Coordination and Organization Design: Theory and Micro-Evidence*

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Abstract

We explore the relationship between the volatility of a firm's local environment and its organizational structure. Using micro-level data on managers working for a large retailer, we empirically test and provide support for our theory that a more volatile local environment results in more decentralization only when the need for coordination among sub-units is low. In contrast, more local volatility is associated with more centralization when coordination needs are high. Our evidence supports the argument that centralized organizations are better at adapting to local shocks when coordination is important.

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1 Introduction

The use of authority is a central feature of the way firms coordinate the production and provision of goods and services (Coase 1937; Simon 1951; Williamson 1975). Of particular interest is the extent to which authority is delegated from the center to lower-level managers. The management literature is replete with examples of firms that underperformed competitors because they either failed to empower managers close to the facts or, instead, were too decentralized to realize important synergies (Roberts 2004; Garicano and Rayo 2016). In this paper, we explore how the unpredictability and volatility of a firm's local environment affect decentralization, and how this depends on the need for coordination.

Seminal economic theories on why firms delegate authority emphasize the need to adapt decisions to local information (Hayek 1945; Holmstrom 1977; Aghion and Tirole 1997; Dessein 2002). Indeed, lower-level managers often have better information than top managers as they are closer to the firm's field operations. However, what matters for organizational performance is not just independent adaptation to local shocks and emergent events, but also the ability to engage in what Williamson (2002) calls "coordinated adaptation." Despite having superior local knowledge, lower-level managers may only be able to act individually on this information. But doing so potentially results in large coordination losses for the organization (Bolton and Farrell 1990; Dessein and Santos 2006; Alonso, Dessein, and Matouschek 2008, 2015 (ADM henceforth)). Incentive conflicts may also play a role: lower-level managers tend to care mainly about the performance of their department or unit. The need for coordination then creates an agency problem in that managers adapt too much to local information (ADM 2008; Rantakari 2008).

In this paper, we provide a synthesis of the above theories and draw novel implications for organization design, which we then test using micro-level data on a large retailer. Our theoretical model predicts that a more volatile local environment results in more decentralization only when the need for coordination across sub-units is low. In contrast and a novel prediction, we expect to see a positive association between local volatility and centralization when coordination needs are high.[1] In addition, our model

[1] As far as we are aware, we are the first to formally put forward this hypothesis.

makes a conceptual distinction between asymmetric information about a local environment (i.e., how difficult it is for the center to learn about local shocks) and the volatility of this local environment (i.e., the variance of these local shocks). Whereas an increase in asymmetric information unambiguously results in more delegation, the impact of an increase in local volatility depends on the need for coordination.

To test our theory, we analyze a novel hand-collected data set that contains rich micro-level information on the authority of lower-level managers employed by one of the largest retail operators in the world. Our data pertains to twelve large general merchandise stores ("stores" hereafter) located within a metropolitan area of Tokyo.[2] Each of our 189 managers is uniquely responsible for one of 23 departments within one of these twelve stores. Examples of departments include kids apparel, clothing and accessories, cosmetics, home furnishing, groceries, and fish. Each store is managed by a general manager ("store manager") to whom the department managers report. While each of the 23 departments covers a distinct product or service, they involve frequent coordination with other departments on various managerial tasks, for instance, sales, pricing, marketing, merchandise, and customer service. As a proxy for the need for coordination, we have survey data, for each department manager, on how important coordination with different departments and functional managers is to successfully perform her job *as a whole*. Based on further information on how much coordination is needed for each managerial task that makes up the job, we can classify an *individual task* as either coordination-intensive or less coordination-intensive.

Our study is the first to provide empirical evidence on the relation between local volatility and the authority of lower-level managers. We equate local volatility with the unpredictability of local demand, sales, or profits faced by an individual manager. First, we have survey data, for each department manager, on the volatility of local demand and its impact on her overall job in terms of sales and profits. Secondly, we construct alternative, objective measures of sales volatility by taking advantage of departmental transaction data. Our preferred objective measure uses the (average absolute) difference between actual monthly sales and planned monthly sales (or sales goals). This neatly captures the unpredictability of local sales. As a robustness check, we further use a measure that only relies on actual sales variations (i.e., month-to-month sales changes).

[2]We provide a detailed description of these general merchandise stores in section 4.

To measure managerial authority, we collected survey data on the job scope of each department manager in terms of the number of tasks delegated to her. Concretely, the company provided us with fifteen tasks in which a manager's job may be involved. Examples of tasks include sales, merchandise, e-commerce, pricing, training, and so on. The job scope of a manager, however, typically only includes a subset of the fifteen possible tasks. For example, a manager may not have any responsibility for e-commerce or training. We view the job scope of a manager as a central measure of a manager's authority as it is both a relatively objective measure and a clear indication of a manager's responsibility. When a task is part of a manager's job, she may still need to involve her superior manager in decision-making. But a task not being part of a manager's job scope is the ultimate sign of a lack of authority. Other empirical papers that use job design and task allocation as a measure of delegation include Bloom, Sadun, and Van Reenen (2012), who survey manufacturing managers to see if they have responsibilities for marketing and sales decisions.[3]

Our empirical context is appealing to test our theory for two major reasons. First, all the twelve stores are located within proximity (all contained in a 25-mile radius circle) and under the administration of the same regional headquarters in Tokyo, Japan. As such, the same unobserved heterogeneity in macroeconomic, technological, or cultural factors would affect, if at all, managerial authority. Moreover, uniform policies on management, personnel, and compensation structure eliminate variations at the corporate level, which in turn increases the reliability of our analysis relative to a multi-corporation study. Second, our usage of individual-level data sheds more light on the exact mechanisms that drive managerial authority. This distinguishes our study from previous empirical work that has used establishment or firm-level data in a cross-section of industries (Colombo and Delmastro 2004; Acemoglu et al. 2007; Bloom et al. 2012; Bloom et al. 2014; Lo et al. 2016). Our approach is similar, however, to many influential studies on the provision of incentives in firms, which often focus on data from one establishment.[4] Similarly, recent empirical work on vertical integration decisions has tended

[3]Among theory papers, see Dessein, Garicano, and Gertner (2010) for a model that explicitly analyzes which functions should be centralized at headquarters, and which ones should be decentralized at the division level.

[4]See, for example, Baker, Gibbs, and Holmstrom (1994) and Lazear (2000). For recent "within-firm" studies, see Larkin (2014), Friebel et al. (2017), Frederiksen, Kahn, and Lange (2020), and Hoffman and

to focus on a single industry (e.g., Baker and Hubbard 2003, 2004; Gil 2009; Forbes and Lederman 2009).

Our empirical results support the argument that centralized organizations are better at adapting to local shocks when coordination is important. As predicted by our theory, we find that local volatility has a large positive effect on delegation when the need for coordination is moderate, but a negative effect when the need for coordination is high. On average, local volatility has no significant correlation with managerial authority.[5] In all our regressions, the negative interaction effect between local volatility and the need for coordination on managerial authority is highly significant. Our analysis controls for store fixed effects, experience, education, age, gender, and relevant personality traits of managers.

While our main measure for managerial authority is the overall job scope of a manager – namely overall task delegation, we also glean insights in the mechanism behind our results by dissecting the fifteen tasks in two categories, based on how much coordination they require with other departments in the same store. Concretely, we identified five tasks – including marketing, customer service, and e-commerce – that require much more coordination than average, as reported by the department managers. We refer to those as functional tasks, and the remainder – for instance, sales, pricing, personnel management – as departmental tasks. We obtain two results. First, consistent with existing theories (ADM 2008; Dessein, Garicano, and Gertner 2010), these five functional tasks are, on average, more likely to be centralized than the ten departmental tasks. Second, when coordination is important for the whole job, we only find a negative effect of local volatility on delegation for these five functional tasks. Intuitively, it is only for those tasks that coordinated adaptation is important. Similarly, if one excludes these functional tasks from the data, the negative interaction effect between local volatility and the need for coordination (at the job-level) becomes non-significant.[6]

We also perform a couple of robustness checks. First, we find similar qualitative results when we use department fixed effects, even though some departments (e.g. deli)

Tadelis (2020). Ichniowski and Shaw (2013) refer to this type of work as "insider econometrics."

[5]Depending on the measure of local volatility, the correlation with task delegation is either weakly (non-significant) positive or weakly (non-significant) negative.

[6]See Section 4 for a detailed description of – and the difference between – the need for coordination at the job-level and the task-level.

receive significantly more task delegation than others. Second, to control for sorting of workers into jobs, we include personality traits in our regressions such as "agreeableness," "risk-loving," and "career aspiration." Again, our results are robust though managers with a high "agreeableness" may sort into jobs that are more coordination intensive, whereas "'risk-loving" managers tend to match with jobs facing more local volatility. Managers with a higher score for "career aspiration" may ask for – and receive – more delegation of authority. Finally, we show how an alternative explanation for our results, based on managerial time-constraints which may be more binding when local volatility is high, does not seem to be supported by the data.

To conclude our analysis, we test a final prediction of our theory. Keeping the volatility of local shocks fixed, a decrease in the center's ability to learn about a local shock, should always result in more delegation, even when the need for coordination is high. To test this hypothesis, we construct a proxy, namely experience difference, for how difficult it is for the center to ascertain local shocks. It is reasonable that a superior manager who is relatively inexperienced to a department manager will be less capable to understand and assess local shocks. Consistent with the prediction of our theory, we find a significant positive effect of experience difference on delegation, and only a small, non-significant interaction effect with the need for coordination.

Related literature. The theory put forward in our paper is closest to those in ADM (2008, 2015), both of which study coordination and adaptation in multi-divisional organizations. Our theory differs from ADM (2008) in that a centralized organizational structure can sometimes be better at adapting to local circumstances than a decentralized one, despite the fact that lower-level managers are better informed about their own local circumstances. Intuitively, in our model, the headquarter manager is endowed with independent information about each local shock. While this information is inferior to that of lower-level managers, headquarters' superior coordination capability allows her to be more adaptive to this information (than a lower-level manager) when coordination is important. The latter effect is largely absent in ADM (2008) as the headquarters manager relies entirely on cheap talk communication from lower-level managers to learn about local shocks. As coordination becomes more important, the informativeness of such cheap talk communication deteriorates, hampering headquarters' ability to engage in coordinated adaptation. The above insight that a centralized firm can be more adaptive than a decentralized one is also present in ADM (2015). Their model, however, abstracts from any efficiency differences between centralization and decentralization beyond coordination and adaptation. As a result, local volatility only affects the magnitude of the advantage of one structure over the other, not the trade-off between structures.

Despite being central to firms' operations, empirical evidence on the responsibilities and decision-making authority of managers is limited and has lagged our understanding of other organizational choices, such as firm boundaries and the provision of incentives in firms. The few empirical studies on the determinants of delegation often focus on measures of local information.[7] In one early study, Baiman and Rajan (1995) show that managers whose business unit is in a different 2-digit SIC code as their parent are delegated more authority. Acemoglu et al. (2007) find that firms closer to the productivity frontier or firms that are operating in more heterogeneous industries are more likely to be decentralized. Recently, Huang et al. (2017) show how state-owned-enterprises in China are more likely to be decentralized when the distance to the government is farther. The proxies for local information used in the above studies mainly measure the information disadvantage of central management – that is how difficult it is for headquarters to be informed about local circumstances. For example, Acemoglu et al. argue that a firm should become more centralized as there is more publicly available information. In contrast, our measures of local volatility capture the unpredictability and variations of the local environment itself. A contribution of our paper is thus to show how an increase in local volatility may have very different consequences for organization design compared to an increase in asymmetric information. Closer to our notion of local volatility, Aghion et al. (2017) look at the impact of environmental turbulence on organizational performance.[8] They provide evidence that firms that delegated more power to local plant managers prior to the Great Recession outperformed their centralized counterparts in sectors that were hardest hit by the subsequent crisis. Coordination plays

[7]Several studies provide indirect tests of the impact of local information, for example by examining the impact of product market competition (Bloom, Sadun, and Van Reenen 2010; Meagher and Wait 2013), information and communication technology (Colombo and Delmastro 2004; Guadalupe, Li, and Wulf 2013; Bloom et al. 2014), or the experience of salespeople (Lo et al. 2016). Others have studied the role of firm and plant size (Colombo and Delmastro 2004; McElheran 2014) and cultural aspects such as trust (Bloom, et al. 2012).

[8]In their theoretical model, turbulence simply reduces the ability of the center to learn about the action taken by the plant manager. It is therefore equivalent to an increase in asymmetric information.

no role in their analysis. More generally, while the trade-off between adaptation and coordination plays a central role in recent theories of organizational design, few papers study the role of coordination. One exception is McElheran (2014) which studies the delegation of decision rights over IT investments across establishments and firms. Whereas she observes more delegation in establishments that contribute more to firm sales, she finds less delegation in establishments whose production is more integrated with the rest of the firm. In contrast to our paper, all of the above research uses firm-level or establishment-level data in a cross-section of industries, typically manufacturing firms.

2 Institutional Context

This section provides background and institutional information on the retailer who provides us data and describes the key features of its managerial practices in our sample stores.

2.1 The company and stores

Japan's retail market generated over US$1.3 trillion in sales in 2017 and is among the largest in the world. The focal company that provided our access to data is a major retailer that operates a large portfolio of various retail formats such as shopping malls and convenience stores throughout the country. Our sample covers all of the twelve general merchandise stores ("stores") in a designated sales region in the metropolitan area of Tokyo. North American Industry Classification System (NAICS: code number 452) defines general merchandise stores as "establishments in this subsector are unique in that they have the equipment and staff capable of retailing a large variety of goods from a single location." Target, Walmart, Marks and Spencer, and Tesco are examples of companies that operate similar stores outside of Japan. Two of our sampled stores are located inside shopping malls while the other ten are standalones. The average floor space of the twelve stores is over 20,000m^2, with a typical store employing about 480 employees and catering to over 11,000 daily shoppers. Annual sales per square footage in these stores in 2017 is US$340, which is slightly higher than the average for retailers in the United States (US$325). All twelve stores report to the same regional headquarters.

2.2 Store managers and department managers

A store manager who directly reports to the regional headquarters is the head of a store. A given store may operate all or a subset of the following 23 departments (or functions): kids apparel, womenswear, clothing and accessories, underwear, menswear, home furnishing, cosmetics, grocery, liquor, daily food, deli, produce, processed meat and poultry, fish, home appliances, pharmacy, online business, sales operation, cashier, customer service, information technology (IT), partners, and shop-in-shop.[9] Each department has one, and only one, manager ("department manager") who formally reports to the store manager, and who manages the department's staff and daily business. Figure 1 shows the organizational structure of the sampled region and its stores.[10] Our survey and company-supplied data cover 189 department managers, who are of the same rank, working in one of the twelve stores. However, missing entries reduce our usable sample size to 168. In our empirical analysis, a department manager is the focal unit of analysis.

