Reflection and Risk: An Experiment on Managerial Traits and Organizational Structure*

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Abstract

We study how micro-level characteristics of managers, specifically cognitive ability and risk preferences, affect the structure and function of organizations. To do so, we model a managerial decision environment in which a manager both determines the skill heterogeneity of her workers and determines whether to retain or delegate the ability to allocate tasks. The manager prefers delegating when uncertainty is sufficiently high relative to the incentive conflict with her workers, which is endogenously determined by her chosen team composition. Experimental data supports the direction of the main predictions, though it shows how and why participants deviate from expected behavior. In particular, we find that higher cognitive ability leads to better team selection, while greater risk tolerance allows managers to optimally delegate decision rights. Generally, the results highlight the difficulties in navigating complex managerial environments and illustrate potentially costly ways in which managers seek to simplify their decisions.

Keywords: managerial decisions, delegation, team selection, task allocation, decision rights.

JEL Codes: C92, D23, D83, L22, M50

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1 Introduction

Organizational researchers have long sought to develop both theoretical and empirical connections between micro (individual) and macro (institutional) characteristics. In particular, managerial traits have been a growing focus in many areas such as organizational economics [Gibbons and Henderson, 2012] and institution theory [Powell and Colyvas, 2008]. The growing interest is largely attributable to improved access to high quality, individual-level data and new methodological approaches [David and Bitektine, 2009]. Recently, Bitektine, Lucas and Schilke [2018] highlighted the usefulness of controled laboratory research in answering some key questions critical to institutional theory. In particular they note how individual heterogeneity among a workforce can not only affect organizational outcomes, but also determine institutional structure itself.

To contribute to this recent literature, we study how cognitive ability and risk tolerance affect managerial performance when managers must make multiple interrelated decisions. Specifically, we develop a model of managerial decision making in which managers decide the skillset of their workgroup and then decide how to allocate decision rights within their group. Our model relies on agency theory to provide a benchmark for optimal decisions in this environment. We test the main predictions of the model in a laboratory experiment, in which we also colect data from a risk preference elicitation [Eckel and Grossman, 2008] and a measure of cognitive ability [Frederick, 2005].

Prior research has linked willingness to take risks with success among executives and entrepreneurs, though the mechanisms through which risk taking benefit performance warrant continued study. Similarly, cognitive ability has been linked to performance in a wide variety of tasks. For both of these traits, little has been done to examine their effects on organizational structure. Our focus on these two behavioral characteristics is motivated both by the promise they carry to better understand managerial choices and organizational performance, and also to identify micro-level factors of institutional structure.

We focus on the decisions of who to hire and how much control to retain over decision-making because they reflect two of the primary mechanisms by which managers can influence organizational composiiton and output. Generally, in choosing the skillsets of workers (which we refer to as team selection), managers must determine whether broadly skilled or highly specialized team members will most effectively complete their anticipated tasks. In navigating this issue, organizations spend significant resources on their hiring processes.[1] Critically, the ability of managers to avoid making team changes impulsively in response to a potentially bad outcome highlights the importance of cognitive ability; avoiding intuitively compelling - yet organizationally damaging - personnel decisions can greatly impact future organizational performance.

[1] See the PWC Saratoga 2013/2014 Human Capital Effectiveness Report. Blatter, Muehlemann and Schenker [2012] finds that for executive hires the search costs amount to over 4 months' wages of the new position. These costs are in addition to actual wages paid, and so highly competitive markets necessitate the ability to hire workers whose skill sets closely match a firm's need.

Personnel decisions depend critically on whether the manager will have final say in key matters or delegate decision rights to workers. The delegation decision is nontrivial, particularly in rapidly evolving business environments where managerial uncertainty about the nature of future tasks may change. In a highly variable environment, a decentralized organization that allows workers to allocate tasks among themselves may be the best option. Intuitively, this enables rapid response to changing local conditions. However, the composition of the team and the nature of the decision play an important role on the final outcome of a decentralized organization. For instance, divisions with overly similar specializations may struggle with how to divide tasks due to skill overlap.[2] When incentive conflicts among workers or divisions reduce firm performance, the manager may prefer a centralized organization where she keeps control over all task allocation decisions. Likewise, the ability to optimally delegate decision rights to better-informed team members may require a manager who is willing to accept risk in order to succeed.

Despite the potential benefit in modeling this decision environment, the interrelatedness of worker selection and allocation of decision rights has not been directly addressed in the academic literature. We develop a simple model incorporating these decisions to study a general problem faced by firms - namely, the efficient completion of multiple tasks. We characterize the optimal combinations of team composition and allocation of decision rights under varying levels of managerial uncertainty. The key component in our model is the ability for the manager to select her team composition. This decision endogenously determines the degree of conflict among workers in a task allocation framework. It also determines the potential harm from a manager mis-allocating tasks across workers.

We aim to capture a broad range of managerial decision-making by highlighting this critical link between employee makeup and the allocation of decision rights within a firm. For instance, a research division may need to decide which types of engineers to hire before all of its projects are known. Moreover, the total cost of a project and the quality of the team's output will depend on task allocation among engineers and how the team's capabilities fit the project requirements.[3] This stylized example highlights the importance of team selection commonly faced in managerial decisions and its connection to an organization's level of decentralization.

The main intuition behind the model can be captured with a simple illustration: A more heterogeneous or specialized team allows the manager to better respond to a more dissimilar task profile in a centralized organizational structure. However, if the task uncertainty is very high, the manager may be unable to make an informed decision. To minimize the ex-ante impact of these mistakes, the manager may instead prefer a team with greater overlap focused around the most common task addressed by the firm. On the other hand, in a decentralized organization, workers have perfect information about tasks but a potential conflict of interest may arise

[2]For instance, the coordination problem among divisions inside Sony Corporation was a major reason behind its loss of leadership in the industry. In 2012, intradivisional mis-coordination left Sony with a catalog of 30 different TV's, none of which could argue that they had the most cutting-edge technology [Tabuchi, 2012].

