4)	(5)	(6)
	Functional	Functional	Functional	Functional	Functional/Span	Span
PCs per employee	0.673** (0.311)	0.721** (0.302)	0.720** (0.301)	0.650** (0.302)	0.0748* (0.0397)	0.364 (0.464)
Ln(Assets)	-0.319 (0.202)	-0.338* (0.196)	-0.336 (0.204)	-0.318 (0.198)	-0.0524* (0.0291)	-0.251 (0.320)
General Mgrs.		0.153*** (0.0351)	0.152*** (0.0348)	0.128*** (0.0322)		
Unrelated Diversif (entropy)			0.0237 (0.304)	-0.00927 (0.304)	0.0105 (0.0439)	0.839* (0.429)
# of segments			-0.00628 (0.0569)	0.000700 (0.0557)	-0.000785 (0.00878)	-0.0968 (0.0897)
CAO				0.351*** (0.118)		
COO				-0.397*** (0.102)		
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,329	2,329	2,329	2,329	2,329	2,329
R-squared	0.086	0.110	0.110	0.142	0.014	0.102
Number of firms	290	290	290	290	290	290

Notes: ***, **, and * represent statistical significances at 1%, 5%, and 10% levels respectively. Standard errors are clustered by firm. Functional manager is defined as the number of functional manager positions reporting directly to the CEO (including the CAO). General managers is defined the number of general managers reporting directly to the CEO. General managers include COO, group managers and division managers. Span is the total number of positions reporting directly to the CEO (i.e., the sum of functional managers and general managers). Column 1, 2, 4, and 6 include firm fixed effects. All include year dummies. Column 1 uses ln(employment) as a firm size control. Column 2 runs a fixed effect Poisson regression. Column 3 includes CEO fixed effects. Column 4 includes an industry trend. Column 5 includes a linear firm trend. Column 6 includes a manufacturing dummy and PCs per employee interaction.

Table 4: Technology's Effect on Functional Centralization (Robustness Check)

	(1)	(2)	(3)	(4)	(5)	(6)
	Functional lnemp	Functional Poisson	Functional CEO FE	Functional Ind Trend	Functional Firm Trend	Functional Manuf
PCs per employee	0.510* (0.299)	0.223** (0.0918)	0.424* (0.225)	0.605** (0.303)	0.567* (0.317)	0.880** (0.398)
Ln(Assets)		-0.0938 (0.0604)	-0.260 (0.229)	-0.463** (0.214)	-0.352 (0.301)	-0.321 (0.197)
General Mgrs.	0.128*** (0.0324)	0.0340*** (0.00892)	0.0883** (0.0360)	0.127*** (0.0311)	0.0980** (0.0408)	0.128*** (0.0322)
Unrelated Diversif (entropy)	0.0148 (0.289)	-0.00276 (0.0972)	0.0812 (0.267)	0.205 (0.310)	0.00964 (0.370)	-0.00785 (0.304)
# of segments	-0.000834 (0.0543)	0.00189 (0.0169)	0.0606 (0.0498)	0.00153 (0.0558)	0.0159 (0.0640)	-0.00127 (0.0554)
CAO	0.353*** (0.117)	0.111*** (0.0359)	0.409*** (0.117)	0.367*** (0.117)	0.430*** (0.139)	0.349*** (0.118)
COO	-0.399*** (0.102)	-0.129*** (0.0329)	-0.329*** (0.110)	-0.398*** (0.105)	-0.353*** (0.125)	-0.401*** (0.102)
Ln(Employment)	-0.413* (0.217)					
Manufacturing*PCs per emp						-0.360 (0.546)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	-	Yes	-	Yes
CEO FE	-	-	Yes	-	-	-
Industry Trend	-	-	-	Yes	-	-
Firm Trend	-	-	-	-	Yes	-
Observations	2,329	2,315	2,323	2,329	2,329	2,329
R-squared	0.145		0.074	0.184	0.700	0.142
Number of firms	290	279		290		290
Number of CEOs			559			

Notes: ***, **, and * represent statistical significances at 1%, 5%, and 10% levels respectively. Standard errors are clustered by firm.