<Insert Figure 1 and Table 1 about here>

2.3 Adaptation and Managerial Discretion

Whereas a department manager's job may be involved in fifteen tasks (Figure 1), the typical job scope only includes a subset of those possible tasks. For example, a manager may not have any responsibility for e-commerce or training. Departmental managers can make decisions, provide key inputs to, or co-decide with their store managers on those tasks. Examples include, but do not limit to: pricing (e.g., discounts and promotional prices), ordering (e.g., timing and quantity), merchandising (e.g., inventory replenishment and product category development), floor layout (within department's floor), and point-of-sale (POS) location (e.g., banners and stands within department's floor). These decisions may be adjusted on an ongoing basis, depending on the changing nature of market demand (e.g., increased shopping from tourists and foreigners in

[9] One store has a Fast Moving Consumer Goods (FMCG) department. This department plays no role in our regression analysis because of missing data.

[10] Figure 1 also includes the list of 15 managerial tasks. We describe the tasks in Section 4.

Tokyo; surged demand of certain products during earthquakes, hurricanes, or erratic temperature) and competition (e.g., new forms of retailing such as online and delivery). In other words, many tasks need department managers' discretion or provide important inputs to the store manager to foster decision-making. Since the scope and depth of retail activities typically depends on the level of demand, adaptation to local shocks is required for virtually all tasks.[11]

2.4 Cross-departmental coordination

Coordination among departments is an important part of store operations. Each month the store manager and all department managers hold several meetings together to devise a master sales plan. The monthly master plan defines targets and activities in terms of major store operations such as targeted customers, sales and marketing activities, merchandise, and inter-departmental coordination. Managers also participate in weekly (e.g., Sunday evening) and daily morning meetings in which the store manager and/or department managers review progress with respect to goals set in the monthly master plan, in addition to sharing information on and discussing how to cope with local competitors' activities, seasonal changes, and customer and product trends.[12] One of the main topics in a weekly and daily meeting is how to allocate tasks and coordinate store operations. Appendix (section 8.1) provides a more detailed descriptions of these meetings. In addition, headquarters may also make top-down, impromptu requests on stores to organize promotional events to attract traffic. For instance, a store may have to organize a "World's Fair" event on short notice when an important foreign ambassador is to visit the store.[13] To take advantage of a potential increase in store traffic, the store also has to keep track of large sports events and concerts if they are held in its proxim-

[11] For example, when there is high demand, there will be (i) more frequent and deeper cleaning since foot traffic is higher and out-of-area shoppers have often lesser hygiene practice, (ii) more frequent handling of foreign currencies and sales-tax rebates, (iii) higher level and replenishment rates for inventory, (iv) larger shelves with different shop floor arrangement, (v) more frequent changes of banners and promotional materials, and (vi) a different (or more) assortment of food and grocery items.

[12] For instance, the tremendous increase in Asian tourists affects some stores or departments more than others. The store manager would share overviewing information obtained from the regional headquarters while department managers would infuse their anecdotal observations from daily interactions with customers and local competition's promotional activities.

[13] Incidentally, the French ambassador to Japan visited a store during a French Product Promotion event merely a few days before our onsite interview.

ity. In both routine and ad hoc meetings, under the leadership of the store manager (and his deputies), department managers have to synchronize merchandising (e.g., inventory and timing of product arrival), decoration (e.g. signs, banners, and floor layout), pricing and bundling (e.g., coupons and discounts), staffing (e.g., overtime arrangements and part-time employees), and marketing materials (e.g., content of advertisement and pamphlets). The importance of such coordination is particularly conspicuous among department managers whose tasks and products may cause externalities to one another (e.g., between womenswear and kids apparel; between produce and daily food). Department managers may also work and agree on standards and possible variations on customer services, training, hygiene, and resolve conflicts and buyer complaints.

Besides group meetings, we observed that department managers often exchange ideas and information and make small decisions in the office, hallways, or on the shop floors. All these managerial practices are consistent with an emphasis on both rank-hierarchy and peer coordination in the literature of Japanese corporate governance (e.g., Jackson and Miyajima 2007, pp.5-6). Indeed, close coordination among peers of the same rank is a distinct characteristic of Japanese companies (Aoki 1986).

2.5 Performance evaluation and compensation

Similar to employment practices of most large Japanese corporations, the company's compensation scheme is based on qualification, ability, and performance as its major components (Jackson 2007, p.293). On the one hand, the majority of the compensation received by department managers is a fixed salary that is commensurate with their industry and company work experience, qualifications, and positions. Performance pay, on the other hand, is made up of three components: (i) a summer bonus, (ii) a winter bonus, and (iii) an achievement bonus. The first two seasonal bonuses sum up to a maximum of four months of the base salary while the achievement bonus can equal one month's worth of base salary. The amount of performance pay is partly based on the achievement of "numerical" targets (i.e., sales revenue and gross profit) and partly based on "behavioral" aspects that relate to corporate and store missions (e.g., merchandise development) and special priority areas (e.g., cross-merchandise selling, food waste rate, price discount depth). In conjunction with a senior manager in the store or a panel of senior managers, and based on company evaluation guidelines, the store manager formally evaluates and decides on the performance pay for each department manager. Importantly, the level of fixed salary and the evaluation and structure of performance pay are identical across departments and across stores. Hence, the uniform compensation structure and performance evaluation process provides an ex-ante incentive scheme that is not variant among department managers (Lo, Ghosh, and Lafontaine 2011).

3 A Model of Coordinated Adaptation

We propose a theory of the trade-off between centralization and decentralization, adapted to our context. Our model synthesizes existing theories but also draws a number of novel implications which will guide our empirical analysis.

Consider an organization which consists of n departments $i \in \mathcal{I} = \{1, ..., n\}$, each operated by a department manager $i \in \mathcal{I}$. In addition, there is also a headquarters, operated by a general manager. Each department i must carry out a set of tasks i_k with $k \in \mathcal{K}$. The main organizational choice is whether to centralize task i_k at headquarters, or to delegate task i_k to department manager i.

In our empirical analysis, the organization corresponds to a particular store, i corresponds to a particular department (for example "home furnishing" or "clothing and accessories"), and k corresponds to a particular task (for example "marketing" or "merchandise").

Following Dessein and Santos (2006, DS henceforth) and ADM (2008), each task i_k must be responsive to a department-specific shock but also be coordinated with task j_k of department $j \in \mathcal{I}_{-i}$. To simplify notation, we will drop the subscript k, and present the model as if there was only one task per department. The extension to multiple tasks per department is immediate.

Formally, each task $i \in \mathcal{I}$, requires taking a primary action a_i. This action must be adapted to a local shock θ_i, which is a random variable θ_i with mean μ_i and variance σ_i^2. Department manager i perfectly observes θ_i. Whenever there is imperfect adaptation, that is $a_i \neq \theta_i$, department i suffers adaptation losses $-(a_i - \theta_i)^2$. In addition, each task j with $j \in \mathcal{I}_{-i}$ must take a coordinating action c_{ji}. Whenever $c_{ji} \neq a_i$, the organization incurs a coordination loss $-\beta_{ji}(a_i - c_{ji})^2$. Given the above discussion, pay-offs of the organization are given by

$$\pi_g = \sum_{i \in \mathcal{I}} \left\{ h(\theta_i) - (a_i - \theta_i)^2 - \sum_{j \in \mathcal{I}_{-i}} \beta_{ji}(a_i - c_{ji})^2 \right\} \tag{1}$$

In the above pay-off structure, which follows DS, any coordination friction between task i and j is necessarily informational. Indeed, under complete information, the organization can achieve both perfect adaptation and coordination. The manager in charge of task j, however, may be unaware of what is the primary action taken in task i, and therefore fail to take the appropriate coordinating action c_{ji}.

An alternative to pay-off structure (1) is to posit that coordination losses are given by $-\beta_{ji}(a_i - a_j)^2$ as in ADM (2008). In the latter formulation, there is a mechanical trade-off between adaptation and coordination, in addition to an informational one. Indeed, it is then typically impossible for task i and j to be both adapted and coordinated, even under complete information. Our model follows DS as the resulting analysis is cleaner and more tractable, especially when there are more than 2 departments. The intuition and mechanism underlying our results, however, do not depend on one particular pay-off specification.[14]

We follow ADM (2008) in assuming an incentive conflict between department managers and the general manager. In particular, we posit that manager i only cares about the performance of his own department, given by

$$\pi_i = h(\theta_i) - (a_i - \theta_i)^2 - \lambda \sum_{j \in \mathcal{I}_{-i}} \beta_{ji}(a_i - c_{ji})^2 - (1 - \lambda) \sum_{j \in \mathcal{I}_{-i}} \beta_{ij}(a_j - c_{ij})^2 \tag{2}$$

where $\lambda \in \left[\frac{1}{2}, 1\right]$ is the fraction of coordination losses caused by action a_i which are internalized by department manager i.[15] In contrast, the general manager cares about the performance of all divisions, $\pi_g = \sum_{i \in \mathcal{I}} \pi_i$. It follows that whenever $\lambda < 1$, the department manager is too eager to adapt to the local shock θ_i. Note that our model

[14]In their analysis, DS show that qualitatively similar results hold when $c_{ji} = a_j$ (the primary action is also the coordinating action) though algebraic expressions are substantially more complex. In ADM (2008), $i \in \{1, 2\}$, which simplifies the analysis.

[15]In ADM (2008), it is assumed that $\lambda \geq 1/2$. In DS, it is assumed that $\lambda = 1$.

allows for the special case where $\lambda = 1$ and preferences between department manager and general manager are fully aligned.[16]

3.1 Information, Coordination, and Relative Efficiency

The main organizational design decision is whether or not to centralize task i at headquarters, or delegate task i to the department manager. While the department manager has better information about local shocks, centralizing allows for better coordination.

3.1.1 Information

Task i must be adapted to local shock θ_i. Under *task delegation*, only the department manager observes θ_i. Under *task centralization*, the general manager learns θ_i with probability q_i. The assumption that lower-level managers have better local information is standard in the literature (e.g., Jensen and Meckling 1995; Aghion and Tirole 1997; Dessein 2002).

3.1.2 Coordination

Task i and $j \neq i$ must be coordinated, which requires that department manager j chooses an action c_{ji} as close as possible to a_i. Action a_i in turn is either chosen by the department manager i (task delegation) or by the general manager (task centralization).

As long as $E(\theta_i) = \mu_i$ is common knowledge across the organization, the department or general manager can always avoid coordination losses by setting $a_i = \mu_i$. No communication is then needed to achieve coordination. Intuitively, in the absence of any communication, department manager j optimally chooses $c_{ji} = \mu_i$ and perfect coordination is achieved. The general manager or the department manager i, however, may want to adapt a_i to the local shock θ_i in which case effective communication about a_i is required in order to achieve coordination. When a_i is chosen by department manager i, we assume that such ex post coordination is successful with probability $p_D < 1$ and fails

[16]Departmental preferences are consistent with the institutional settings of our empirical analysis, where performance evaluations of department managers are directly tied to the performance of their department. They can further be endogenized along the lines of Dessein, Garicano, and Gertner (2010), Friebel and Raith (2010), or still Rantakari (2013), at the expense of a more complex and cumbersome model.

with complementary probability $1 - p_D$.[17] In contrast, when a_i is chosen by the general manager, we assume that ex post coordination is successful with probability $p_C = 1$.

The assumption of perfect coordination under centralization is made for simplicity. What matters for our results is that vertical coordination is more effective than horizontal coordination, that is $p_C > p_D$. Intuitively, while the general manager lacks local knowledge, she has general firm-wide knowledge and a better understanding of how to coordinate departments. As such, she understands better - or can communicate better - what action c_{ji} department j must undertake to achieve coordination with department i. For our purposes, it is not important whether the general manager centralizes c_{ji} or can perfectly communicate to department j the desired choice of c_{ji}. Our assumption that $p_C > p_D$ is similar to that in ADM (2008, 2015).[18] In the latter models, however, a task is either centralized across all divisions or decentralized to all division.[19] Under centralization, there is then no need for communication to achieve coordination.

3.1.3 Efficiency

Finally, we assume that carrying out a task involves a cost r_i^D when carried out by the department manager and a cost r_i^C when carried out by headquarters. Thus,

$$R_i = r_i^C - r_i^D$$

is the relative efficiency of centralizing or decentralizing a task, ignoring any adaptation and coordination benefits. We allow both for $r_i^C > r_i^D$ and $r_i^C < r_i^D$. Whenever R_i is negative, it is "cheaper" for a task to be carried out at headquarters than at the departmen-

[17]One possible interpretation is that p_D is a measure of communication quality – that is the ability of agent i to communicate effectively his non-standard action to agent j. In ADM (2008), the quality of coordination also depends on the ability to communicate, but communication breakdowns stem from communication being strategic and noisy, as in Crawford and Sobel (1982).

[18]Also in Aoki (1986), central management is assumed to have a superior coordination ability. Comparing centralized to decentralized decision-making structures, Aoki posits that the ability of sub-units to cope with emergent events and make use of their on-the-spot knowledge is "limited by their partial understanding of the whole mechanism operating within the firm" (p.973). Central management, on the other hand, has "perfect a priori knowledge of technological possibilities" but incomplete knowledge of "emergent events affecting these technologies".

[19]Consistent with our data, our model allows for a task to be centralized for some departments and decentralized for others.

tal level. This may correspond, for example, to situations where headquarters is more skilled in a task or enjoys economies of scale or scope (e.g. in training, e-commerce, IT infrastructure). In contrast, whenever R_i is positive, a task is more efficiently executed by the department manager (ignoring any informational or coordination benefits), for example, because this manager caries out many other departmental tasks as well. In order to derive comparative statics on the probability of delegation, we assume that R_i is a uniformly distributed random variable whose value is realized prior to the organization design decision, and who has support on $[R_i^-, R_i^+]$ with $R_i^- < 0 < R_i^+$.

3.2 Organization Design

We summarize the timing of our model as follows:

(1) The relative efficiency of delegating task i, $R_i = r_i^C - r_i^D$, is realized.

(2) **Organization Design**: The general manager decides whether to centralize task i or to delegate task i to department manager i.

(3) Local information θ_i is realized and observed by manager i. If task i is centralized, the general manager learns θ_i with probability q_i.

(4) **Action Choice** a_i and realization of adaptation losses $-(a_i - \theta_i)^2$.

(5) **Coordination**. If task i is centralized, $c_{ji} = a_i$ (coordination is perfect). If task i is delegated to manager i, manager j learns a_i with probability $p_D < 1$ in which case she sets $c_{ji} = a_i$. With probability $1 - p_D$, communication fails and manager j sets $c_{ji} = E(a_i)$.

Assume first that task i is delegated to manager i. For a given realization of θ_i and action a_i, expected payoffs to manager i equal

$$E(\pi_i|a_i, \theta_i) = h(\theta_i) - (a_i - \theta_i)^2 - \lambda \sum\nolimits_j \beta_{ji} E((a_i - c_{ji})^2) - (1 - \lambda)T.$$

In the above expression, T is a term that is independent of a_i. With probability p_D, ex post coordination succeeds and manager j sets $c_{ji} = a_i$. With probability $1 - p_D$, ex post coordination fails, and manager j sets $c_{ij} = E(\theta_i) = \mu_i$. We will later verify that, in equilibrium, $E(a_i) = \mu_i$ so that $c_{ij} = \mu_i$ is indeed the optimal choice for manager j whenever coordination fails.