[3]Our model may also inform the organizational decision making process after a merger between firms, divisions or branches. The decision of which workers to retain and how to adjust the organizational structure is closely related to the new potential projects or tasks given to the newly merged firm.

between workers and manager. Workers with similar specializations may have difficulty agreeing on the efficient division of tasks. The manager can reduce the potential incentive conflict by selecting a more heterogeneous team in terms of specializations.

We use the model to develop a controlled laboratory experiment in which we can compare behavior to the benchmark predictions and evaluate the impact of managerial ability and risk preferences. We find generally that managers delegate decision rights more often as uncertainty grows,though the shift toward decentrailzation occurs gradually rather than at a specific informational threshold, as predicted by the model.[4] Second, we find that managers tend to select less specialized teams in centralized organizations than in decentralized, as predicted, but under-diversify relative to the benchmark predictions.

We further find two behavioral results worth noting. In the delegation decision, there is a general tendency to centralize more than is optimal. So, while the response to uncertainty is in line with the model's predictions, our data suggest that managers may suffer from a desire for control, which can be a costly decision [Bartling et al., 2014; Fehr, Herz and Wilkening, 2013; Owens, Grossman and Fackler, 2014]. More risk tolerant managers perform significantly better in their delegation decsions, and so we see more decentralized organizations than we do from risk averse managers. As for team selection, when managers observe that a worker's decision goes against their interest in previous rounds, they overreact by choosing a more homogeneous team in subsequent rounds. As uncertainty is reduced, this effect becomes more evident. Controlling for cognitive ability via the cognitive reflection test [Frederick, 2005], we find that managers who can better avoid making impulsive decisions perform significantly better.

These findings together tell us much about how individuals in managerial positions may use team selection to help navigate uncertainty, but they also highlight the challenging nature of these environments. Even when managers successfully find an optimal team composition, a single unforeseen negative outcome can make them abandon their strategy. In doing so, they adopt strategies that may seem safer, but prove very costly. Those managers who resist such intuitive reactions and consistently choose ideal teams, as well as risk tolerant managers more willing to delegate, leave less money on the table. Our data suggest that a critical hurdle may be consistency, to sustain profitable strategies and avoid impulsive tactical changes when short-term losses arise.

The rest of the paper is organized as follows: We discuss related literature more thoroughly in section 2 before developing our theoretical model in section 3. Our experimental design and specific hypotheses comprise section 4 and we discuss our results in section 5. Section 6 concludes with general comments and discussion for further study.

[4]This pattern is consistent with managers using pre-determined team compositions to simplify their delegation choice, as we discuss further in the Appendix.

2 Literature Review

Decision rights, incentive conflict, and adaptation: A rich theoretical literature in organizational economics studies the implications of modern property rights theory for the organizational structure within firms (e.g. Grossman and Hart [1986]; Hart and Moore [1990]).[5] Specifically, there has been a focus on how the allocation of decision rights affects a firm's ability to balance the trade-offs between "coordinated growth" (suggesting a centralized organization, as in Williamson [1996]) and rapid adaptation to local conditions, which favors a more decentralized organization as suggested by Hayek [1945]. These studies, like ours, develop models of incomplete contracts to derive predictions for when firms may benefit from centralized or decentralized decision making.[6]

A recent focus in this area has been the role of communication in helping firms manage the coordination-adaptation tension.[7] In a closely related theoretical paper, Dessein and Santos [2006] study organizations in which branches can change tasks to accomodate changing local tastes, but branch positions are fixed. The purpose of their study is to highlight the connection between communication technologies and adaptability. Other prominent theoretical examples are a closely related set of papers by Rantakari [2008] and Alonso, Dessein and Matouschek [2008, 2012], in which centralized firms may receive such distorted information that decentralization may be optimal even under situations with a strong need for coordination. Evdokimov and Garfagnini [2015] experimentally test a version of the models found in Alonso, Dessein and Matouschek [2008] and Rantakari [2008], and find results in line with the comparative statics of the model.

Brandts and Cooper [2016] experimentally test the behavioral assumptions behind many of these models; namely that divisions will successfully coordinate and that management will optimally utilize communication. They find that communication is not as strategic as predicted, and that managers struggle to optimally interpret communication. They also find that the coordination problem between divisions is non-trivial and leads to greater than predicted conflict.

Empirical studies of organizational structure are less common outside the lab due to identification challenges, though some important exceptions should be noted. McElheran [2014] finds that between-firm variation in decentralization is consistent with theoretical predictions based on the relative importance of adaptability or coordination within a firm. Thomas [2010], however, finds that adaptation to local preferences can lead to over-specialization of product lines at the expense of firm profits.

Our model differs from those mentioned above in several important ways. The primary distinction is that we endogenize the degree of coordination conflict by allowing the central

[5] Mookherjee [2006] provides a thorough overview of early work in this area.

[6] For example, several related articles study the tension in multi-divisional firms between task-specific managers and managers who oversee multiple tasks (Dessein, Garicano and Gertner [2010]; Hart and Holmstrom [2010]; Hart and Moore [2005]).

[7] This work largely builds off of early models of communication by Crawford and Sobel [1982], Bolton and Dewatripont [1994], and Dessein [2002].

manager to select her workers. To focus on worker selection, we exogenously determine the central manager's degree of informational uncertainty. This uncertainty is endogenous (though ambiguous) in Alonso, Dessein and Matouschek [2008, 2012] as well as in Rantakari [2008] and Dessein [2002].