Table 5: Type of Functional Manager: Technology and Business Relatedness

	(1)	(2)	(3)	(4)	(5)	(6)
	Admin.	Admin.	Admin.	Product	Product	Product
	Functional	Functional	Functional	Functional	Functional	Functional
	Mgrs.	Mgrs.	Mgrs.	Mgrs.	Mgrs.	Mgrs.
Unrelated Diversif (entropy)	0.298 (0.264)			-0.307** (0.128)		
Vertical Relatedness		-1.176 (2.023)			0.852 (0.608)	
Complementarity			-0.103 (0.287)			0.222** (0.106)
PCs per employee	0.560** (0.234)	0.937* (0.541)	0.938* (0.541)	0.0899 (0.141)	-0.0189 (0.196)	-0.0235 (0.198)
Ln(Assets)	-0.213 (0.160)	-0.211 (0.240)	-0.223 (0.243)	-0.105 (0.0745)	-0.253** (0.100)	-0.237** (0.0983)
General Mgrs.	0.0948*** (0.0264)	0.0985*** (0.0342)	0.0998*** (0.0344)	0.0335** (0.0142)	0.0280* (0.0165)	0.0266 (0.0163)
# of segments	-0.0399 (0.0489)	-0.0307 (0.0498)	-0.0291 (0.0490)	0.0406** (0.0193)	0.0330 (0.0246)	0.0305 (0.0245)
CAO	-0.707*** (0.0960)	-0.671*** (0.128)	-0.667*** (0.128)	0.0579 (0.0531)	0.114* (0.0607)	0.114* (0.0599)
COO	-0.225*** (0.0846)	-0.189* (0.109)	-0.189* (0.109)	-0.172*** (0.0393)	-0.134*** (0.0449)	-0.134*** (0.0449)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,329	1,502	1,502	2,329	1,502	1,502
R-squared	0.176	0.159	0.159	0.062	0.095	0.100
Number of firms	290	213	213	290	213	213

Notes: ***, **, and * represent statistical significances at 1%, 5%, and 10% levels respectively. Standard errors are clustered by firm. Administrative functional managers include CFO, General Counsel, Human Resources, Public Relations, Planning, and Chief Information Officer. Product functional managers include heads of R&D, marketing, sales, sales & marketing, and manufacturing.

Table 6: Type of Functional Manager: Interaction between Technology and Business Relatedness

	(1)	(2)	(3)	(4)	(5)	(6)
	Admin.	Admin.	Admin.	Product	Product	Product
	Functional	Functional	Functional	Functional	Functional	Functional
	Mgrs.	Mgrs.	Mgrs.	Mgrs.	Mgrs.	Mgrs.
Unrelated Diversif (entropy)	0.265			-0.202		
	(0.300)			(0.134)		
PCs per employees*Unrelated Diversif	0.133			-0.426*		
	(0.704)			(0.227)		
Vertical Relatedness		1.203			-2.141	
		(2.839)			(1.394)	
PCs per employees*Vert Relatedness		-11.63			14.63**	
		(11.34)			(5.877)	
Complementarity			-0.398			0.0654
			(0.381)			(0.121)
PCs per employees*Complementarity			1.378			0.729*
			(1.391)			(0.429)
PCs per employee	0.529**	1.086*	0.317	0.189	-0.206	-0.352
	(0.234)	(0.580)	(1.010)	(0.162)	(0.207)	(0.272)
Ln(Assets)	-0.212	-0.215	-0.220	-0.106	-0.247**	-0.235**
	(0.161)	(0.239)	(0.241)	(0.0756)	(0.100)	(0.0978)
General Mgrs.	0.0947***	0.0979***	0.101***	0.0340**	0.0287*	0.0273*
	(0.0263)	(0.0343)	(0.0343)	(0.0142)	(0.0163)	(0.0162)
# of segments	-0.0386	-0.0340	-0.0262	0.0366*	0.0370	0.0321
	(0.0482)	(0.0502)	(0.0492)	(0.0192)	(0.0246)	(0.0243)
CAO	-0.707***	-0.667***	-0.669***	0.0596	0.108*	0.113*
	(0.0958)	(0.128)	(0.128)	(0.0526)	(0.0580)	(0.0595)
COO	-0.224***	-0.190*	-0.187*	-0.174***	-0.131***	-0.133***
	(0.0839)	(0.108)	(0.109)	(0.0392)	(0.0436)	(0.0448)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,329	1,502	1,502	2,329	1,502	1,502
R-squared	0.177	0.160	0.161	0.065	0.113	0.105
Number of firms	290	213	213	290	213	213