It follows that

$$\begin{aligned} E(\pi_i|a_i,\theta_i) &= h(\theta_i) - (a_i-\theta_i)^2 - \lambda \sum\nolimits_j (1-p_D)\beta_{ji}(a_i-\mu_i)^2 - (1-\lambda)T \\ &= h(\theta_i) - (a_i-\theta_i)^2 - \lambda(1-p_D)\beta_i(a_i-\mu_i)^2 - (1-\lambda)T \end{aligned}$$

where $\beta_i \equiv \sum_j \beta_{ji}$. Therefore, maximizing her payoffs, division manager i sets

$$a_i = a_i^D \equiv \mu_i + \left(\frac{1}{1+\lambda\beta_i(1-p_D)}\right)(\theta_i - \mu_i).$$

It follows that under delegation, expected *coordination losses* to the whole organization are given by

$$CL_D = (1-p_D)\beta_i(a_i^D-\mu_i)^2 = (1-p_D)\beta_i\left(\frac{1}{1+\lambda\beta(1-p_D)}\right)^2\sigma_i^2.$$

A fraction λ of those are internalized by department manager i. Expected *adaptation losses* under delegation are given by

$$AL_D = E((a_i^D-\theta_i)^2) = \left(\frac{\lambda\beta_i(1-p_D)}{1+\lambda\beta_i(1-p_D)}\right)^2\sigma_i^2.$$

Consider next the case where task i is centralized. The general manager then chooses $a_i = \theta_i$ if informed and $a_i = \mu_i$ if uninformed. Since the general manager is informed with probability q_i, expected adaptation losses under centralization equal

$$AL_C = (1-q_i)\sigma_i^2.$$

There are no coordination losses, as the general manager can perfectly communicate a_i to manager $j : CL_C = 0$. We summarize the payoffs under centralization and decentralization as follows:

Lemma 1 If task i is delegated, organizational payoffs related to task i equal

$$h(\theta_i) - AL_D - CL_D - r_i^D. \tag{3}$$

If task i is centralized, organizational payoffs related to task i equal

$$h(\theta_i) - AL_C - r_i^C. \tag{4}$$

We are now ready to endogenize the optimal organization design. From (3) and (4), task delegation is optimal if and only if

$$R_i \geq \overline{R}_i \equiv AL_D + CL_D - AL_C \tag{5}$$

where $R_i = r_i^C - r_i^D$ is the relative efficiency of delegation. Denoting by $G(.)$ the distribution of R_i, the probability of delegation to manager i is then given by

$$P_i = 1 - G(\overline{R}_i). \tag{6}$$

Note first that the adaptation and coordination losses, AL_D, AL_C, and CL_D, are all linearly increasing in the volatility of the local environment σ_i^2. Second, adaptation and coordination losses under delegation, $AL_D + CL_D$, are increasing in the need for coordination β_i and the manager's incentive conflict $(1 - \lambda)$. In contrast, under centralization, adaptation losses AL_C are only a function of the general manager's information q_i. When coordination needs β_i are small, we therefore have that

$$AL_D + CL_D < AL_C$$

so that the department manager is better at coordinated adaptation. Intuitively, when the need for coordination is limited, the department manager is very effective at responding to local shocks whereas headquarters only observes those shocks imperfectly. As a result, an increase in volatility of local shocks σ_i^2 then favors delegation.

As the need for coordination becomes more important, however, the department manager becomes much less effective at adapting to local shocks, as doing so increasingly creates coordination failures under decentralized decision-making. For large enough coordination needs, the center is then better at coordinated adaptation, that is

$$AL_D + CL_D > AL_C.$$

As a result an increase in local volatility σ_i^2 then favors centralization.

The following proposition summarizes the main testable predictions of our model. The first part discusses the interaction between local volatility and the need for coordination. This interaction effect is novel in the literature on organization design. The second part summarizes the familiar comparative statics with respect to asymmetric information and incentive conflicts. The proof is provided in Appendix (section 8.2).

Proposition 1. *Let P_i be the probability of delegating task i to manager i.*

1. *There exists a threshold $\overline{\beta}_i > 0$ for the need for coordination β_i such that more local volatility increases delegation for $\beta_i < \overline{\beta}_i$ but increases centralization for $\beta_i > \overline{\beta}_i$:*

$$\begin{aligned} \frac{\partial P_i}{\partial \sigma_i^2} &\geq 0 \textit{ if } \beta_i < \overline{\beta}_i \\ \frac{\partial P_i}{\partial \sigma_i^2} &\leq 0 \textit{ if } \beta_i > \overline{\beta}_i \end{aligned}$$

   where the inequalities are strict whenever $P_i \in (0,1)$. Moreover, an increase in the need for coordination β_i has both a direct negative impact on delegation and a negative interaction effect with local volatility:

$$\frac{\partial P_i}{\partial \beta_i} < 0 \textit{ and } \frac{\partial P_i}{\partial \beta_i \partial \sigma_i^2} < 0.$$

2. *Delegation increases when headquarters is less informed ($1 - q_i$ is larger) but is decreasing in the incentive conflict, $1 - \lambda$, between headquarters and the department manager:*

$$\frac{\partial P_i}{\partial (1 - q_i)} \geq 0; \quad \frac{\partial P_i}{\partial (1 - \lambda)} \leq 0.$$

Part 1 of Proposition 1 states our main hypothesis: local volatility makes task delegation more likely when the need for coordination is low, but less likely when the need for coordination is high. This comparative static result with respect to local volalitily is novel and not present in ADM (2008, 2015).[20]

[20] See page 5 for a summary of what distinguishes our theory from ADM (2008, 2015). Rantakari (2013) also studies the impact of environmental volatility on organization design in a model similar to ADM (2008). In his model, the need for coordination is a choice variable and firms optimally choose to be more loosely integrated in more volatile environments. As a result, he finds that firms operating in more volatile environments tend to be more decentralized.

Part 2 of Proposition 1 makes a distinction between the impact of asymmetric information about the local environment (the parameter $1 - q_i$ which captures how difficult it is for the center to learn about local shocks) and the volatility of the local environment (i.e. the variance σ_i^2 of these local shocks). Whereas an increase in asymmetric information $(1 - q_i)$ unambiguously results in more delegation, the impact of an increase in local volatility σ_i^2 depends on the need for coordination. The differential impact of local volatility and asymmetric information on task delegation is reminiscent of the conceptual distinction between risk and asymmetric information and their impact on incentive pay (Prendergast 2002, Raith 2008).

At our retailer, company executives agreed about the importance of coordination and delegation in managing their organization, and they viewed local volatility as a major challenge to their retail business since retailing is an everyday business. Consistent with our model, they noted that in order to adapt to local volatility, time-intensive, inter-departmental coordination is often crucial, which in turn requires frequent and face-to-face communication among managers. Consistent with our results, the company believed that top-down, centralized decisions are often more efficient than horizontal communication to ensure smooth adaptation in some cases. At the same time, department managers are often in a better position than headquarters to ensure adaptation in others.

4 Data and Measures

4.1 Selection of survey participants and data collection procedure

To shed light on issues of managerial authority and coordination among peer managers, public, secondary data are unlikely to come by. Instead, we chose to use a survey to collect primary data. To design our questionnaire, we conducted two rounds of meetings with company executives and managers. The first round of meetings involved executives working in the strategic planning function of the company president's office. These face-to-face meetings, accompanied by email exchanges, provided an overview of the company's mission and strategy, geographic coverage, organizational issues, types of retail formats, financial performance, store operations, and major challenges. The company eventually designated all of the twelve stores belonging to a regional Tokyo metropolitan sales district for our study. After gathering more specific information on internal organization, compensation scheme, and performance metrics of managers in the stores, we designed a list of pilot questions and conducted full-day visits to two stores. At the two stores, we met the store managers, senior managers (e.g., merchandise manager), and several department managers. These on-site pilot interviews provided detailed information on types of tasks, coordination issues, and challenges from local volatility, which in turn was helpful in our questionnaire design. We conducted the survey by distributing hard copies of the questionnaire to all of the 189 department managers across the twelve stores. Managers at each store returned their completed questionnaires in a sealed envelope (printed with one of our university names and logos) and then put these envelopes into a box designated for our survey usage. In the process, we ensured that the content of each questionnaire remained confidential to company executives who would only receive a store-level overview. All managers filled out the questionnaire; however, a few had missing entries in various questions so the actual sample size in our regressions varies and is somewhat smaller.

To supplement our survey, the company headquarters agreed to supply demographic data such as education, age, and gender of each manager. Moreover, we also received monthly transaction data on sales revenue and sales-to-plan ratio. Based on the original transaction data and some further work, we obtained a total of 24 months' data on sales revenue, sales changes, and sales-to-plan ratio.

4.2 Variables and measurement

We begin by briefly describing the variables we used in our empirical analysis. While some of our measures are cardinal (e.g., task delegation, sales deviations, age), other variables are ordinal and are reported by managers on a 1-7 scale (e.g., demand uncertainty, need for coordination). See Table 2 for detailed descriptions and their summary statistics.

<Insert Table 2 about here>

Task delegation: To measure the tasks allocated to a department manager and hence the extent of delegation, the company provided us a list of fifteen tasks in which a manager may be involved in her job. These fifteen tasks are sales, marketing, customer service, property management, IT management, e-commerce, merchandise, product, personal selling, pricing, personnel, training, shop floor, ordering, and checkout. We asked each manager to indicate which of the fifteen tasks her job covers. Although the manager may still need to involve her superior manager in the decision making on those tasks, a higher number of tasks bundled into a manager's job scope indicates a larger extent of responsibility. We created this measure de novo. See Figure 1 for a schematic representation of these tasks.

Functional versus *Departmental task delegation*: In addition to treating overall delegation as the dependent variable, we also examine how local volatility and the importance of coordination affect the extent of delegation for two subgroups of tasks: functional and departmental tasks. Functional tasks such as customer service and marketing are inter-departmental coordination-intensive, whereas departmental tasks such as product and sales are less coordination intensive with other departments. Subsection 5.3 provides a more detailed discussion. This classification is based on the need for coordination among departments and peer managers of *a particular task*.

Need for coordination: As discussed above, inter-departmental coordination is a major part of a department manager's job in both routine and ad hoc business operations. To capture their perception of its importance, we ask department managers to rate on a seven-point scale how important smooth coordination among departments and peer managers is for the manager to perform her job well. It is important to notice that this question is about a manager's *whole job*. We created this measure de novo for our context.

Local volatility: Volatility in local demand for a product category may disrupt routines and thus require adaptive actions from departments. To capture local shocks that matter to managers at the department level, we use a total of three different measures. The first measure is from our survey of department managers while we use transaction data to construct two alternative, objective measures for a subset of about 130 departments which directly generate revenues. We describe these measures as follows.

Demand uncertainty: Our questionnaire asks managers to rate on a seven-point scale the unpredictability of local customer demand and its impact on sales and profits at their units.

Sales deviations: Using transaction data on monthly sales-to-plan ratios at the department level, this measure captures deviations between actual sales and sales targets. Actual sales are recorded in the company archive. Planned sales are decided in the following process. The company headquarters first allocates its aggregate sales goals to sales regions and further down to the store level in a series of semi-annual and quarterly meetings. Executives in the regional and store levels then sub-allocate their goals to the department level for planning and bonus purposes.[21] We view the planned sales numbers as the best estimates of expected sales revenues. Then matching to our theoretical setup, any deviation of realized monthly sales may be viewed as local volatility caused by unexpected local shocks. Original data are expressed in the form of a sales-to-plan ratio, with 100 being on target. For instance, 94 and 115 mean actual sales are 94% and 115% respectively of the monthly planned target. We take the average of the absolute difference between the monthly sales-to-plan ratio and 100 across the 24-month transaction data period as the measure. We use its logarithm values in our regressions to minimize skewness of the original measure.

Sales changes: This measure equals the variance of month-to-month sales changes in percentage points across the 24 months of transaction data. As a result, each sales-generating department has 23 data points. We use again its logarithm values in our regressions to minimize skewness of the original measure. This measure might be subject to expected factors such as seasonality; for example, higher sales in December should not be viewed as a local shock as they are likely to be anticipated. We use *sales changes* merely as a robustness check and include all its regression results in the online appendix.

The correlation between the two transaction-based measures of local volatility, *Sales deviations* and *Sales changes*, is only mild (ρ=0.21 with $p<0.10$), and the correlations between the self-reported *Demand uncertainty* and the sales-based measures are tiny and not statistically significant (ρ=0.01 and ρ=0.08, respectively). These measures may then capture different aspects of local volatility. We also notice that the sales-to-plan ratios

[21] Newly renovated or brand new stores, which do not exist in our transaction data, would receive discretionary treatment in the goal planning process.

across departments in a given store often correlate (on a month by month basis). There is, however, a non-significant negative correlation (ρ=-0.14) between the need for coordination reported by a given department manager and the extent to which the sales-to-plan ratios of her department correlate with other departments in the same store. In other words, inter-department correlations in sales shocks do *not* translate into a higher need for inter-departmental coordination. In addition, neither do our three measures of local volatility - demand uncertainty, sales deviations and sales changes - show significant correlations with the need for coordination (ρ=-0.09, -0.01, 0.11, respectively).[22]

Aside from the main variables of interest mentioned above, we are able to obtain information on individual characteristics. Each manager reports the number of years – including work and training – she has had in each of the fifteen tasks; the average value is called *Experience*. Moreover, the human resources department provided archival data on each manager's education level, age, and gender. These four variables are included in all regressions. To minimize omitted-variable bias potentially caused by sorting into jobs or biased reporting, we further include three personality traits often used in management studies – career aspiration, agreeableness, and risk loving – in additional analysis.

4.3 Sources of variations

Before using regressions to analyze how local volatility and need for coordination affect organization design, we first examine the sources of variations by sorting stores and departments in our three key variables: *Need for coordination*, *Demand uncertainty*, and *Task delegation*. While the correlation between demand uncertainty and (i) need for coordination (ρ=-0.09) and (ii) task delegation (ρ=0.08) are not statistically significant, the negative correlation between need for coordination and task delegation (ρ=-0.16) is statistically significant at the 0.10 level. We summarize the means and standard deviations of coordination need, demand uncertainty, and task delegation by department in Table O-1 and by stores in Table O-2 in the online appendix.