Team Composition: Becker and Murphy [1992] theoretically establish that a more specialized team increases productivity, but it also increases the cost of coordination within teams. Other research shows that skill heterogeneity in manager-worker pairs [Mello and Ruckes, 2006] and beliefs heterogeneity among workers [Van den Steen, 2010] may affect willingness to delegate due to incentive conflicts. The main trade-off in our paper differs from the trade-off analyze in these studies. Our study explores efficient task completion within an organization when workers are horizontally differentiated but vertically separated from management.[8]

We also contribute to the literature studying risk preferences and managerial performance, as well as cognitive ability and decision making. We use these traits to understand how they affect the optimal organizational structure of their firms.

Risk preferences and managers: Understanding individual attitudes towards risk is intimately linked to the goal of understanding and predicting economic behavior. For example, Dohmen et al. [2011] elicit the willingness to take risks through a representative panel survey in Germany. They find that risk tolerance is the best predictor of various economic and health behaviors, including smoking, holding stocks, self-employment, and participation in active sports. The attitude to risk can also explain labor market outcomes such as job selection. Agents that are more willing to take risk move towards jobs with performance pays schemes [Grund and Sliwka, 2010], with more volatile earnings [Bonin et al., 2007] and are more likely to become entrepreneurs [Caliendo, Fossen and Kritikos, 2009].

Researchers in both the economic and management literature have studied risk-taking attitudes of entrepreneurs, managers and workers. While most have found little difference between entrepreneurs and managers, they generally conclude that these groups take more risk than the rest of the population [Brockhaus Sr, 1980; Koudstaal, Sloof and Van Praag, 2015]. Notably, Holm, Opper and Nee [2013] find that the entrepreneurs are more willing to accept uncertainty in strategic situations than in non-strategic ones, and MacCrimmon and Wehrung [1990] find a strong correlation between success and risk taking among top executives. The ability of managers and entrepreneurs to take risk is an important determinant in understanding firm performance. However, the mechanisms that connect willingness to take risk and firm success is not clear. In this paper, we seek to understand how risk tolerance of managers affects their organizational structure decisions.

Cognitive reflection and decision making: Several measures have been used to capture cognitive abilitiy (GRE scores, education level, etc), but one of the most utilized recent measures

[8]Friebel and Raith [2010] highlights ways in which centralization affects the allocation of capital to projects proposed by well-informed division managers. Garicano [2000] focuses on the importance of knowledge acquisition and the cost of communication as determinants of task allocation inside a firm, while Garicano and Santos [2004] study how to match the tasks or projects with horizontally-differentiated talent focusing on market solutions but not on organizational ones.

is the Cognitive Reflection Test [Frederick, 2005].[9] The CRT correlates strongly with other cognitive measures, yet it more strongly predicts behaviors in a wide range of choice tasks [Toplak, West and Stanovich, 2011]. Critically for our study, Frederick [2005] notes that the CRT is designed to measure deliberative thinking and resistance to impulsive choices. The test includes three questions, each with an intuitive yet incorrect answer, and so the correct answer requires conscious reflection. Several studies have shown that the agents with higher scores in the CRT test are more risk averse and more patient [Benjamin, Brown and Shapiro, 2013; Dohmen et al., 2010; Frederick, 2005]. Oechssler, Roider and Schmitz [2009] confirm the previous results and relate the CRT with other common behavioral biases. In particular, they show that participants with low scores on the CRT are more likely to be subject to the conjunction fallacy and to conservatism in updating probabilities.

Moreover, the evidence suggests that higher CRT individuals play more strategically. Brañas-Garza, García-Muñoz and González [2012] shows that subjects with higher scores on the CRT, but not on the Ravens Matrices task, are more likely to play dominant strategies in the beauty contest guessing game.[10] Kiss, Rodriguez-Lara and Rosa-García [2016] find that participants with higher CRT tend to identify the dominant strategy easier when strategic uncertainty is present in an extended version of the Diamond and Dybvig [1983] bank-run game. Finally, there is evidence that CRT scores have implications for financial decisions. Corgnet, Hernán-González, Kujal and Porter [2014] shows that high CRT traders were much less susceptible to asset bubbles by correctly trading based on fundamental value. Bosch-Rosa, Meissner and Bosch-Domènech [2018] shows that the appearance of large bubbles in experimental asset markets may be due to the share of low-CRT traders. In fact, no bubbles appear in their markets when all agents have a high CRT score. The CRT explains behavior in a wide variety of economic decisions, yet it has not yet been tied directly to managerial behavior. We make a first step in this direction by studying how managers with different cognitive ability handle complex situations determining the organizational structure of their firms.

3 A Theoretical Model of Organizational Structure

Agency models assume that organizations are built by the interactions and decisions made by their members. These rational agents make choices in order to maximize their utilities, and the organizational structure adapts as a means to help managers give appropriate incentives to align preferences and ensure information flows properly. Two of the most common issues in agency theory models to motivate the managerial delegation are the relative importance of the conflict of interests (misalignment of preferences) and the asymmetry of information between the manager and workers. The main predictions of these theoretical models are: 1) when the manager's information is poor relative to that of the workers, it is optimal to delegate some decisions even if there are imperfectly aligned preferences. 2) On the other hand, when the

[9] For more information about the use of the CRT test see a recent meta analysis by Brañas-Garza, Kujal and Lenkei [2019]. They include 118 CRT studies totaling 44,558 participants across 21 countries.

[10] Burnham et al. [2009] show that cognitive abilities measured by a standard psychometric test of mental ability also exhibit behavior that is closer to the Nash equilibrium in a beauty contest game.

consequences of incentive misalignment are worse than the informational asymmetry, a manager will prefer to retain control of organizational decisions.