Notes: ***, **, and * represent statistical significances at 1%, 5%, and 10% levels respectively. Standard errors are clustered by firm. Columns 1, 4, 5, and 6 are for functional managers only (CFO, General Counsel, and Human Resources). Columns 2, 3, 7, and 8 are for general managers only (division managers). Administrative functional managers include CFO, General Counsel, Human Resources, Public Relations, Planning, and Chief Information Officer. Product functional managers include heads of R&D, marketing, sales, sales & marketing, and manufacturing.

Table 7: Reporting Relationship, Compensation, and Technology (Position Fixed Effects)

	<i>Functional Only</i>	<i>Functional Only</i>	<i>Functional Only</i>	<i>Gen Only</i>	<i>Gen Only</i>
	(1)	(2)	(3)	(4)	(5)
	Reports to CEO	Ln(Total Comp)	Ln(Total Comp)	Reports to CEO	Ln(Total Comp)
PCs per employee	0.160** (0.0658)	0.109* (0.0586)	0.0859 (0.0842)	-0.0168 (0.0697)	-0.0254 (0.0938)
Reports to CEO			0.137*** (0.0289)		
Reports to CEO * PCs per employ			0.000951 (0.0848)		
Unrelated Diversif (entropy)	0.146** (0.0582)	-0.0423 (0.0721)	-0.0623 (0.0722)	0.0900 (0.0652)	0.00631 (0.0591)
# of segments	-0.0119 (0.0102)	-0.00206 (0.0147)	-0.000424 (0.0147)	-0.00207 (0.00997)	-0.00393 (0.0135)
Ln(Sales)	-0.0825* (0.0451)	0.278*** (0.0389)	0.289*** (0.0380)	-0.124*** (0.0389)	0.181*** (0.0562)
Year Dummies	Yes	Yes	Yes	Yes	Yes
Position FE	Yes	Yes	Yes	Yes	Yes
Observations	5337	5337	5337	8959	8943
R-squared	0.041	0.576	0.585	0.040	0.513

Notes: ***, **, and * represent statistical significances at 1%, 5%, and 10% levels respectively. Standard errors are clustered by firm. Columns 1 through 3 are for functional managers only (CFO, General Counsel, and Human Resources). Columns 4 and 5 are for general managers only (division managers).

Appendix I—Description of positions

General Managers (“Line” Positions)

Chief Executive Officer (CEO). The highest executive authority in the corporation. Reports to the Board of Directors. May also be Chairman or President.

Group Chief Executive (Group Manager): The highest authority in the group. A group is the highest level of multiple profit centers linking the corporate CEO or COO directly to two or more single profit center units (divisions).

Division Chief Executive (Division Manager): The highest authority in the division. A division is the lowest level of profit center responsibility for a business unit that engineers, manufactures and sells its own products.

Chief Operating Officer (COO). The corporation’s second in command; provided the person’s span of responsibility is as broad or almost as broad as the Chief Executive’s, and provided he or she has line rather than staff or advisory responsibility. This person may be the President if the Chief Executive Officer is the Chairman of the Board.

Functional Managers (Corporate “Staff” Positions)

Administrative Functional Managers

Chief Financial Officer (CFO). Functional head responsible for all financial operations of the corporation. Has responsibility for both the treasury and accounting functions. Indicate whether responsibilities also include data processing, investor relations, internal audit, and tax.

General Counsel. The head of all legal affairs of the company. Responsible for, or may be, Corporate Secretary; supervises outside legal counsel.

Human Resources (CHRO). Head of all human resources with responsibility for establishing and implementing corporate-wide policies.

Chief Information Officer (CIO). The highest level of operating management over the combined functions of programming, data processing, machine operation, and systems work related to data processing.