On the one hand, Column 1 in Table O-1 shows that the mean values of coordination

[22] The lack of correlations in our data between the importance of coordination and sales shocks (or inter-department correlations of sales shocks) validates our theoretical assumption in Section 3 that β_{ji} and θ_i are independent.

need are quite different across departments: scores range from 4 to 6.33 and the standard deviation of these mean values is 0.55. Restricting attention to departments that are present in a majority of stores ($\geq$ 6), we observe that the fish, meat, daily food, deli, and grocery departments have among the lowest needs for coordination whereas kids, womenswear, menswear, underwear, cosmetics, and produce have above average needs for coordination. On the other hand, Column 1 in Table O-2 shows that differences in the mean values of coordination need across stores are much smaller, with a range of 4.56 to 5.83 and the standard deviation of the mean values being 0.32. We use box plots in Figure 2 to visualize such differences where the middle boxes represent *Need for coordination* by store and by department in Panels A and B respectively.

<Insert Figure 2 about here>

We replicate the same exercise on *Demand uncertainty* and find that the standard deviation of the mean value by department (Table O-1, column 3) is almost identical to that sorted by stores (Table O-2, column 3): 0.56 versus 0.54. The bottom boxes in Figure 2 visually show these results. For brevity, we omit tables and box plots for *Sales deviations*, but results are similar.

Lastly, columns 5 and 6 in the two tables in the online appendix show the extent of *Task delegation* by departments and by stores respectively. The mean values across departments in column 5 of Table O-1 range from 5.00 to 14.33 with produce, daily food, cosmetics, and menswear having below-average task delegation and deli, meat, fish, underwear, and womenswear having above-average task delegation. The mean values across stores shown in column 5 of Table O-2 show a much tighter range. Indeed, the standard deviation of the mean values of task delegation sorted by department is larger than that sorted by stores: 2.77 versus 0.91. This suggests that the main source of variation in task delegation in our data comes from departments, as clearly shown by the top boxes in Figure 2.

Formally, we use analysis of variance, or ANOVA, to evaluate the joint null hypotheses of equality across departments and stores. On need for coordination, the ANOVA shows that between-department variations are of marginal significance (F=1.28; p=0.19) but between-store variations are not significant at all (F=1.05; p=0.41). The ANOVA on task delegation also shows a statistically significant result on between-department variations (F=4.30; p=0.00) but not for between-store variations (F=0.75; p=0.69). On demand uncertainty, the ANOVA shows a marginally significant result on between-department variations (F=1.31; p=0.17) and a significant one on between-store variations (F=3.73; p=0.00). In sum, the above analyses show that, while departments exhibit larger variations than stores in terms of the need for coordination and task delegation, stores probably have larger variations in terms of demand uncertainty.

5 Main results

5.1 Econometric specifications

Our regression analysis proceeds as follows. We first use overall *Task delegation* in a job as the outcome or dependent variable. This variable indicates how many tasks are delegated to a department manager out of a total of fifteen possible tasks. We subsequently compare the extent of delegation of *Functional tasks* (that are coordination intensive) and *Departmental tasks* (that are less coordination intensive) by treating them as separate dependent variables. These regressions use *Demand uncertainty* as our first measure of local volatility. To make use of our alternative, transaction-based measures of local volatility, we then restrict our analysis to sales-generating departments. This analysis covers two transaction measures of local volatility, *Sales deviations* and *Sales changes,* for comparison purposes. We then check robustness in our main regressions by including (i) alternative fixed effects and (ii) personality traits. Finally, we examine the differential effect of asymmetric information about local shocks on delegation by using experience difference between department and superior managers as a proxy for the center's ability to learn about local shocks.

Most of our regressions use ordinary least squares (OLS) in the following specification:

$$Y_i = \alpha + \beta_1 \textit{Local volatility}_i + \beta_2 \textit{Need for coordination}_i + \beta_3 \textit{Local volatility}_i \times \textit{Need for coordination}_i + X_i' b + \epsilon_i,$$

where i denotes the department manager, Y_i is one of the aforementioned outcome variables, α is the intercept, and X_i is a vector of control variables, including *Experience*, *Education*, selected personal characteristics, and store fixed effects. Notice that $\beta_3 < 0$ is necessary to validate our main hypotheses. For comparison purposes, we omit the interaction term between local volatility and need for coordination, i.e., suppress the value of β_3 as zero, in some regressions. Robustness checks use department fixed effects or clustered standard errors or include personality traits. Recall that we use *Demand uncertainty*, *Sales deviations*, and *Sales changes*, as alternative measures of local volatility to show the consistency of our main results.

5.2 Overall task delegation

Table 3 shows our first results on overall *Task delegation*. In column 1, we include the two main variables of interest, *Demand uncertainty* and *Need for coordination*, and four control variables, *Experience*, *Education*, *Age*, and *Gender*. We add the interaction term of *Demand uncertainty* and *Need for coordination* in column 2. To control for unobserved demographic, market, and the store manager's characteristics, we add store fixed effects in column 3. While the first three columns use robust standard errors, column 4 uses standard errors clustered by 23 departments. Notice that using clustered standard errors only changes inference (i.e., standard errors) but not estimated values of coefficients.

<Insert Table 3 about here>

Results are consistent across the four specifications in the table. Column 1 shows that, as expected, task delegation is decreasing in need for coordination (β_2= -0.50) but increasing in demand uncertainty (β_1= 0.26), although the latter is not statistically significant. When the interaction term of *Demand uncertainty* and *Need for coordination* is added to columns 2 to 4, the magnitude of the positive coefficient of *Demand uncertainty* increases tremendously (β_1 = 2.06 or 1.85) and turns to be significant, whereas the increased standard errors render the coefficient on *Need for coordination* no longer significant. Importantly, the interaction term with *Need for coordination* is negative (β_3 = -0.33 or -0.29) and statistically significant. This large moderation effect means that as the need for coordination increases, the marginal effect of demand uncertainty on delegation decreases and eventually turns to be negative. Specifically, the marginal effect of *Demand uncertainty* on task delegation in column 2 is 0.74 at the 10^{th} percentile (=4) but -0.26 at the 90^{th} percentile (=7) of possible values of *Need for coordination*.

Panel A of Figure 3 graphically illustrates this interaction effect by using the results obtained in column 2 of Table 3. The upward-sloping grey line depicts the case when the *Need for coordination* is low (10^{th} percentile): an increase in *Demand uncertainty* from low (10^{th} percentile; =1) to high (90^{th} percentile; =5) increases *Task delegation* by about 28%. On the other hand, the downward sloping black line shows that when *Need for coordination* is high (90^{th} percentile), an increase in *Demand uncertainty* from low to high decreases *Task delegation* by approximately 10%.[23]

<Insert Figure 3 about here>

These results are consistent with our hypothesis that task delegation is increasing in local volatility when the need for coordination is low, but decreasing in local volatility when the need for coordination is high. Intuitively, in the former case, autonomous adaptation to local shocks is sufficient. This favors decentralization as lower-level managers observe local shocks better. In contrast, in the latter case, coordinated adaptation to local shocks is called for. This favors centralization as the center is better at coordinating tasks across departments. This novel finding amends what we know from conventional wisdom and previous empirical studies, namely that more local information in general positively correlates with how much authority is delegated (e.g. Nagar 2002; Acemoglu et al. 2007; Huang et al. 2017).

On other variables, as one would expect, task delegation increases in *Experience* and *Education*, as both are proxies of agent ability. Another interesting variable would be tenure. Although we do not have a direct measure on tenure, *Age* is a good proxy for it in our context since age and tenure are often positively correlated in large Japanese companies. In our regressions, *Age* has negative correlations with delegation. This implies that, after controlling for ability, younger rather than older managers are "rewarded" with more delegation. In other words, it does not appear that delegation is a reward for

[23] To calculate the values of the endpoints, we assume that the control variables are at their mean values.

tenure or seniority.[24] Lastly, females are delegated fewer tasks but the standard errors are too large to yield more precise coefficients. It is worth noting that including store fixed effects (columns 3 and 4) helps to isolate store-specific factors such as store management style and culture but does not qualitatively change our main results (column 2). While none of the store fixed effects are statistically significant in column 4, standard errors clustered by departments tremendously increase the overall significance of the regression. Notice that a store's department composition may be a response and thus endogenous to its neighboring demand and competitive environment. While store fixed effects partly take care of such composition effect, we are limited by our data to fully account for it.

5.3 Task delegation: functional versus departmental tasks

To further shed light on the mechanism behind our results, we categorize the fifteen managerial tasks into two groups, functional tasks and departmental tasks, based on how coordination intensive they are. Notice that while our variable *Need for Coordination* is about the whole job of a department manager (asked in a single survey question to each manager), the classification in *Functional* versus *Departmental tasks* is based on the coordination need of a particular task. Concretely, for each of the fifteen tasks, managers rated on a seven-point scale the extent of discretion and flexibility they have when coordinating horizontally with peer department managers. A score of zero is recorded if a task is not part of a manager's job. Based on the average score on each task across all managers, we classify it either as a functional or departmental task. We refer to the five tasks that are most likely to be coordination-intensive as *Functional tasks* and the other ten, which are less likely to be coordination-intensive, as *Departmental tasks*. The five functional tasks, with their average scores in parentheses, are marketing (1.88), customer service (1.97), property management (1.48), IT management (1.96), and e-commerce (2.02). The ten departmental tasks are merchandise (3.35), product (3.59), sales (3.46), personal selling (2.99), pricing (3.19), personnel management (3.27), training (2.93), shop floor (3.48), ordering (4.23), and checkout (3.66).

Following the same specifications as for overall task delegation, Table 4 shows our

[24]Note also that all managers in our sample have the same managerial rank.

results. As in the previous table, we report four regressions, but using functional task delegation (columns 1-4) or departmental task delegation (columns 1′-4′) as the outcome variable. While *Need for coordination* itself has a negative impact on delegations (columns 1 and 1′), we find two major differences between functional and departmental tasks.

<Insert Table 4 about here>

First, one would expect that *Functional tasks,* such as customer service and marketing, are more likely to be centralized (as they are more likely to be coordination-intensive) whereas *Departmental tasks,* such as sales and merchandise, are more likely to be "entrusted" to a specific department. Table 4 shows that this is indeed the case. The intercept of the departmental task regression (α = 11.22) is almost four times larger than that of the functional task regression (α = 2.96), while there are only twice as many departmental as functional tasks (10 vs. 5). The same pattern on the intercepts holds after we include the interaction term in the remainder of the three columns (columns 2-4 and 2′-4′). Specifically, all of the intercepts for *Departmental tasks* are large and statistically significant (α = 9.99, or 10.87), whereas those for *Functional tasks* are very small and not significant (α = -0.45, or -1.30).

Second, after the inclusion of the interaction term between *Demand uncertainty* and *Need for coordination* (columns 2-4 and 2′-4′) only *Functional task delegation* shows the same pattern as overall *Task delegation* (as shown in Table 5): the coefficient of the interaction term is negative and statistically significant (β_3 = -0.22) in columns 2-4 for functional tasks but this is not the case in columns 2′-4′ for departmental tasks. Intuitively, it is only for tasks that are potentially coordination-intensive that the impact of local volatility should depend on the need for coordination. Instead, our theory predicts that local volatility always increases delegation for tasks that require limited coordination. This is exactly what we observe in Table 4. Specifically, for units which report low coordination needs (10^{th} percentile; = 4), we find that more local volatility increases both the extent of *Functional delegation* and the extent of *Departmental task delegation*: from columns 2 and 2′, the marginal effect of *Demand uncertainty* is respectively 0.39 and 0.31. In contrast, for units with high coordination needs (90^{th} percentile; =7), more local volatility reduces the extent of *Functional task delegation,* but continues to increase the extent of *Departmental task delegation:* the marginal effect of *Demand uncertainty* is respectively -0.23 and 0.07.

We further examine whether a particular task is driving the results by dropping one task at a time from the dependent variables of task delegation and functional/departmental delegation. The results are robust to what we find in Table 4.

In summary, the results in Table 4 provide further evidence for the mechanism behind our results, and the importance of taking into account the need for coordination to understand the impact of local information on organization design.

5.4 Transaction-based measures of local volatility

To supplement our analysis using the survey-based measure of local volatility, we use transaction data to construct our alternative, objective measure for a subset of about 130 departments which directly generate revenues.

First, to make an apples-to-apples comparison, Table 5 sticks to our survey-based measure *Demand Uncertainty* but excludes department managers whose units do not directly generate sales revenues from our analysis. Table 5 is also a robustness check on our previous results. Indeed, one may suspect that departments that do not directly generate sales and profits are different from other departments – for instance, local volatility may play less a role for a department which is not customer facing – and wonder whether this might drive some of our results on task delegation. The excluded departments are sales operations, cashier, customer service, partners, and IT. Except for *Age* which is not statistically significant throughout, the results on our main variables and control variables are qualitatively similar to those in Tables 3 and 4.

<Insert Table 5 about here>

Tables 6 shows our results using the transaction-based measure of local volatility: *Sales deviations* (see Subsection 4.2 on data and variables for details). We exclude store fixed effects in these regressions because of smaller samples. We find that their inclusion generates similar, albeit slightly weaker, results. To match our theoretical model, we first use transaction data to construct the variable *Sales deviations* from the monthly ratio of realized to planned sales. Presumably, planned sales are the best measure of expected sales. As such, this variable excludes shocks to sales that are fully anticipated by the center (e.g. those based on seasonality). Table 6 reports the results of this alternative measure (in its logarithm value) of local volatility. Both the main variables of interests and other variables show qualitatively similar results to our original, survey measure on local volatility. Specifically, in the three regressions with the inclusion of the interaction term in the table, we see (1) the positive direct effect of log(*Sales deviations*) and its negative interaction effect with coordination need on overall and functional task delegation, but (2) weak or little effect of these two terms on departmental tasks.

<Insert Table 6 about here>

All in all, our two measures of local volatility generate consistent results in terms of its direct and interaction effects on task delegation. Using the results in column 2 of Table 6, Figure 3 graphically illustrates the differential effect of log(*Sales Deviations*) for low (10th percentile) and high (90th percentile) need for coordination. As we see, local volatility has opposite effects on task delegation under high versus low coordination needs.

Lastly in Table O-4 in the online appendix, we take another perspective at this novel prediction by creating a median split of our sample in terms of *Need for coordination*. In the table, local volatility shows a positive effect on overall task delegation when coordination need is low. In contrast, when coordination need is above its median value, transaction measures of local volatility have a strong negative and statistically significant effect on task delegation. The effect of *Demand uncertainty*, which was positive and significant for low coordination needs, instead becomes non-significant. These patterns obtained from much smaller sub-samples also appear to be consistent with our main results analyzed above.

5.5 Robustness checks

Using our survey-based measure of local volatility, we run two checks to ensure our results presented above are robust to alternative specifications.

Department fixed effects We used store fixed effects in the previous sets of regressions to control for unobserved heterogeneity at the store level. We can instead include department fixed effects to control for unobserved departmental characteristics. For instance, becoming a manager in a department such as cashier or e-commerce may require training or even a license that might correlate with our variables of interests such as need for coordination. Department fixed effects also helps to control for department manager's style and staffing decisions. We organize our analysis of task delegation in two regressions, one with and one without the interaction term between demand uncertainty and coordination need. As in our main specification, we sequentially report results for overall task delegation, functional task delegation, and departmental task delegation. Table O-5 in the online appendix shows these results in six columns.