These considerations are even more relevant when managers delegate to a group, rather than a single person. Teams in such situations must coordinate their actions, which - in expectation - exacerbates the conflict of interest between workers and manager. In this scenario, a key factor highlighted by the transaction memory system theory (see Ren and Argote [2011] for a review of TMS) is that the ability to coordinate in a team depends on the individual's knowledge (or specialization) and their ability to recall what others know. When team members have developed work roles and responsibilities that allow them to create and use specialized knowledge and have also figured out how to coordinate their behavior, the team is said to have developed a TMS [Wegner, 1987; Wegner, Giuliano and Hertel, 1985]. The latter is especially important when the team has to decide how to allocate tasks among team members. In fact, the TMS of a team is something to be considered by a manager facing the decision to delegate or not the decision rights to allocate task.

However, a new question emerges when we allow managers to impact the coordination capacity of their team. A manager could learn that each productivity factor is beneficial when combined with the other factor but contributes considerably less to team performance by itself [Reagans, Miron-Spektor and Argote, 2016]. Thus, the manager can affect the capacity to coordinate of her team when deciding on the level of specialization of the team members. This raises our central question; how will the behavioral traits of a manager affect the optimal organization structure of the firm?

Our contribution in this paper is to analyze how risk preferences and cognitive ability inform the organizational structure of teams as determined by two managerial decisions. 1) Managers choose the level of specialization of their team, which endogenously will impact on the trade-off between misalignment of preferences and asymmetry of information through the coordination ability of the team, and 2) managers decide whether to delegate or not to the team members the decision rights to allocate the tasks they receive. In order to evaluate the manager's performance on these decisions we compare their selections with the predictions we obtain on an agency theory model where we assume agents are perfectly rational for different levels of information asymmetry.

3.1 A benchmark model

The following model captures the trade-off between the misalignment of preferences and information asymmetries in a simple scenario where we have an organization comprised of three members, a principal who makes managerial decisions and two agents who must complete their assigned tasks. The main aim of the manager is to efficiently allocate tasks among workers via two "levers": first, the structure of decision rights - in particular, to determine whether to retain or delegate to her workers the ability to allocate tasks - and secondly, the skillsets of the workers on her team.

Worker heterogeneity is modeled by different specializations θ_i on the interval $[0,1]$. The manager thus selects her team, (θ_1, θ_2) (For ease of exposition and without loss of generality, we assume throughout that $\theta_1 \leq \theta_2$). This specialized knowledge horizontally differentiates the workers, endogenizing the coordination problem and the misalignment of preferences with the manager. Ex-ante, an agent with a particular set of skills may not be better than another; it depends on the nature of the task. This captures the idea that firms are often able to distinguish potential employee skill sets but it is more difficult to recognize ex ante a worker's productivity (i.e. vertical differentiation). Once selected, each worker independently receives a randomly drawn task, t_i^o for $i = \{1, 2\}$, from a uniform distribution function defined on the same interval, $U[0,1]$.[11] Critically, managers select their team prior to knowing the exact tasks to complete, (t_1^o, t_2^o).

Each worker focuses exclusively on their own task and all tasks must be completed. The manager therefore selects a team to minimize the total expected cost of the firm defined by $\mathbb{E}\big[\sum_{i=1,2} C_i(t_i^f, \theta_i)\big]$, where $C_i(t_i^f, \theta_i) = |\theta_i - t_i^f|$ and t_i^f is the final task assigned to worker i.[12] In this task allocation framework, final task assignment depends on the randomly drawn tasks, i.e. $(t_1^f, t_2^f) \in \{(t_1^o, t_2^o), (t_2^o, t_1^o)\}$. The total cost to the firm increases as the distance between the workers' specializations and their final assigned tasks increases. A higher distance may imply more time or resources spent by the firm to complete the tasks or a reduction in the quality of the final output.

We assume each worker receives a fixed payment that is sufficient to cover her best outside option. As a consequence, workers focus on minimizing their own cost, $C_i(\theta_i, t_i^f)$. We implicitly assume a positive correlation between workers effort and the distance of their skills to the final assigned task. Critically, this implies that the manager and workers have imperfectly aligned incentives. Workers do not internalize the impact of their decisions on their coworker's cost.

In this context, centralized organizations allow managers to reallocate tasks directly. In a decentralized organization, the workers decide unanimously whether or not to reallocate their originally assigned tasks. In our model, workers observe both tasks with certainty, while managers observe each task independently with some probability p, known ex-ante by all agents. The manager under centralization can therefore observe none, one or both tasks before deciding whether to reallocate tasks among workers, potentially leading to costly mistakes in task allocation. While the differences in objective functions may favor a centralized organization, the manager's information quality plays a critical role in the trade-off between organizational structures. The relative importance of the misalignment of manager and worker preferences, and the availability of information for the manager, are the key determinant of the manager's delegation decision. Importantly, the team selected by the manager endogenously impacts the balance between those two forces, as we explain shortly.

The timing of the decisions in this game is as follows:

[11] It is possible to obtain qualitatively similar results assuming symmetric unimodal distribution functions defined on the same interval. However, this simple setup facilitate our empirical analysis.

[12] We obtain similar results with risk averse agents if we consider strict monotonically decreasing utilities as functions of the absolute value distance between workers' specializations and tasks.

1. Given p, the manager chooses whether to delegate the rights to reallocate tasks.
2. The manager chooses (θ_1, θ_2) and the workers receive randomly drawn tasks, (t_1^o, t_2^o).
3. The manager observes each task with an independent probability p, while workers observe both tasks.
4. The manager (if in a centralized organization) or the workers (if decentralized) determine the final task assignment, $(t_1^f, t_2^f) \in \{(t_1^o, t_2^o), (t_2^o, t_1^o)\}$.
5. Costs for the manager and workers are realized.