Long-Range Planning & Business Development (Strategy). Functional head responsible for developing and obtaining agreement on overall corporate strategy to enhance sales and profits. Recommends the allocation of resources to existing businesses, acquisitions of new businesses, and disposition of existing businesses.

Public Relations (PR or Communications). Functional head responsible for the development and dissemination of favorable persuasive material in order to promote goodwill, develop credibility, and create a favorable public image for the company. (Excludes government relations.)

Chief Administrative Officer (CAO). Functional head responsible for the administration of two or more major, nonrelated corporate staff functions such as finance, human resources, law, purchasing, data processing, public relations, and long-range planning and business development.

Product Functional Managers

Sales & Marketing. The head of all sales and marketing. Responsible for the development of objectives, policies, and programs for marketing and selling activities of the corporation. This position may not necessarily have direct supervisory responsibility over line sales and marketing activities, but provides counsel, direction, and guidance in plans for marketing, market studies, market research, advertising, and sales training.

Sales. Functional head with responsibility for organization-wide planning, directing and managing all sales personnel. Responsible for sales service activities (where applicable) and customer service.

Marketing. Functional head of organization-wide marketing activities including customer and economic analysis, market testing and research, advertising, and sales promotion.

Research & Development. Responsible for applied research and development and design and development engineering for the entire corporation. Oversees and directs the research and development activities of the corporation leading to new or improved products or processes. Provides technical assistance and, when necessary, correlates research activities with other functions and operating units.

Manufacturing. The corporate head of manufacturing operations responsible for the machining, fabricating, assembling, and processing operations required in manufacturing and production. Generally responsible for manufacturing or process engineering, planning manpower and facilities requirements, production scheduling, and sometimes responsible for inventory controls, developing quality standards, and purchasing. This position should be a staff position at the corporate level with functional rather than line responsibility.

Appendix II: Variable Descriptions

Firm Variables

Variable	Description
Ln(Assets)	Natural log of firm assets.
# of segments	Number of business segments.
Functional Managers	Number of functional managers reporting to the CEO (including the CAO). Administrative functional managers include CFO, CIO, officers of law, human resources, public relations, and planning. Product Functional Managers include officers of R&D, marketing, sales, sales & marketing, and manufacturing.
General Managers	Number of general managers reporting to the CEO. Includes COO, group and division managers.
Span	Total number reporting to the CEO. Number of functional managers plus general managers.
Functional Managers / Span	Number of functional managers divided by total number reporting to CEO.
CAO	Dummy variable equals 1 if chief administrative officer reports to CEO
COO	Dummy variable equals 1 if chief operating officer reports to CEO
PCs per employee	Numbers of PCs per employee

Business Relatedness Variables

Variable	Description
Unrelated Diversification (Entropy)	Firm diversification measures. Suppose a firm has several segments operating in different 2-digit SICs. Unrelated diversification is the weighted average of all 2-digit SIC group share in sales, i.e. the summation of the share multiplied by the log of the inverse of the share. <i>Source: Palepu (1985), Compustat Segment.</i>
Relatedness Vertical Relatedness Complementarity	Firm relatedness measures. We calculate weighted averages of the vertical and complementarity measures, where the weight is the share in sales. We denote the primary segment as the segment with the most sales. Fan & Lang (2000) calculate interindustry relatedness coefficients using input-output commodity flow tables. We use coefficients based on 1992 tables. <i>Source: Fan & Lang (2000), Compustat Segment, Bureau of Economic Analysis: Benchmark Input-Output Account for the U.S. Economy</i>
Vertical Relatedness	Vertical relatedness is the dollar value of industry i's output required to produce 1 dollar's worth of industry j's output. Forward vertical relatedness is when i is the secondary segment and j is the primary segment. Backward vertical relatedness is the reverse. We use the simple average of the two.
Complementarity	Forward complementarity measures the overlap in markets to which a firm's various segments sells its products. Backward complementarity measures the overlap in markets for the input industries of the firm's segments. We use the simple average of FWcomp and BKcomp. To calculate complementarity, Fan & Lang (2000) compute the percentage of an industry's output supplied to each intermediate industry, denoted b_{ik} . For each pair of industries i and j, compute the simple correlation between b_{ik} and b_{jk} across all k except I and j.