Compared to previous results when the interaction term is excluded, we find here that the coefficients of *Demand uncertainty* and *Need for coordination* in column 1 are weaker. One would expect this because, as we show above, the source of variation of need for coordination mainly comes from departments rather than stores. Using department fixed effects then removes a meaningful part of variation and thus a channel through which coordination needs affect organization design. The coefficients of the three main variables, nonetheless, are almost the same when the interaction term is included in column 2. For other variables, the results on *Experience* and *Age* are no longer statistically significant while that on *Education* remains qualitatively the same. Similarly, for functional task delegation (1′ and 2′) and departmental task delegation (columns 1″ and 2″), the results of the three variables of main interest (demand uncertainty, coordination need, and their interaction term) are qualitatively similar to those in Table 6.

Finally, department fixed effects show that the deli department has a higher level of overall task delegation (driven by the delegation of more functional tasks), whereas e-commerce and certain non-revenue generating departments such as cashier, IT, and partners have a lower level of overall task delegation (driven by the delegation of less departmental tasks).

In summary, our key results on demand uncertainty and its interaction term with need for coordination qualitatively remain the same when we use department fixed effects.

Inclusion of personality traits Agents may sort into jobs along certain characteristics. Therefore, controlling for personality traits that endogenously sort into job profiles based on local volatility and need for coordination helps to alleviate concerns for omitted-variable bias. For this purpose, we asked managers to self-report the following three personality traits on seven-point scales.

Agreeableness measures how much a manager is cooperative versus going alone, which may match to tasks or jobs that need a great deal of peer coordination. Our measure is adopted from the Big Five traits in the management literature (John 1990; Goldberg 1993). Selected from one of the items in the Domain-Specific Risk-Taking ("DOSPERT") scale from the management and organization literature (Blais and Weber 2006), we use *Risk loving* to measure how likely an individual would invest 5% of his annual income in a very speculative stock. A risk-loving manager may be more likely to match to jobs that exhibit more local volatility. Lastly, managers reported their *Career aspiration*, that is, how consciously they were intent on pursuing a career in the company as an executive.

Conceptually, we posit that subjects with a high rating for *Agreeableness* may be sorted to departments that have a high need for coordination (Barrick, Steward, and Piotrowski 2002) and respondents with a high score for *Risk-loving* to departments exhibiting higher local volatility. One might also speculate that subjects with a high score for *Career aspiration* may be more relational, coordinative, or simply more "power-hungry." In our data, although the coefficients of correlation between *Career aspiration* and the two main task characteristics are close to zero, that between *Agreeableness* and *Need for coordination* is quite significant (=0.30) and that between *Risk-seeking* and *Demand uncertainty* is also positive (=0.05).

<Insert Table 7 about here>

Table 7 reports the results of those regressions. The main results here on *Demand uncertainty*, *Need for coordination*, and their interaction term (first three rows) remain qualitatively the same across overall task delegation, functional task delegation, and departmental task delegation. On other variables that were previously included, we find similar results, except that the precision of the coefficient of *Education* is somewhat reduced. For the three newly added variables, being agreeable and thus cooperative has little to no effect on delegation. However, having a more long-term, career-aspiring mentality and being more risk-loving positively correlate with the three kinds of task delegation. The result on long-term career aspiration is consistent with our comparative static results on λ: a department manager who consciously pursues a career as an executive in the company is likely to care about the store-wide business rather than just her departmental one; that is, she should have a higher incentive alignment with the store manager. An alternative interpretation is that such managers are more ambitious, and may ask for (and receive) more responsibilities as part of their job.

5.6 Managerial time constraints

Our theoretical explanation is grounded in an extensive theoretical literature that focuses on the role of local information and coordination costs in driving delegation decisions. However, one might wonder whether a model with managerial time constraints might also fit the data. For example, busier managers may oversee fewer tasks because those tasks are more time-consuming. Moreover, time constraints may be more likely to bind under volatile conditions and when tasks need to be coordinated. [25]

In such a model with time constraints, more volatility may have two opposing effects: (i) it may make delegation more attractive, as it increases local information (the standard argument); or (ii) it may make delegation less attractive, if it makes time constraints more likely to bind. More local volatility then results in more delegation when time constraints are slack, but this effect is reduced and can even be reversed when time constraints are binding. To the extent that time constraints are more likely to bind when there is more need for coordination, this would be an alternative explanation for our findings.

To test this alternative theory, we use the "number of subordinates" in a department as a proxy for managerial time constraints. As is well-known, retailing is a labor intensive business and regulated by labor laws. When the number of subordinates (i.e., both full-time and part-time employees) increases in a department, workloads such as employees' shift scheduling, the extent of training, and people management go up. As

[25] We are grateful to a referee for suggesting this alternative explanation for our results.

a result, the department manager's time tends to be more constrained with more subordinates. The time-constraints theory implies that there should be a negative interaction effect between "number of subordinates" and "local volatility" in our task delegation regression. To test this, we replace coordination need with the number of subordinates in our regressions. As shown by three regression tables in Tables O-6 to O-8 in the online appendix, we find extremely small and highly non-significant interaction effects across the three alternative measures of local volatility. The direct effect of the number of subordinates is, nonetheless, positively correlated with three kinds of delegations in the regressions using demand uncertainty (e.g., columns 1 and 1" in Table O-6). All in all, it appears that our data are not consistent with this alternative theory.

6 The center's ability to learn about local shocks

So far, we have tested the main prediction of our theory: whether an increase in local volatility makes delegation more or less likely, depends on the need for coordination among sub-units. Our theory also has an additional comparative static: keeping local volatility fixed, a decrease in the center's ability to learn about local shocks unambiguously makes task delegation more likely.

In our model, local volatility corresponds to the variance σ_i^2 of the local shocks θ_i. Since the department manager perfectly observes θ_i, the expected asymmetric information between the department manager and the center further depends on the probability q_i with which the center's signal is informative about the local shock θ_i. Thus $1 - q_i$ captures how difficult it is for the center to learn about local shocks. Proposition 1 shows that, in contrast to an increase in the volatility of local shocks, a decrease in the center's ability to learn about local shocks, q_i, unambiguously makes delegation more likely.

In this subsection, we test this unambiguous prediction by constructing a proxy for how difficult it is for the center to observe or understand local shocks affecting a particular department. We posit that the superior manager who is relatively inexperienced to a department manager will have a lower ability to observe and assess local shocks. Based on this, we construct the variable *Experience difference* by taking the difference between the experience of the two as follows:

$$\textit{Experience difference}_i = \textit{Experience}_i - \textit{Experience}_{i,s}$$

where the subscript *i,s* denotes department manager i's superior manager. Since we do not have data on store managers' experience, the superior manager in our constructed variable is a senior manager at the store who both has a higher formal rank and works the most directly and closely with the corresponding department manager. Although the store manager is their formal report, department managers often regard these superiors as deputy store managers. Using internal organization charts and human resources' ranking information, we are able to identify each department manager's unique superior in our data set. Rather than being a direct measure, we view this variable as a proxy for asymmetric information, i.e., the difficulty of the center's ability to learn about local shocks at the departments. It is worthwhile to note that our constructed variable *Experience difference* involves higher-ranking managers' experience which never occurs in other analyses. We also note that the correlation between our new measure and our three measures of local volatility ranges from very weak to mild: ρ=0.19, 0.08, and 0.01, for *Demand uncertainty*, *Sales deviations*, and *Sales changes* respectively. These small correlations confirm that our measures for local volatility, which capture local sales or demand variations, and *Experience difference*, which captures the ability to assess those local demand variations, are indeed two different constructs.

Since a superior manager – especially the merchandise manager – typically supervises several departments in the same store, one would expect a positive correlation between the two variables, *Experience difference* and *Experience*. Indeed, the two variables have a high coefficient of correlation (ρ=0.73). As such, we exclude *Experience* in the analysis here to avoid multi-collinearity.

<Insert Table 8 about here>

Table 8 uses the same format as our previous regressions but treats *Experience difference* and its interaction term with coordination need as the main variables of interests. Note that we include *Demand uncertainty* in the regressions because the prediction from our theoretical model assumes that local volatility is being kept fixed. The key differences between the effect of experience difference and local volatility on task delegation are as follows.

First, *Experience difference* has little or no interaction effect with *Need for coordination*, as shown in columns 2, 2′, and 2″. Second, columns 1, 1′, and 1″ show that *Experience difference* has a stronger and more significant average effect on task delegation than demand uncertainty. Jointly these results imply that, unlike previous regressions using local volatility as the main variable of interest, the difficulty of assessing local shocks, as proxied by *Experience difference*, has an unambiguous (positive) effect on delegation. Overall, the results in Table 8 are supportive of our theory and complement results in cross-firm studies such as Baiman and Rajan (1995), Acemoglu et al. (2007), and Huang et al. (2017). The proxies for local information used in the latter studies mainly measure the information disadvantage of central management - that is how difficult it is for headquarters to be informed about local circumstances. As Table 8 shows and our theory predicts, the harder it is for central management to assess local shocks, the more likely she delegates. In contrast, as shown in our previous results, the impact of an increase in the volatility of local shocks on decentralization depends on the need for coordination.

The differential impact of local volatility and asymmetric information is reminiscent of the conceptual distinction between risk and asymmetric information in the literature on incentive pay. As noted by Prendergast (1999), both concepts are often highly correlated in the data, but have different implications theoretically for organizational design. The same is true in our paper. A key difference with Prendergast's argument is that asymmetric information and risk affect two complementary organizational design practices: incentive pay and delegation. Asymmetric information makes delegation more attractive, which in turn makes it optimal to increase incentive pay (Prendergast 2002; Raith 2008). One empirical strategy, therefore, has been to test the impact of risk on incentive pay, while controlling for the decision-making authority (e.g. De Varo and Kurtulus 2010). In contrast, the argument in this paper does not rely on complementary organizational design choices. It should further be noted that, in our setting, managers are subject to a uniform compensation structure and performance evaluation process.

7 Conclusion

This paper has presented one of the first micro-level studies of managerial authority and task allocation inside organizations. Our data concerns just under 170 individual department managers, employed by the same retail firm, subject to the same incentive scheme, working in the same geographic region, and belonging to the same mid-level managerial rank. Working closely with firm management, we obtained detailed data on personal characteristics, job descriptions, department-level sales, and so on. As far as we are aware, previous studies on organizational design have instead used firm-level or establishment-level data in a cross-section of industries or countries.

We have shown how the relationship between local information (Hayek, 1945) and organizational design is more complex than previously suggested. Our theoretical model predicts that a more volatile local environment results in more decentralization only when the need for coordination is low. In contrast, and a novel prediction, we expect to see a positive association between local volatility and centralization when coordination needs are high. In other words, centralized organizations are better at adapting to local shocks when coordination is important. Our data on the managerial authority of department managers is strongly supportive of this theory.

Our empirical analysis differs from previous work on the determinants of delegation, such as Baiman and Rajan (1995), Acemoglu et al. (2007), and more recently Huang et al. (2017), in that we construct measures of local volatility which capture the unpredictability and variations of the local environment itself. In contrast, the proxies for local information used in the above studies mainly measure the information disadvantage of central management – that is how difficult it is for headquarters to be informed. Conceptually, the volatility of local shocks and asymmetric information about local shocks capture two different aspects of local information that managers may possess. An increase in asymmetric information about a given environment always favors decentralization. In contrast, an increase in the volatility of this environment favors centralization when coordination among sub-units is important.

8 Appendix

8.1 A Brief Description of Managerial Meetings in the Store

Each month, under the supervision and guidance of the store manager, department managers formulate a master sales plan. Components in the monthly plan ranges from strategic sales planning, its implementation, marketing strategy, line up of merchandise, to details on product freshness and pricing. Every week, the regional headquarters also communicate its merchandise status and plan to its stores.

Regular daily meetings are hold from Monday to Saturday by the store manager (or his deputies) and department managers. In addition, the store manager holds a Sunday meeting with selected managers as well. Although the monthly sales plan includes a certain level of details, realized ongoing sales are subject to local volatility and other uncertainties and thus deviations from any component that is specified in the master plan. Factors such as weather (temperature and precipitation), local events (sports games), disasters (typhoon, earthquake), seasonal diseases, product fads, or tourist arrivals may all influence customer demand and cause sales fluctuations. As such, department managers have to be attentive to make sure inventory turnovers and merchandise levels are within acceptable ranges. When one department's products and pricing cause externalities to others (e.g., sales bundles, special store award points), managers may raise and discuss related issues in these regular meetings. Responding to customer demand, the store would also organize ad hoc promotional events by focusing on, for instance, "World Fair" (ethnic holidays or geographic specialty), "Summer Heat"/"Winter Sale" (warmer-than-usual temperature), and "Disaster Prevention" (heavy rain, typhoon, or earthquakes). Typically, inter-departmental coordination and agreement are necessary for the success of storewide sales events or corrective adjustments in terms of the scope and sites of promotional floor space, content of point-of-sale (POS) materials, highlighted merchandise in local advertisement, product bundling, and staff training. In these daily and weekly meetings, the store manager may instruct and coordinate human resources in terms of the hiring and allocation of regular employees and part-time employees since some departments may have to share with or borrow employees from others. As is typical in Japan, our stores' operation hours tend to be long (e.g., from

7:00 am to 11pm, 365 days a year) but foot traffic may vary across departments, hours, and days in a week. Ad hoc sales promotions further stimulate business in the store. Therefore, flexible and coordinative labor input that provides special support such as merchandise preparation, personal selling, and product display to selected departments and shop floor is essential.

8.2 Proof of Proposition 1

Part (i) We have that $P_i = 1 - G(\overline{R}_i)$, where

$$\overline{R}_i \equiv AL_D + CL_D - AL_C = \left(q_i - \frac{1 + (2\lambda - 1)\beta_i(1 - p_D)}{(1 + \lambda\beta_i(1 - p_D))^2} \right) \sigma_i^2. \tag{7}$$

Assume $P_i \in (0, 1)$. From (6) and (7), then

$$\frac{\partial P_i}{\partial \sigma_i^2} = -g(\overline{R}_i)\overline{R}_i/\sigma_i^2.$$

It follows that $\partial P_i/\partial \sigma_i^2 > 0$ if $\overline{R}_i < 0$ and $\partial P_i/\partial \sigma_i^2 < 0$ if $\overline{R}_i > 0$. Moreover, since $\lambda \in [1/2, 1]$,

$$\frac{\partial \overline{R}_i}{\partial \beta_i} = \frac{(1 - p_D)\left(1 + \lambda(2\lambda - 1)\beta_i(1 - p_D)\right)}{(\lambda\beta_i(1 - p_D) + 1)^3}\sigma_i^2 > 0.$$

Since $\overline{R}_i = -(1 - q_i)\sigma_i^2 < 0$ for $\beta_i = 0$ and $\overline{R}_i = q_i\sigma_i^2 > 0$ in the limit as β_i goes to infinity, it follows that there exists a unique $\overline{\beta}_i > 0$ such that

i) $\overline{R}_i < 0$ (and thus $\partial P_i/\partial \sigma_i^2 > 0$) if $\beta_i < \overline{\beta}_i$, and

ii) $\overline{R}_i > 0$ (and thus $\partial P_i/\partial \sigma_i^2 < 0$) if $\beta_i > \overline{\beta}_i$.