We proceed by solving for the sub-game perfect Nash equilibrium using backward induction. First, we solve the manager's problem in a centralized organization and explain the main trade off the manager faces. Then, we solve the manager's problem in a decentralized organization and underline the main incentive conflict between the manager and the workers. Finally, we compare centralization to decentralization in order to determine the manager's optimal delegation decision given the level of information, p. All proofs are contained in appendix A.

3.2 Manager's problem in a centralized organization

In a centralized organization, the manager retains control over the decision rights to reallocate tasks. In this context, the following proposition is satisfied.

Proposition 1 *For any p, given (θ_1, θ_2), the manager's optimal task allocation decision will depend on the observability of the original task realizations (t_1^o, t_2^o) such that:*

1. *If the manager observes both tasks, (t_1^o, t_2^o), she allocates tasks minimizing $\sum_{i=1,2} C_i(t_i^f, \theta_i)$.*
2. *If the manager observes only one of the original task realizations - t_o^o, she assigns this task to worker θ_1 if $t_o^o \leq t^*$. t^* depends on (θ_1, θ_2) and takes the value $t^* = 1/2$ if and only if $\theta_1 + \theta_2 = 1$, which implies symmetry.*
3. *If the manager does not observe either task, the manager is indifferent between any assugnment. Without loss of generality, we assume the status quo prevails.*

Given the optimal task allocation of the manager in proposition 1, we step back in the game to analyze how managers optimally select their teams in a centralized organization. Recall that managers choose their team before learning if they will observe none, one or both original tasks, but knowing they will face those cases with probability $(1-p)^2$, $2p(1-p)$, and p^2 respectively. The manager also knows the value of p. This information allows the manager to map the probability to exchange task for any realized pair of (t_1^o, t_2^o) for a given (θ_1, θ_2).[13] Then, the manager has to select the pair of workers' specializations that allows her to minimize her $ex-post$ errors in the task reallocation (remember we are assuming a centralized organization). Two types of errors appear as a consequence of the established rule. The manager may fail to exchange tasks, or she may exchange tasks with some probability when she should not. Solving

[13] A specific example is explained in the theoretical appendix.

this problem results in our next proposition.

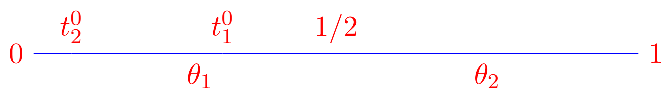
Proposition 2 *For any p, there is a unique and symmetric $(\theta_1^C(p), \theta_2^C(p))$ in a centralized organization, such that the heterogeneity of the team is a monotonically increasing function of p.*

Managers prefer a more heterogeneous team in a centralized organization if they expect to successfully enable the reallocation of tasks, i.e. if they have better access to task information.[14] A poor information environment increases the probability that the manager makes bad decisions. As a consequence, the manager will choose a more homogeneous team to minimize the impact of misinformation. When $p = 0$, a manager will minimize the maximum expected distance each worker can face, positioning them on the ex-ante expected task locations, $\theta_1 = \theta_2 = E[t^o] = 1/2$. However, when $p = 1$, the manager would not choose the same specialization for both workers since task reallocation would not change the final outcome. To take advantage of reallocation possibilities, the manager must select a more heterogeneous team.

3.3 Decentralized organization and incentive conflict

In a decentralized organization, the manager delegates reallocation rights to the workers. Workers decide unanimously whether to reallocate the tasks.[15] The manager's objective is unchanged in the decentralized organization. She must choose a team that minimizes the expected distance between workers' specialization and tasks. Critically, the workers' preferences are not perfectly aligned with the manager's preferences in this case. Because unanimity is required to reallocate tasks in the decentralized organization, either worker can unilaterally guarantee the status quo task assignment. We can therefore identify instances, as in Figure 1, where the manager would like to exchange the tasks but one of the workers will not.

FIGURE 1: MAIN INCENTIVE PROBLEM IN A DECENTRALIZED ORGANIZATION



In the example shown in Figure 2, worker θ_1 minimizes her cost with her assigned task and will vote against reallocation. As a result no exchange takes place, though both other group members would have preferred reallocation. The reallocation of tasks in this case also maximizes the joint profits for the entire group. We assume no monetary transfer between workers. We focus here on organizational solutions where monetary transfers between members of the team

[14] In a firm setting, if the information environment depends on manager expertise, our proposition implies that a naive manager would prefer a more homogeneous team than an expert or experienced manager in a centralized organization.

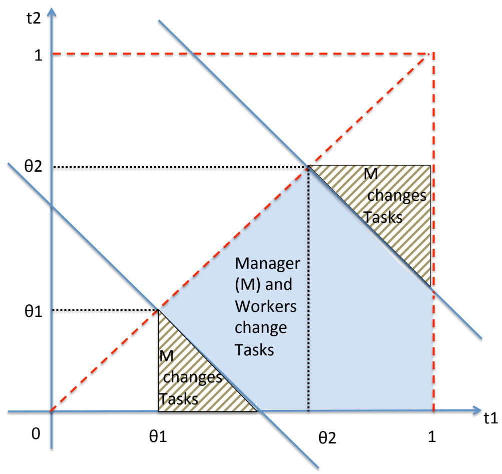
[15] Unlike in a centralized organization, initial task assignment plays an important role in the decentralized organization since both workers may want the same task. This may depend on experience, knowledge, rank or luck (e.g. project arrival). For simplicity, we assume tasks are randomly assigned. While other assignment rules may be interesting to study, they are beyond the scope of this paper.

are unlikely - for instance, when those transfers carry a reputational cost. .[16]

Proposition 3 *For any p, given (θ_1, θ_2), workers reallocate tasks if and only if the following three conditions are satisfied: 1) $t_2^o \leq t_1^o$, 2) $t_2^o \geq \max(0, 2\theta_1 - t_1^o)$, and 3) $t_1^o \leq \min(1, 2\theta_2 - t_2^o)$.*

The proof follows directly from each worker's task-reallocation conditions.[17] The shaded area of Figure 2 represents the cases satisfying these conditions on the plane (t_1^o, t_2^o) for a particular (θ_1, θ_2). This area highlights the cases in which both workers decide to reallocate tasks. On the other hand, the two striped triangular areas show cases where the manager would like to exchange tasks when she has perfect information ($p = 1$), yet one of the workers does not.[18] These areas are the graphical representation of the expected incentive conflict between manager and workers in a decentralized organization, given (θ_1, θ_2).