Compensation Variables

Variable	Description
Total Compensation (CEO, functional managers, division manager)	Total compensation consists of base salary, bonus, and long-term incentives. <i>Source: Hewitt Associates</i>

Appendix III: Types of Functional Managers, Technology, and Diversification

	<i>Administrative Functional Managers</i>						<i>Product Functional Managers</i>					
	(1) Admin. Functional Mgrs. (All)	(2) General Counsel	(3) Human Resources	(4) Public Relations	(5) Chief Financial Officer	(6) Planning	(7) Chief Information Officer	(8) Product Functional Mgrs. (All)	(9) Research & Develop.	(10) Sales & Marketing	(11) Marketing Only	(12) Manufact.
PCs per employee	0.5598* (0.0173)	0.2045* (0.0381)	0.1291 (0.1032)	0.0924 (0.2924)	0.0784 (0.2686)	0.0411 (0.5697)	0.0143 (0.7637)	0.0899 (0.5256)	0.0375 (0.5880)	0.0296 (0.5823)	0.0189 (0.6346)	0.0000 (0.9996)
Unrelated Diversif (entropy)	0.2978 (0.2608)	-0.0057 (0.9445)	0.0583 (0.4610)	0.2255 (0.0619)	0.1149 (0.1336)	-0.0805 (0.2462)	-0.0147 (0.7530)	-0.3071* (0.0167)	-0.1123 (0.0680)	-0.0859 (0.0606)	-0.0653 (0.1316)	-0.0422 (0.3272)
General Mgrs.	0.0948*** (0.0004)	0.0172* (0.0475)	0.0156 (0.1072)	0.0038 (0.7276)	0.0189 (0.0569)	0.0288** (0.0065)	0.0105 (0.1028)	0.0335* (0.0189)	0.0131 (0.1047)	0.0011 (0.8331)	0.0170** (0.0023)	0.0031 (0.5494)
Ln(Assets)	-0.2128 (0.1853)	-0.0044 (0.9230)	-0.1238* (0.0230)	-0.0465 (0.4230)	-0.0168 (0.7322)	-0.0202 (0.6405)	-0.0011 (0.9743)	-0.1050 (0.1597)	-0.0372 (0.3984)	0.0086 (0.7244)	-0.0377 (0.1701)	-0.0404 (0.0980)
# of segments	-0.0399 (0.4157)	-0.0061 (0.6800)	0.0060 (0.6541)	-0.0457 (0.0532)	-0.0036 (0.7876)	0.0131 (0.2908)	-0.0036 (0.7422)	0.0406* (0.0369)	0.0218 (0.0712)	0.0106 (0.1290)	-0.0028 (0.7250)	0.0110 (0.0923)
CAO	-0.7068*** (0.0000)	-0.1925*** (0.0000)	-0.2647*** (0.0000)	-0.0700* (0.0407)	-0.1254** (0.0010)	-0.0117 (0.7247)	-0.0425** (0.0034)	0.0579 (0.2759)	0.0635* (0.0409)	-0.0309 (0.1501)	0.0038 (0.7383)	0.0204 (0.3086)
COO	-0.2247** (0.0083)	-0.0542 (0.0519)	-0.0627* (0.0289)	-0.0241 (0.4269)	-0.0383 (0.1990)	-0.0228 (0.4227)	-0.0226 (0.1538)	-0.1724*** (0.0000)	-0.0683** (0.0027)	-0.0637*** (0.0002)	0.0089 (0.3880)	-0.0431** (0.0021)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	2329	2329	2329	2329	2329	2329	2329	2329	2329	2329	2329	2329
R-squared	0.1765	0.0851	0.1329	0.0316	0.0728	0.0298	0.064	0.0622	0.0377	0.0263	0.0503	0.0239

Notes: ***, **, and * represent statistical significances at 1%, 5%, and 10% levels respectively. Standard errors are clustered by firm. Columns 1 through 6 are for Administrative functional managers only (CFO, General Counsel, Human Resources, Public Relations, Planning, and Chief Information Officer). Columns 7 through 12 are for Product Functional Managers (R&D, marketing, sales, sales & marketing, and manufacturing.)

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