In addition, we have that

$$\frac{\partial P_i}{\partial \beta_i} = -g(\overline{R}_i)\frac{\partial \overline{R}_i}{\partial \beta_i} < 0$$

and

$$\frac{\partial P_i}{\partial \beta_i \partial \sigma_i^2} = -g(\overline{R}_i)\frac{\partial \overline{R}_i}{\partial \beta_i}\frac{1}{\sigma_i^2} < 0,$$

Part (ii) It easy to verify that $\frac{\partial \overline{R}_i}{\partial (1 - q_i)} < 0$ and $\frac{\partial \overline{R}_i}{\partial \lambda} < 0$ and thus $\frac{\partial P_i}{\partial (1 - q_i)} > 0$ and $\frac{\partial P_i}{\partial \lambda} > 0$ whenever $P_i \in (0, 1)$. QED.

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Figure 1: Organizational Structure: Stores, Departments, and Tasks

REGIONAL HEADQUARTERS

A Tokyo metro area

⇩

12 STORES

Each store is headed by a Store Manager

⇩

23 DEPARTMENTS or FUNCTIONS

Each store has all or a subset of 23 departments/functions. Each is headed by a department manager

1.Kids Apparel 2.Womenswear 3.Clothing Accessories 4.Underwear 5.Menswear 6.Home Furnishing 7.Cosmetics 8.Grocery 9.Liquor 10.Daily Food 11.Deli 12.Produce 13.Processed Meat and Poultry 14.Fish 15.Sales operation 16.Cashier 17.e-Commerce 18. Customer Service 19.Information Technology (IT) 20.Partners 21.Home Appliances 22.Pharmacy 23.Shop-In-Shop

⇩

15 MANAGERIAL TASKS

Each department manager is delegated with all or a subset of 15 tasks

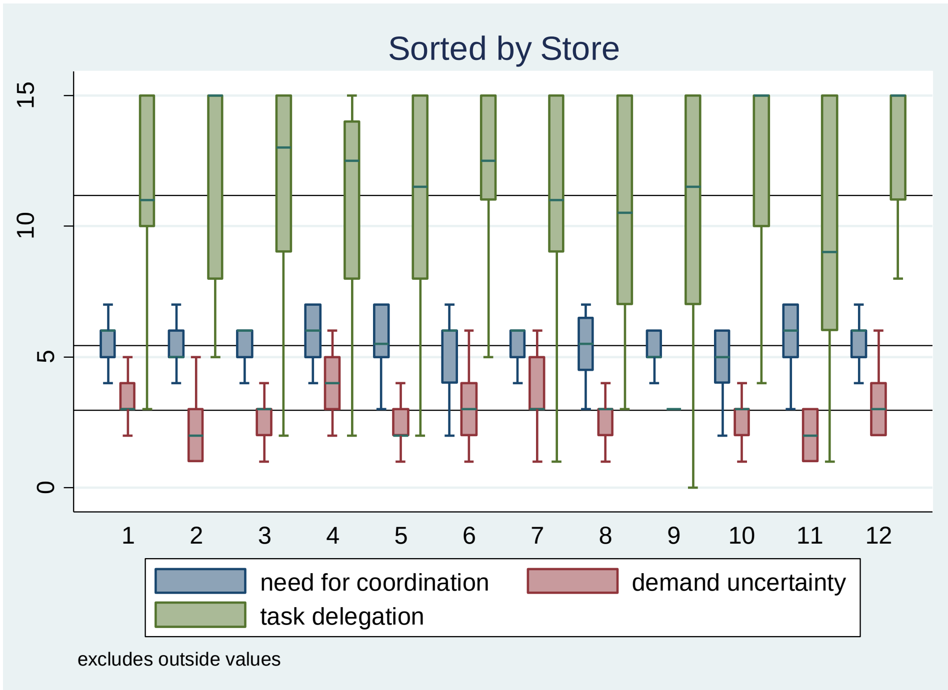
Five Functional Tasks:
Marketing, Customer Service, Property Management, IT Management, and e-Commerce

Ten Departmental Tasks:
Merchandise, Product, Sales, Personal Selling, Pricing, Personnel Management, Training, Shop Floor, Ordering, and Checkout

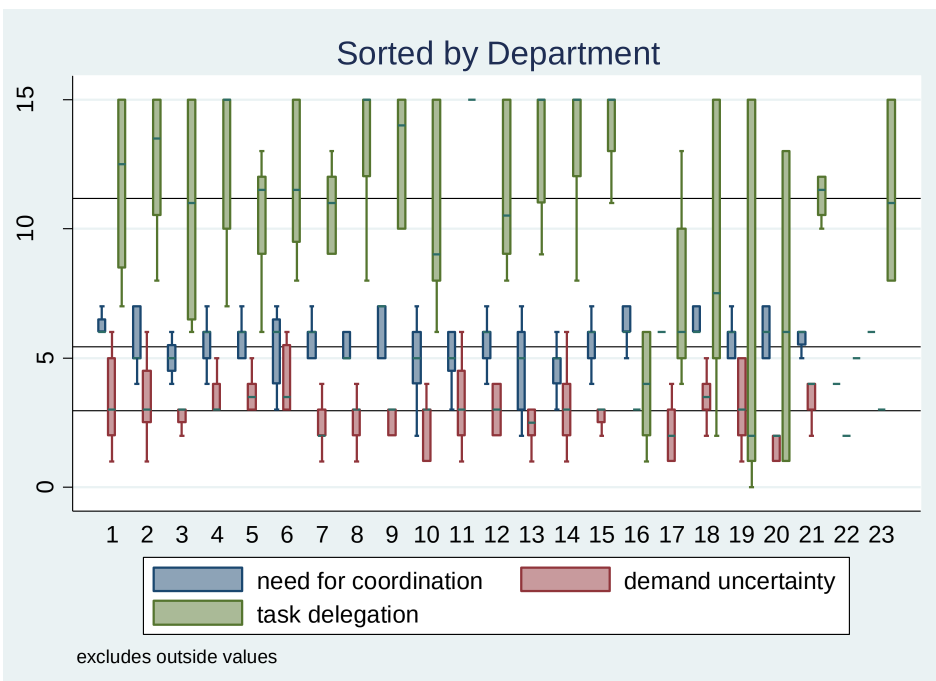
Figure 2 Box Plot of Sources of Variation

(Top: Task delegation   Middle: Need for coordination Bottom: Demand uncertainty)

Panel A

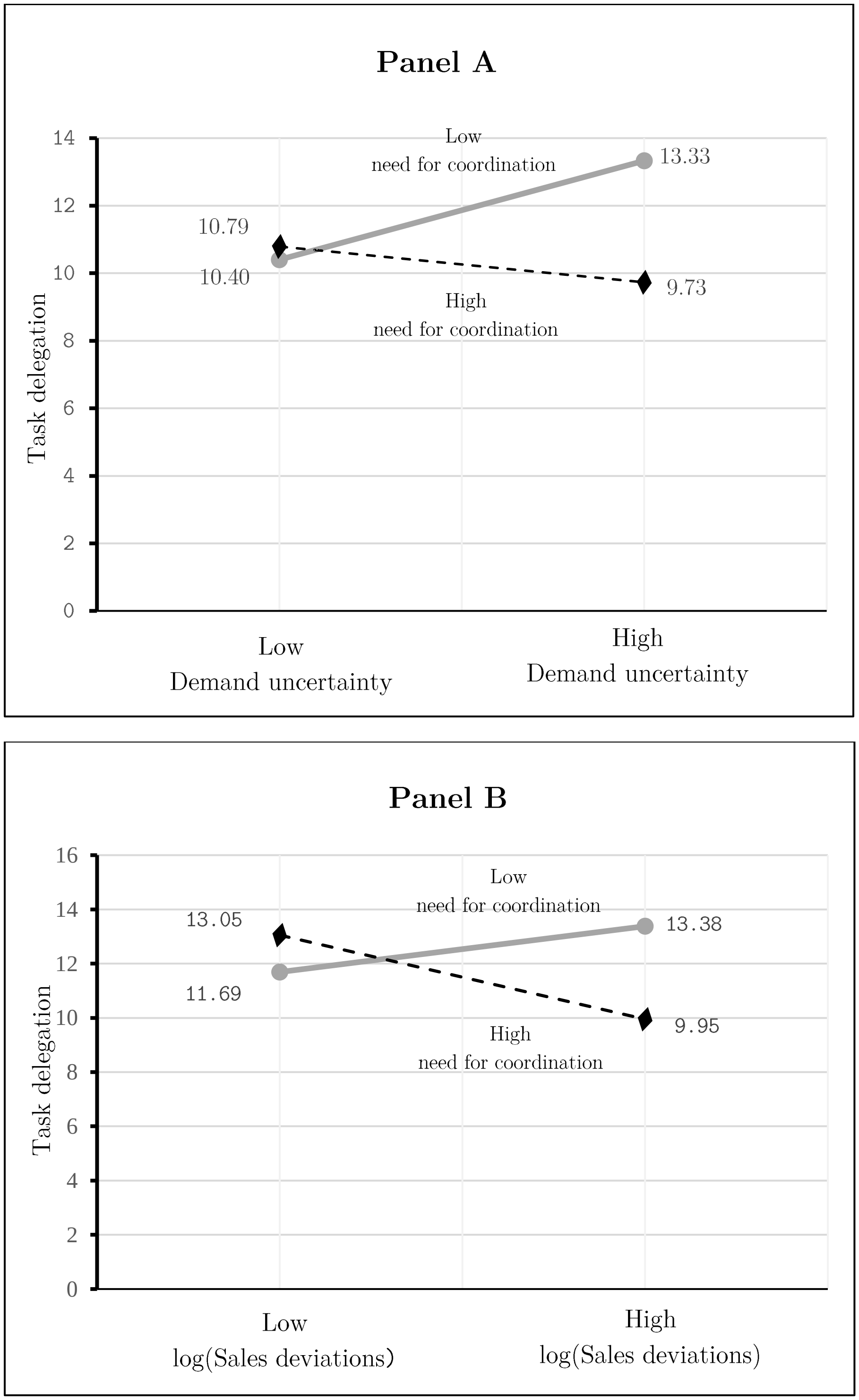


Panel B



Note: Long horizontal lines are corresponding mean values.

Figure 3 Interaction Effect of Need for Coordination and Demand Uncertainty



Panels A and B use estimates obtained in Model 2 of Tables 3 and 6 respectively. In both panels, Low and High values of *Coordination need* are at their 10th-percentile (=4) and 90th-percentile (=7) respectively. Low and High values of *Demand Uncertainty* are at their 10th-percentile (=1) and 90th-percentile (=5) respectively, and those for log(*Sales Deviation*) are at their 10th-percentile (=0.98) and 90th-percentile (=2.61) respectively.

Table 1 Overview of Stores in Our Sample

Item	Value	Remarks
Number. of stores	12	All stores report to the same company subsidiary headquarters
Number of department managers	189	All managers were sampled, but some had missing answers/information
Average no. of managers per store	15.75	
Average floor space under direct management of store	~20,000 m^2	From ~10,000 to ~36000 m^2
Average no. of employees	483	From 253 to 753
Average no. of daily shoppers	11,208	From ~5,200 to ~18,500

Table 2 Variables and Summary Statistics

Variables	N	Description	Mean	SD	Min	Max
Job Characteristics						
Local volatility – Demand uncertainty	168	Impact of local, proximate customers on sales and profit to your unit (1 very stable<—>very volatile 7)	2.96	1.23	1	6
Local volatility – Sales deviations[†]	125	Mean of the absolute differences between monthly ratio of realized-to-planned sales revenue at department and 100; original data on monthly sales-to-plan ratio included 24 months and were recorded as percentage points	8.03	6.38	1.71	41.27
Need for coordination	168	To perform well in your job, smooth coordination among different departments and functional managers is critical (1 completely disagree<—>completely agree 7)	5.44	1.16	2	7
Task delegation	168	Number of tasks the manager has to perform in her/his job.	11.15	4.14	0	15
Delegation – functional tasks	168	Number of coordination-intensive, functional tasks the manager has to perform in her/his job.	2.59	2.09	0	5
Delegation – departmental tasks	168	Number of less coordination-intensive, departmental tasks the manager has to perform in his/her job.	8.78	2.69	0	10
Personnel Variables						
Experience	168	Number of years you have as experience - including training and work - in the following 15 areas. Note: please put a "0" in the cells if you don't have any experience or training in that item.	7.37	5.12	0	21.87
Education[†]	168	1 junior high, 2 high school, 3 technical school, 4 university, 5 master's	3.22	1.05	1	5
Age[†]	168	Years of age	43.61	9.15	24	65
Gender[‡]	168	0 male, 1 female	0.27	0.45	0	1
Career aspiration	168	How consciously are you intended to pursue a career inside the company as an executive? (1 not much <—> very much 7)	2.95	1.52	1	7
Agreeableness	168	The following item relates to your personality: agreeable, organized (i.e., sympathetic, cooperative, but not aggressive or going alone) (1 completely disagree<—>completely agree 7)	4.57	1.32	1	7
Risk seeking	165	Investing 5% of your annual income in a very speculative stock (1 extremely unlikely<—>extremely likely 7)	2.39	1.54	1	7

[†] Original data provided by company headquarters. Others are self-reported in questionnaire.

Table 3 Determinants of Task Delegation

	Task Delegation			
	1	2	3	4
Demand uncertainty	0.26	2.06***	1.85**	1.85***
	(0.24)	(0.79)	(0.82)	(0.67)
Need for coordination	-0.50**	0.46	0.40	0.40
	(0.24)	(0.48)	(0.49)	(0.40)
Demand uncertainty ×		-0.33**	-0.29*	-0.29**
Need for coordination		(0.15)	(0.15)	(0.12)
Experience	0.30***	0.31***	0.32***	0.32***
	(0.08)	(0.08)	(0.08)	(0.08)
Education	0.57**	0.57**	0.56*	0.56*
	(0.29)	(0.29)	(0.31)	(0.32)
Age	-0.09*	-0.09*	-0.09*	-0.09*
	(0.05)	(0.05)	(0.05)	(0.05)
Gender	-0.70	-0.61	-0.58	-0.58
	(0.70)	(0.70)	(0.74)	(0.88)
Constant	12.96***	7.69**	7.96**	7.96***
	(2.48)	(3.22)	(3.43)	(2.75)
12-store fixed effects[#]	No	No	Yes	Yes
			(0)	(0)
Clustered standard errors (by 23 departments)	No	No	No	Yes
R^2	0.174	0.188	0.222	0.222
F-statistic	5.41	5.89	2.79	32.18
N	168	168	168	168

OLS regressions. Dependent variable is overall task delegation. *p < 0.10; **p < 0.05; ***p < 0.01. Robust standard errors in parentheses in columns 1, 2, and 3. Standard errors clustered by 23 departments in parentheses in column 4. [#]The twelve stores are all the general merchandise stores reporting to the same regional headquarters. Number of statistically significant (p< 0.10) fixed effects in parentheses.