Figure 2: Reallocation regions in a decentralized organization



The parallel downward-sloping diagonals in Figure 3 determine the area where workers reallocate tasks, and they cross the 45 degree line at the positions selected by the manager. As the manager chooses a more homogeneous team, these parallel lines converge and the areas representing the incentive conflict grow larger. A manager can reduce the areas of conflict by choosing a more heterogeneous team, shifting the parallel lines outward. As a result, the members of the team exchange tasks more often. However, an overly heterogeneous team will increase the average expected distance between workers' specialization and tasks. Managers select their teams to minimize the total expected cost, given the workers decision to reallocate tasks or not. Since the manager affects the final results of the workers only through the positions selected, the optimal positions are independent of the level of information p as the following proposition states:

[16] See Garicano and Santos [2004] and Fuchs and Garicano [2010] for market-based solutions to efficient matching.

[17] It is possible to show that the worker θ_1 will be willing to reallocate tasks only if $t_2^o \in [\max(0, 2\theta_1 - t_1^o), t_1^o]$ and the worker θ_2 will be willing to reallocate tasks only if $t_1^o \in [t_2^o, \min(1, 2\theta_2 - t_2^o)]$.

[18] In the bottom left is the area where worker θ_1 does not want to exchange tasks. In the top right is the area where worker θ_2 does not want to exchange tasks. Notice that the shaded area plus the two triangular areas equals the region where a perfectly-informed manager decides to reallocate tasks. In this graphical example we assume symmetric positions around $E[T^o]$, but this is not a necessary condition.

Proposition 4 *For any p, there is a unique, symmetric* (θ_1^D, θ_2^D) *around the expected task in a decentralized organization. The optimal team composition is independent of p and it is more heterogeneous than the optimal team composition in a centralized organization for any p.*

3.4 Optimal organizational structure

Given the optimal team selection in centralized and decentralized organizations, we can integrate them into the manager's organizational structure decision to compare the expected costs generated by both solutions based on the level of information, p:

Proposition 5 *There exists a level of information* p^* *such that:*

- *If* $p \geq p^*$*, the manager prefers a centralized organization with* $(\theta_1^*, \theta_2^*) = (\theta_1^C(p), \theta_2^C(p))$.
- *If* $p < p^*$*, the manager prefers a decentralized organization with* $(\theta_1^*, \theta_2^*) = (\theta_1^D, \theta_2^D)$.

Proposition 5 states that the manager prefers to have the right to reallocate tasks when the level of information is "good enough." On the other hand, when the manager's information is poor, she prefers to delegate task reallocation rights to the workers. This result has been shown in prior work. For instance, Dessein [2002] shows a similar result without team selection driven by the communication technology between the principal and the agents. A main contribution of this project, then, is to relate this finding directly to optimal team composition.

4 The Experiment

Using a controlled laboratory experiment, we test how agents respond to the model's trade-off between the manager's information and her potential incentive conflict with her workers' decisions in order to respond effectively to randomly drawn tasks.

4.1 Experimental design

We implement a hybrid between/within design in which participants were randomly assigned a role of Manager (M), Worker 1 (W_1), or Worker 2 (W_2) in three-person groups. Roles were denoted Participant A, Participant B1, and Participant B2 and the experiment was presented as one of economic decision-making to avoid framing effects. In the experiment we consider a uniform distribution of the tasks over the support $[0, 100]$. We use four different treatments, each capturing a different level of information. Specifically, the probability p took one of the following fixed values in each treatment: $[0.2, 0.5, 0.8, 0.9]$. The body of experimental work on the control premium (among other topics) demonstrates that people are much more likely to sub optimally retain control than to sub optimally cede control. Thus, we focus more on values of p below $p^* = 0.82$. Our design allows us to examine the behavior of participants as they approach the information threshold in three environments that call for decentralization, and one in which centralization is optimal.

Each session was broken into three blocks consisting of several rounds. The first two allow the manager to familiarize herself with team selection in a centralized or decentralized environment, after which she enters a third block in which she decides both the team composition and now the organizational structure as well. This provides a stronger test of the model by giving participants experience and feedback in both organizational settings before they must choose the organizational structure themselves.

Blocks 1 and 2 lasted ten rounds each with either Centralized or Decentralized organizational structure, fixed during the block (counterbalanced for each value of p). It was announced that groups would be fixed for each block with random rematching between blocks. The timing was as in the model. At the beginning of each round, participants were reminded the value of p for the session and the role they were assigned. Then, managers chose the type of workers θ_1 and θ_2 by assigning each a "placement" between 0 and 100. Once the placement decision was made, the positions of W_1 and W_2 were fixed for the remainder of the round. Once both workers had been placed, the position of the tasks assigned to each worker were revealed. Workers saw both task positions with certainty, and were told which task had been matched to them. Managers saw each task position independently with the probability p for that session. Once the tasks were revealed or not to all group members, participants completed a "switch" task. This task determined whether the workers would switch their originally assigned tasks or not. Participants knew that workers and tasks could not be repositioned between 0 and 100, they could only switch which task was assigned to which worker. In the Centralized environment, the manager made the switch decision unilaterally, whether she saw one, both, or neither task position. In the Decentralized environment, workers voted over whether to switch. Only an unanimous vote to switch would result in a switch. If only one worker voted to switch, the tasks remained as initially assigned. After the switch tasks, payoffs were realized for all the participants.