Table 4 Task Delegation – Functional Tasks vs. Departmental Tasks

	Delegation - Functional Tasks				**Delegation - Departmental Tasks**			
	1	2	3	4	1'	2'	3'	4'
Demand uncertainty	0.11	1.27***	1.42***	1.42***	0.21	0.63	0.42	0.42
	(0.13)	(0.47)	(0.49)	(0.42)	(0.14)	(0.50)	(0.51)	(0.36)
Need for coordination	-0.30**	0.32	0.38	0.38	-0.31**	-0.09	-0.18	-0.18
	(0.14)	(0.29)	(0.29)	(0.26)	(0.14)	(0.28)	(0.27)	(0.21)
Demand uncertainty ×		-0.22**	-0.22**	-0.22***		-0.08	-0.04	-0.04
Need for coordination		(0.08)	(0.09)	(0.07)		(0.10)	(0.10)	(0.07)
Experience	0.09***	0.09***	0.10***	0.10***	0.25***	0.25***	0.26***	0.26***
	(0.03)	(0.03)	(0.04)	(0.03)	(0.05)	(0.05)	(0.05)	(0.06)
Education	0.18	0.18	0.21	0.21	0.40**	0.40**	0.39**	0.39**
	(0.16)	(0.15)	(0.17)	(0.18)	(0.17)	(0.17)	(0.19)	(0.20)
Age	-0.01	-0.01	-0.01	-0.01	-0.11***	-0.11***	-0.11***	-0.11***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)	(0.03)	(0.03)
Gender	-0.27	-0.21	-0.24	-0.24	-0.72*	-0.70*	-0.60	-0.60
	(0.38)	(0.37)	(0.40)	(0.44)	(0.39)	(0.40)	(0.42)	(0.65)
Constant	2.96**	-0.45	-1.30	-1.30	11.22***	9.99***	10.87***	10.87***
	(1.29)	(1.92)	(2.00)	(1.61)	(1.42)	(1.70)	(1.93)	(1.82)
12-store fixed effects#	No	No	Yes (0)	Yes (0)	No	No	Yes (1)	Yes (1)
Clustered standard errors (by 23 departments)	No	No	No	Yes	No	No	No	Yes
R^2	0.098	0.121	0.165	0.165	0.291	0.293	0.333	0.333
F-statistic	3.82	4.25	2.06	49.53	9.89	8.58	3.94	15.86
N	168	168	168	168	168	168	168	168

OLS regressions. Dependent variables are functional task delegation in columns 1-4 and departmental task delegation in columns 1'-4'. *p < 0.10; **p < 0.05; ***p < 0.01. Robust standard errors in parentheses in columns 1, 2, 3, 1', 2' and 3'. Standard errors clustered by 23 departments in parentheses in columns 4 and 4'. [#] The twelve stores are all the general merchandise stores reporting to the same regional headquarters. Number of statistically significant (p< 0.10) fixed effects in parentheses.

Table 5 Sales-Generating Departments Only – Task Delegation

Excludes: Sales Operations, Cashier, Customer Service, Partners, and Information Technology

	Task Delegation	**Task Delegation**	**Delegation – Functional Tasks**	**Delegation – Functional Tasks**	**Delegation – Departmental Tasks**	**Delegation – Departmental Tasks**
	1	2	1'	2'	1''	2''
Demand uncertainty	0.31	2.14***	0.16	1.77***	0.18*	0.42
	(0.24)	(0.70)	(0.17)	(0.50)	(0.10)	(0.36)
Need for coordination	-0.34	0.63	-0.30*	0.56*	-0.19*	-0.06
	(0.22)	(0.45)	(0.15)	(0.30)	(0.10)	(0.22)
Demand uncertainty × Need for coordination		-0.35***		-0.31***		-0.05
		(0.13)		(0.09)		(0.07)
Experience	0.19**	0.20**	0.09*	0.10*	0.14***	0.14***
	(0.08)	(0.08)	(0.05)	(0.05)	(0.04)	(0.04)
Education	0.56*	0.57*	0.25	0.26	0.30*	0.31*
	(0.30)	(0.30)	(0.19)	(0.19)	(0.16)	(0.16)
Age	-0.02	-0.03	-0.00	-0.00	-0.05*	-0.05*
	(0.05)	(0.05)	(0.03)	(0.03)	(0.03)	(0.03)
Gender	0.05	0.15	0.06	0.15	-0.03	-0.01
	(0.72)	(0.69)	(0.48)	(0.45)	(0.34)	(0.34)
Constant	10.08***	4.88	1.91	-2.65	9.64***	8.94***
	(2.29)	(3.13)	(1.51)	(2.09)	(1.16)	(1.60)
12-store fixed effects#	Yes	Yes	Yes	Yes	Yes	Yes
	(0)	(0)	(0)	(1)	(0)	(0)
R^2	0.122	0.148	0.138	0.187	0.166	0.168
F-statistic	1.27	1.85	1.45	1.97	1.35	1.30
N	137	137	137	137	137	137

OLS regressions. Dependent variables are overall task delegation in columns 1-2, functional task delegation in columns 1'-2', and departmental task delegation in columns 1''-2''. *p < 0.10; **p < 0.05; ***p < 0.01. Robust standard errors in parentheses. #The twelve stores are all the general merchandise stores reporting to the same regional headquarters. Number of statistically significant (p< 0.10) fixed effects in parentheses.

Table 6 Effect of Departmental Sales Deviations

	Task Delegation	Task Delegation	Delegation – Functional Tasks	Delegation – Functional Tasks	Delegation – Departmental Tasks	Delegation – Departmental Tasks
	1	2	1’	2’	1’’	2’’
log(*Sales deviations*)	-0.27	4.95**	-0.22	2.50†	0.19	0.67
	(0.41)	(2.04)	(0.30)	(1.56)	(0.17)	(1.08)
Need for coordination	-0.37*	1.41**	-0.33**	0.60	-0.14*	0.02
	(0.20)	(0.69)	(0.15)	(0.56)	(0.09)	(0.44)
log(*Sales deviations*) ×		-0.98***		-0.51*		-0.09
Need for coordination		(0.37)		(0.29)		(0.21)
Experience	0.12*	0.15**	0.06	0.08	0.06**	0.07**
	(0.07)	(0.07)	(0.05)	(0.05)	(0.03)	(0.03)
Education	0.40	0.48*	0.20	0.24	0.23**	0.24**
	(0.26)	(0.27)	(0.19)	(0.20)	(0.10)	(0.10)
Age	0.01	0.01	0.01	0.01	-0.01	-0.01
	(0.04)	(0.04)	(0.03)	(0.03)	(0.02)	(0.02)
Gender	0.12	0.29	0.34	0.43	-0.05	-0.04
	(0.69)	(0.66)	(0.49)	(0.46)	(0.26)	(0.26)
Constant	11.85***	2.01	2.99*	-2.15	8.66***	7.75***
	(2.03)	(4.17)	(1.57)	(3.27)	(0.70)	(2.16)
12-store fixed effects#	No	No	No	No	No	No
R^2	0.084	0.130	0.083	0.108	0.096	0.098
F-statistic	2.50	3.13	1.94	2.34	2.61	2.44
N	125	125	125	125	125	125

OLS regressions. Dependent variables are overall task delegation in columns 1-2, functional task delegation in columns 1’-2’, and departmental task delegation in columns 1’’-2’’. *p < 0.10; **p < 0.05; ***p < 0.01. †p < 0.10 one-tail test. Robust standard errors in parentheses. #Store fixed effects are excluded in this table to save degrees of freedom in estimations. Nevertheless, including store fixed effects generates almost identical results as none of the fixed effects are statistically significant.

Table 7 Effect of Personality Traits on Task Delegation

	Task Delegation	Task Delegation	Delegation – Functional Tasks	Delegation – Functional Tasks	Delegation – Departmental Tasks	Delegation – Departmental Tasks
	1	2	1'	2'	1''	2''
Demand uncertainty	0.27	1.81**	0.23	1.59***	0.18	0.15
	(0.26)	(0.92)	(0.16)	(0.51)	(0.14)	(0.54)
Need for coordination	-0.34	0.48	-0.22	0.51*	-0.23	-0.25
	(0.27)	(0.55)	(0.15)	(0.31)	(0.15)	(0.31)
Demand uncertainty ×		-0.29*		-0.25***		0.01
Need for coordination		(0.17)		(0.09)		(0.10)
Experience	0.30***	0.30***	0.10***	0.10***	0.24***	0.24***
	(0.08)	(0.08)	(0.04)	(0.04)	(0.05)	(0.05)
Education	0.35	0.36	0.16	0.16	0.23	0.23
	(0.31)	(0.30)	(0.17)	(0.17)	(0.18)	(0.18)
Age	-0.07	-0.07	-0.00	0.00	-0.10***	-0.10***
	(0.04)	(0.04)	(0.02)	(0.02)	(0.03)	(0.03)
Gender	-0.11	-0.05	-0.13	-0.08	-0.25	-0.26
	(0.73)	(0.73)	(0.41)	(0.40)	(0.40)	(0.40)
Career aspiration	0.47**	0.45**	0.21*	0.20*	0.25*	0.25*
	(0.22)	(0.22)	(0.12)	(0.12)	(0.13)	(0.13)
Agreeableness	-0.08	-0.09	-0.10	-0.11	0.02	0.02
	(0.27)	(0.27)	(0.14)	(0.13)	(0.16)	(0.16)
Risk loving	0.33*	0.33*	0.11	0.11	0.28**	0.28**
	(0.20)	(0.20)	(0.11)	(0.10)	(0.12)	(0.12)
Constant	10.03***	5.56	1.25	-2.71	9.83***	9.93***
	(2.70)	(3.68)	(1.54)	(2.09)	(1.50)	(2.03)
12-store fixed effects[#]	Yes	Yes	Yes	Yes	Yes	Yes

	(0)	(0)	(1)	(1)	(1)	(1)
R^2	0.235	0.244	0.162	0.190	0.366	0.366
F-statistic	2.50	2.68	1.83	2.13	4.08	3.86
N	163	163	163	163	163	163

OLS regressions. Dependent variables are overall task delegation in columns 1-2, functional task delegation in columns 1'-2', and departmental task delegation in columns 1''-2''.
*p < 0.10; **p < 0.05; ***p < 0.01. Robust standard errors in parentheses. #The twelve stores are all the general merchandise stores reporting to the same regional headquarters.
Number of statistically significant (p< 0.10) fixed effects in parentheses.

Table 8 Effect of Experience Difference

(Difference of experience between department manager and superior manager)

	Task Delegation	Task Delegation	Delegation – Functional Tasks	Delegation – Functional Tasks	Delegation – Departmental Tasks	Delegation – Departmental Tasks
	1	2	1'	2'	1''	2''
Experience difference	0.24***	0.17	0.06**	0.06	0.21***	0.13
	(0.07)	(0.18)	(0.03)	(0.09)	(0.04)	(0.11)
Need for coordination	-0.34	-0.34	-0.22	-0.22	-0.20	-0.20
	(0.24)	(0.24)	(0.15)	(0.15)	(0.13)	(0.13)
Experience difference ×		0.01		0.00		0.01
Need for coordination		(0.03)		(0.02)		(0.02)
Demand uncertainty	0.31	0.31	0.22	0.22	0.17	0.17
	(0.26)	(0.26)	(0.16)	(0.16)	(0.13)	(0.13)
Education	0.39	0.38	0.17	0.17	0.29	0.28
	(0.32)	(0.32)	(0.18)	(0.18)	(0.19)	(0.19)
Age	-0.06	-0.06	0.01	0.01	-0.08***	-0.08***
	(0.04)	(0.05)	(0.02)	(0.02)	(0.03)	(0.03)
Gender	-0.87	-0.86	-0.36	-0.36	-0.66	-0.65
	(0.78)	(0.78)	(0.44)	(0.44)	(0.42)	(0.42)
Constant	12.90***	12.88***	2.03	2.03	11.62***	11.60***
	(2.74)	(2.75)	(1.43)	(1.43)	(1.60)	(1.60)
12-store fixed effects#	Yes	Yes	Yes	Yes	Yes	Yes
	(2)	(2)	(1)	(1)	(2)	(2)
R^2	0.189	0.190	0.131	0.131	0.313	0.316
F-statistic	2.13	2.06	1.53	1.50	3.89	3.89
N	163	163	163	163	163	163

OLS regressions. Dependent variables are overall task delegation in columns 1-2, functional task delegation in columns 1'-2', and departmental task delegation in columns 1''-2''. *$p < 0.10$; **$p < 0.05$; ***$p < 0.01$. Robust standard errors in parentheses. #The twelve stores are all the general merchandise stores reporting to the same regional headquarters. Number of statistically significant ($p < 0.10$) fixed effects in parentheses.

ONLINE APPENDIX

Table O-1 Need for coordination, Demand uncertainty, and Task delegation: Means and Standard Deviations Sorted by Department

		Need for coordination		Demand uncertainty		Task delegation		
		1	2	3	4	5	6	
	Department Name	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev	N
1	Kids apparel	5.750	1.581	3.375	1.768	11.750	3.327	8
2	Womenswear	5.625	1.118	3.375	1.600	12.625	2.669	8
3	Clothing accessories	5.000	0.816	2.750	0.500	10.750	4.924	4
4	Underwear	5.667	0.866	3.111	1.364	13.000	3.122	9
5	Menswear	5.833	0.753	3.667	0.816	11.143	2.911	6
6	Home furnishing	5.375	1.506	4.125	1.356	11.875	2.850	8
7	Cosmetics	5.500	1.080	2.400	0.843	11.182	1.888	10
8	Grocery	5.000	1.342	2.727	1.104	13.091	2.587	11
9	Liquor	6.333	1.155	2.667	0.577	13.000	2.646	3
10	Daily food	5.000	1.612	2.364	1.206	10.909	3.673	11
11	Deli	5.000	0.953	3.167	1.642	14.333	2.015	12
12	Produce	5.700	0.823	2.900	0.876	11.300	2.830	10
13	Processed meat	4.700	1.636	2.400	0.699	13.300	2.312	10
14	Fish	4.600	0.843	3.200	1.398	13.100	2.726	10
15	Sales operation	5.625	0.916	2.875	1.126	13.375	3.292	8
16	Cashier	6.000	0.943	3.000	1.054	5.600	5.232	10
17	e-Commerce	5.833	0.983	2.167	1.169	7.333	3.502	6
18	Customer service	6.000	1.095	3.500	1.049	8.667	5.391	6
19	IT	5.714	0.756	3.143	1.464	5.286	6.676	7
20	Partners	6.000	1.000	1.667	0.577	6.667	6.028	3
21	Home appliances	5.750	0.500	3.500	1.000	11.250	0.957	4
22	Pharmacy	4.000	0.000	2.000	0.000	5.000	0.000	1
23	Shop-in-shop	6.000	0.000	3.000	0.000	11.333	3.512	3
Total		5.435	1.161	2.964	1.233	11.149	4.139	168

Table O-2 Need for coordination, Demand uncertainty, and Task delegation: Means and Standard Deviations Sorted by Store

	Need for coordination		Demand uncertainty		Task delegation		
	1	2	3	4	5	6	
Store	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev	N
1	5.833	0.857	3.278	1.074	11.222	3.750	18
2	5.364	1.206	2.091	1.300	11.818	3.842	11
3	5.385	1.044	2.769	1.166	11.385	4.445	13
4	5.778	1.003	4.000	1.029	10.889	4.013	18
5	5.429	1.399	2.357	1.008	10.929	3.970	14
6	5.278	1.526	3.056	1.474	12.278	3.083	18
7	5.353	0.862	3.529	1.375	10.235	4.507	17
8	5.375	1.408	2.625	0.916	10.889	4.512	8
9	5.214	0.802	2.929	0.475	10.143	5.127	14
10	4.556	1.424	2.556	0.882	12.444	4.127	9
11	5.800	1.146	2.200	0.862	9.733	5.457	15
12	5.308	1.251	3.231	1.423	12.769	2.743	13
Total	5.435	1.161	2.964	1.233	11.149	4.139	168

Table O-3 Effect of Departmental Sales Changes

	Task Delegation	Task Delegation	Delegation – Functional Tasks	Delegation – Functional Tasks	Delegation – Departmental Tasks	Delegation – Departmental Tasks
	1	2	1’	2’	1’’	2’’
log(*Sales changes*)	-0.07	1.71*	-0.04	0.72	0.04	0.59*
	(0.20)	(0.87)	(0.14)	(0.62)	(0.08)	(0.32)
Need for coordination	-0.36*	-1.46***	-0.32**	-0.79**	-0.12	-0.46***
	(0.20)	(0.54)	(0.15)	(0.40)	(0.08)	(0.17)
log(*Sales changes*) ×		-0.34**		-0.15†		-0.11*
Need for coordination		(0.16)		(0.11)		(0.06)
Experience	0.13*	0.14*	0.07	0.07	0.07**	0.07**
	(0.07)	(0.07)	(0.05)	(0.05)	(0.03)	(0.03)
Education	0.42	0.41	0.23	0.22	0.20**	0.20**
	(0.27)	(0.26)	(0.19)	(0.19)	(0.10)	(0.10)
Age	0.01	0.01	0.01	0.01	-0.01	-0.01
	(0.04)	(0.04)	(0.03)	(0.03)	(0.02)	(0.02)
Gender	-0.04	0.14	0.16	0.24	-0.01	0.05
	(0.67)	(0.65)	(0.47)	(0.46)	(0.26)	(0.26)
Constant	11.12***	16.53***	2.46	4.76*	9.11***	10.80***
	(2.22)	(3.64)	(1.75)	(2.69)	(0.78)	(1.25)
12-store fixed effects#	No	No	No	No	No	No
R^2	0.083	0.121	0.078	0.091	0.087	0.108
F-statistic	2.41	2.35	1.86	1.61	2.68	3.61
N	128	128	128	128	128	128

OLS regressions. Dependent variables are overall task delegation in columns 1-2, functional task delegation in columns 1’-2’, and departmental task delegation in columns 1’’-2’’. *p < 0.10; **p < 0.05; ***p < 0.01. †p < 0.10 one-tail test. Robust standard errors in parentheses. # Store fixed effects are excluded in this table to save degrees of freedom in estimations. Nevertheless, including store fixed effects generates almost identical results as none of the fixed effects is statistically significant.

Table O-4 Effect of Local Volatility on Task Delegation under High versus Low Coordination Need

(Need for coordination by median split)

	Task delegation		Task delegation		Task delegation	
	Low	**High**	**Low**	**High**	**Low**	**High**
	1	1'	2	2'	3	3'
Demand uncertainty	0.57*	0.06				
	(0.32)	(0.33)				
log(*Sales deviations*)			0.55	-1.24**		
			(0.50)	(0.59)		
log(*Sales changes*)					0.40†	-0.54**
					(0.29)	(0.27)
Experience	0.29**	0.32***	0.11	0.15	0.12	0.18*
	(0.12)	(0.10)	(0.09)	(0.11)	(0.09)	(0.11)
Education	0.24	0.64*	0.44	0.33	0.33	0.40
	(0.49)	(0.37)	(0.42)	(0.35)	(0.43)	(0.33)
Age	-0.11	-0.06	0.00	0.02	-0.01	0.00
	(0.08)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
Gender	0.37	-1.43*	0.47	-0.27	0.61	-0.55
	(1.18)	(0.86)	(1.07)	(0.82)	(1.05)	(0.76)
Constant	12.04***	9.28***	9.01***	11.07***	12.16***	7.11***
	(3.38)	(2.64)	(2.94)	(2.58)	(3.47)	(2.43)
R^2	0.149	0.195	0.067	0.147	0.086	0.166
F-statistic	2.00	4.06	0.78	2.30	1.29	2.93
N	73	95	62	63	62	66

OLS regressions. Dependent variable is overall task delegation. *p < 0.10; **p < 0.05; ***p < 0.01. † p < 0.10 one-tail test. Robust standard errors in parentheses. Samples in regressions are median split in *Need for coordination*: Low = ratings are 2, 3, 4, and 5; High = ratings are 6 and 7. Store fixed effects excluded to save degree of freedom.

Table O-5 Task Delegation with Department Fixed Effects

	Task Delegation	**Task Delegation**	**Delegation – Functional Tasks**	**Delegation – Functional Tasks**	**Delegation – Departmental Tasks**	**Delegation – Departmental Tasks**
	1	2	1'	2'	1''	2''
Demand uncertainty	0.09	2.01*	0.06	1.32**	0.02	0.55
	(0.24)	(1.05)	(0.13)	(0.58)	(0.13)	(0.56)
Need for coordination	-0.14	0.90	-0.20	0.48	-0.10	0.18
	(0.26)	(0.61)	(0.14)	(0.34)	(0.13)	(0.32)
Demand uncertainty ×		-0.36*		-0.23**		-0.10
Need for coordination		(0.19)		(0.10)		(0.10)
Experience	0.05	0.05	0.05	0.05	0.03	0.03
	(0.07)	(0.07)	(0.04)	(0.04)	(0.04)	(0.04)
Education	0.58**	0.59**	0.20	0.21	0.35**	0.35**
	(0.28)	(0.28)	(0.16)	(0.15)	(0.15)	(0.15)
Age	0.05	0.06	0.02	0.02	-0.00	-0.00
	(0.04)	(0.04)	(0.02)	(0.02)	(0.02)	(0.02)
Gender	-0.30	-0.02	-0.11	0.07	-0.45	-0.38
	(0.83)	(0.83)	(0.46)	(0.46)	(0.44)	(0.44)
Constant	6.97**	0.79	1.00	-3.05	8.47***	6.77***
	(3.09)	(4.49)	(1.72)	(2.49)	(1.63)	(2.39)
12-store fixed effects	No	No	No	No	No	No
23-departments fixed effects‡	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.431	0.445	0.308	0.332	0.627	0.629
F-statistic	3.76	3.82	2.21	2.36	8.34	8.08
N	168	168	168	168	168	168

OLS regressions. Dependent variables are functional task delegation in columns 1-4 and departmental task delegation in columns 1'-4'. *p < 0.10; **p < 0.05; ***p < 0.01. †p < 0.10 one-tail test. Standard errors in parentheses. ‡Base department of the twenty-three department fixed effects is kids apparel. Store fixed effects are excluded.

Table O-6 Effect of Manager's Time Constraint – Sales-Generating Departments Only

Excludes: Sales Operations, Cashier, Customer Service, Partners, and Information Technology

	Task Delegation	**Task Delegation**	**Delegation – Functional Tasks**	**Delegation – Functional Tasks**	**Delegation – Departmental Tasks**	**Delegation – Departmental Tasks**
	1	2	1'	2'	1''	2''
Demand uncertainty	0.34	0.19	0.16	-0.04	0.13	0.13
	(0.24)	(0.42)	(0.17)	(0.29)	(0.10)	(0.20)
No. of subordinates	0.04**	0.02	0.02	-0.01	0.03***	0.03
	(0.02)	(0.05)	(0.01)	(0.04)	(0.01)	(0.02)
Demand uncertainty × No. of subordinates		0.01		0.01		-0.00
		(0.01)		(0.01)		(0.01)
Experience	0.22***	0.22***	0.09*	0.09*	0.13***	0.13***
	(0.08)	(0.08)	(0.05)	(0.05)	(0.04)	(0.04)
Education	0.55**	0.55**	0.26	0.26	0.32**	0.32**
	(0.28)	(0.28)	(0.18)	(0.18)	(0.15)	(0.15)
Age	-0.03	-0.03	0.00	0.00	-0.03	-0.03
	(0.05)	(0.05)	(0.03)	(0.03)	(0.03)	(0.03)
Gender	-0.29	-0.28	-0.04	-0.03	0.04	0.04
	(0.70)	(0.70)	(0.49)	(0.49)	(0.32)	(0.32)
Constant	7.78***	8.30***	-0.10	0.58	7.68***	7.66***
	(2.00)	(2.37)	(1.30)	(1.58)	(1.06)	(1.25)
12-store fixed effects#	Yes	Yes	Yes	Yes	Yes	Yes
	(0)	(0)	(0)	(0)	(0)	(0)
R^2	0.148	0.149	0.122	0.127	0.191	0.191
F-statistic	1.31	1.42	1.27	1.34	1.34	1.73
N	133	133	133	133	133	133

OLS regressions. Dependent variables are overall task delegation in columns 1-2, functional task delegation in columns 1'-2', and departmental task delegation in columns 1''-2''. *p < 0.10; **p < 0.05; ***p < 0.01. Robust standard errors in parentheses. #The twelve stores are all the general merchandise stores reporting to the same regional headquarters. Number of statistically significant (p< 0.10) fixed effects in parentheses.

Table O-7 Effect of Manager's Time Constraint – Sales Deviations

	Task Delegation	Task Delegation	Delegation – Functional Tasks	Delegation – Functional Tasks	Delegation – Departmental Tasks	Delegation – Departmental Tasks
	1	2	1'	2'	1''	2''
log(*Sales deviations*)	-0.84*	-1.46**	-0.79**	-1.25***	0.17	0.07
	(0.51)	(0.65)	(0.37)	(0.46)	(0.24)	(0.28)
No. of subordinates	0.03	-0.04	0.02	-0.03	0.01	0.00
	(0.02)	(0.06)	(0.01)	(0.04)	(0.01)	(0.02)
log(*Sales deviations*) × *No. of subordinates*		0.03		0.02		0.00
		(0.02)		(0.02)		(0.01)
Experience	0.16**	0.15**	0.09*	0.08	0.07**	0.07**
	(0.08)	(0.08)	(0.05)	(0.05)	(0.03)	(0.03)
Education	0.47*	0.47*	0.26	0.26	0.23**	0.23**
	(0.28)	(0.29)	(0.19)	(0.19)	(0.11)	(0.11)
Age	0.01	0.01	0.02	0.02	-0.01	-0.01
	(0.05)	(0.05)	(0.03)	(0.03)	(0.02)	(0.02)
Gender	-0.02	0.03	0.32	0.35	-0.10	-0.09
	(0.79)	(0.78)	(0.56)	(0.55)	(0.29)	(0.29)
Constant	9.87***	11.02***	1.40	2.25	7.81***	7.99***
	(2.21)	(2.45)	(1.49)	(1.68)	(1.00)	(1.03)
12-store fixed effects#	Yes	Yes	Yes	Yes	Yes	Yes
	(0)	(0)	(1)	(0)	(0)	(0)
R^2	0.118	0.128	0.149	0.160	0.128	0.129
F-statistic	1.12	1.43	1.47	2.03	1.08	1.04
N	122	122	122	122	122	122

OLS regressions. Dependent variables are overall task delegation in columns 1-2, functional task delegation in columns 1'-2', and departmental task delegation in columns 1''-2''. *p < 0.10; **p < 0.05; ***p < 0.01. Robust standard errors in parentheses. #The twelve stores are all the general merchandise stores reporting to the same regional headquarters. Number of statistically significant (p< 0.10) fixed effects in parentheses.

Table O-8 Effect of Manager's Time Constraint – Sales Changes

	Task Delegation	Task Delegation	Delegation – Functional Tasks	Delegation – Functional Tasks	Delegation – Departmental Tasks	Delegation – Departmental Tasks
	1	2	1'	2'	1''	2''
log(*Sales changes*)	-0.14	0.14	-0.10	0.07	0.06	0.16
	(0.21)	(0.39)	(0.15)	(0.26)	(0.08)	(0.16)
No. of subordinates	0.02	-0.01	0.02	0.00	0.01	0.00
	(0.02)	(0.03)	(0.01)	(0.02)	(0.01)	(0.01)
log(*Sales changes*) × *No. of subordinates*		-0.01		-0.01		-0.00
		(0.01)		(0.01)		(0.00)
Experience	0.16**	0.15**	0.08	0.08	0.08***	0.08***
	(0.08)	(0.08)	(0.05)	(0.05)	(0.03)	(0.03)
Education	0.49*	0.47*	0.29	0.28	0.21*	0.20*
	(0.27)	(0.28)	(0.19)	(0.19)	(0.11)	(0.11)
Age	0.00	0.00	0.02	0.02	-0.01	-0.01
	(0.05)	(0.05)	(0.03)	(0.03)	(0.02)	(0.02)
Gender	-0.31	-0.38	0.01	-0.03	-0.05	-0.07
	(0.71)	(0.70)	(0.50)	(0.50)	(0.29)	(0.29)
Constant	7.83***	8.75***	-0.37	0.19	8.48***	8.79***
	(2.39)	(2.61)	(1.67)	(1.76)	(0.98)	(1.12)
12-store fixed effects#	Yes	Yes	Yes	Yes	Yes	Yes
	(0)	(0)	(0)	(0)	(0)	(0)
R^2	0.107	0.114	0.115	0.120	0.130	0.135
F-statistic	0.83	0.79	1.13	1.03	1.16	1.06
N	125	125	125	125	125	125

OLS regressions. Dependent variables are overall task delegation in columns 1-2, functional task delegation in columns 1'-2', and departmental task delegation in columns 1''-2''. *p < 0.10; **p < 0.05; ***p < 0.01. Robust standard errors in parentheses. #The twelve stores are all the general merchandise stores reporting to the same regional headquarters. Number of statistically significant (p< 0.10) fixed effects in parentheses.