Payoffs in experimental currency (ECU) for group members were determined as shown in equations 4 and 5:

$$\pi_{W_i} = 50 - |T_i - W_i| \tag{1}$$

$$\pi_M = 50 - 0.5 \sum_i |T_i - W_i| \tag{2}$$

where task T_i is matched with worker W_i at the end of the round. π_{W_i} and π_M are the payoffs for the agents with the role of workers and managers respectively. These formulas were explained to participants with several examples, and participants were given a calculation screen during the instructions with which to familiarize themselves with the payoffs (see Appendix C for experimental materials including instructions and screenshots). The experimenter walked through an example at this time, with and without switching tasks. It was possible, though improbable, for participants to earn negative payoffs in a round. To minimize this risk, participants received their total earnings collected over all rounds of the session and were reminded of this fact. Once all participants had some time to experiment with the payoff calculator, the experimenter made the following scripted comments to help ensure participants knew how their decisions affected their payoffs: "What these payoff functions tell you is simply that you maximize your payoffs when you minimize the distance between each B participant and that participant's final marker. Note also that the A participant increases his or her payoff by minimizing the distance between each B participant and that participant's marker. Nothing in the payoff function depends on the B participants being close to each other or far apart from each other."

Once participants completed both the placement and switch tasks, results were displayed providing them with information about their decisions in that round and their payoffs. In the Centralized rounds, workers were informed of their final assigned task, task positions, whether the manager switched tasks, and the payoffs of all group members. Each manager was reminded of any task position revealed to her, but workers did not see which task positions had been revealed to the manager. In the Decentralized rounds, the manager was notified whether or not the workers chose to switch tasks; otherwise the information revealed was the same.

At the conclusion of the second block, participants were read instructions for block 3, which we refer to as the Selector stage. Block 3 consisted of 16 rounds that were identical to blocks 1 and 2 with one addition. Prior to making the placement decision, the manager made a new decision to begin each round of block 3 that determined whether that round would be played in a Centralized or Decentralized environment. Specifically, the manager selected whether herself or the workers would complete the switch task for the round. Once the manager made this choice, she completed the placement decision and the round then mimicked either a round from block 1 or a round from block 2.

Following the Selector stage, participants completed a demographic survey, an incentivized risk elicitation measure [Eckel and Grossman, 2008], and the CRT [Frederick, 2005].[19]

4.2 Experimental procedure

We conducted this experiment in two locations. Initial sessions were run in the [labname1] at [location1], and a second round of sessions were run in the [labname2] at [location2]. Participants were recruited using ORSEE [Greiner, 2015] at [location2] and all sessions were run using the zTree software [Fischbacher, 2007]. [location2] sessions consisted of 24 participants, and each participant received a $10 show-up fee in addition to money accumulated from the game. [location1] sessions had 21 or 24 participants, with each receiving a €5 show-up fee. Sessions lasted just under two hours and average earnings were approximately $24 and €16 ($22) in [location2] and [location1], respectively (exhange rates were 60 ECU per $1 and 90 ECU per €1).

Instructions were first read aloud that included the value of p for the session (translated

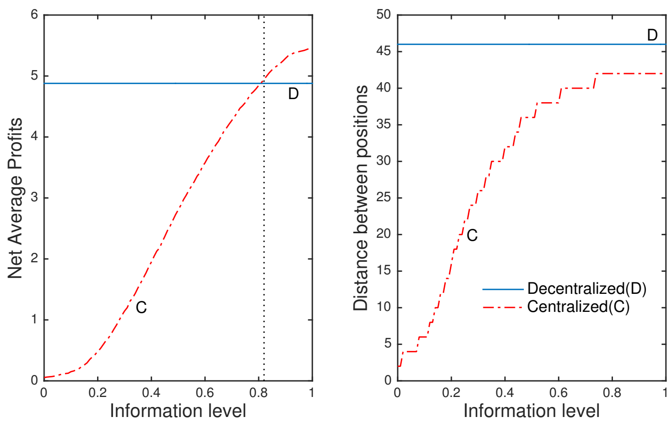
[19]The CRT is commonly unincentivized, as in our study. Brañas-Garza, Kujal and Lenkei [2019] examine over one hundred studies involving the CRT and find no effect of incentivization on performance.

to [locaction1 language] for [location1] by a native speaker also fluent in English), after which participants were randomly assigned a role of Manager, Worker 1, or Worker 2 (again, these were referred to as role A, B1, and B2, respectively) in three-person groups. Participants were only read instructions for each block as it was reached, though they knew there would be three blocks from the beginning. They were also reminded (before block 1 and each subsequent block) that they would play in the same role and face the same value of p for all blocks. During the instructions at the beginning of the session, all participants were given the chance to familiarize themselves with placement selection and switching decision using the exact same screen they would see during the experiment.

4.3 Experimental predictions

Figure 3 represents a Monte Carlo simulation of the main predictions under the previous assumptions of the model given the experimental design.[20] In the left hand panel, we plot the net average payoffs using equations 1 and 2 minus the expected payoffs obtained with a perfectly homogeneous "50-50" team (25 ECU per round). Notice that the value of p^* predicted by the model for this experiment is approximately 0.82. At this value, the participant in the role of the manager is indifferent between the two types of organization. For values above 0.82, the manager prefers a centralized organization; and for values below, the manager prefers to delegate.

FIGURE 3: PAYOFFS AND TEAM COMPOSITION PREDICTIONS



Notes. The figures summarize our main predictions. It shows the differences, as information quality increases, between expected profits by organizational structure (left hand figure) and team composition (right hand figure).

Prediction 1 *In all treatments except the* 90% *treatment, the manager will delegate decision rights to the workers.*

In the right hand panel, we plot the optimal distance between positions for the different levels

[20]We use a Monte-Carlo simulation with 100 managers playing 500 rounds for values of $p \in [0, 1]$. The simulation focuses on symmetric positions of (θ_1, θ_2) around the ex-ante expected task. We restrict our attention to these cases because the theory predicts this structure on equilibrium.

of p. The model predicts the following regarding team selection: In a centralized organization, the manager should select the positions around $(42, 58)$ in the 20% treatment, positions $(35, 65)$ in the 50% treatment, positions $(31, 69)$ in the 80% treatment and positions $(30, 70)$ in the 90% treatment. In a decentralized organization, the manager should select the position of $(27, 73)$ in all the treatments independently of the level of information. More generally, the predictions with respect to team composition are:

Prediction 2 *Team composition in a decentralized organization is always more heterogeneous than in a centralized organization for any level of information.*

Prediction 3 *In a centralized organization, the heterogeneity of the team increases with the level of information of the manager.*

Prediction 4 *In a decentralized organization, the team composition is independent of the level of information of the manager.*

While not explicitly addressed in the model, we add two behavioral predictions based on prior research. First, we expect managers with greater risk aversion scores to underperform on both decisions related to the organizational structure of the firm. On one hand, managers face uncertainty in both tasks received by their team members. This may lead them, in the extreme, to choose a completely homogeneous team, securing a minimum expected gain. However, completely homogenous teams are a strictly dominated strategy for any level of information above zero both in a centralized or decentralized organization. In a situation with a completely homogenous team, the delegation decision does not play any important role because both workers are in the same position, any task allocation generates the same result. On the other hand, even if the agents with higher risk aversion scores do not choose completely homogeneous teams, they will tend to select more homogeneous teams. This will increase the incentive conflict between the manager and the workers (increasing uncertainty in workers behavior) as predicted by the model and so managers will favor centralized organizations. All together, we hypothesize the following behavioral prediction:

Prediction 5 *Agents with higher risk tolerance (a) select teams closer to the optimal predictions of the model and (b) make better delegation decisions.*

Second, the cognitive ability of the managers may play an important role. Managers with lower cognitive abilities may simplified the game selecting a perfectly homogeneous team. In such a case, to delegate or not the task allocation decision becomes irrelevant. Beyond it being a strictly dominated strategy for any level of information above zero, the literature suggests that agents with low score on the CRT test have difficulties to identify these types of situations. The complexity of the decisions suggests that managers who make intuitive or impulsive decisions in each round will underperform. Moreover, the desire to simplify the complexity of the decision-making framework will generate that the agents with low CRT scores change their decisions among rounds less often. It would increase the difficulties of these agents to find the optimal strategies. All together, we hypothesize the following behavioral prediction:

Prediction 6 *Agents with higher cognitive abilities (a) select teams closer to the optimal pre-*

dictions of the model and (b) make better delegation decisions.

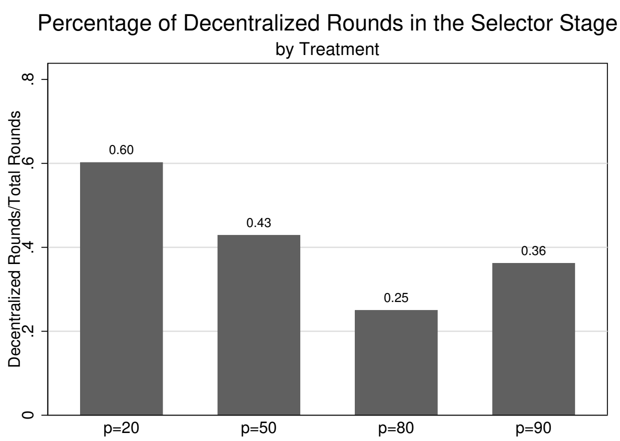
5 Experimental Results

We address first the main theoretical predictions by looking first at the delegation decision, and then at team selection. After examining overall results relative to our benchmark model, we look more closely at manager characteristics to determine the effects of cognitive ability and risk preferences.

5.1 Organizational structure decisions

Our first benchmark prediction is that managers will delegate in the Selector stage in all information conditions except the 90% treatment, since the threshold for centralized control is at $p = 0.82$. Figure 4 plots the percentage of rounds in which managers delegate in the Selector stage by treatment. The rate of decentralization is highest in the 20% treatment and declines as the managers' uncertainty falls. The differences in proportions between treatments are significant (Pearson's chi-squared = 128.99; p=0.000). While managers do not delegate in all rounds below the threshold, they do so significantly more often when facing poorer information. Interestingly, the rate of delegation in the 90% treatment is statistically indistinguishable from both the 50% and 80% treatments - a result we return to later. Remember that the uncertainty threshold leading to the first prediction assumes that managers adjust their team composition optimally. However, some managers do not optimally select their team composition, as we show in the next section.

Figure 4: Delegation by treatment



Notes. Plot of the percentage of decentralized rounds in the "Selector" stage. There are 30 managers in the 20% and 80% treatments and 29 managers in the 50% and 90% treatments for totals of 480 and 464 rounds, respectively.

To further explore the organizational structure decision of the managers, we implement the following logistic regression specification to control for additional factors:

$$Delegate_{ir} = \alpha + \delta_r + \beta_1 50\%_i + \beta_2 80\%_i + \beta_3 90\%_i + \gamma X_i + u_{ir}$$

where $Delegate_{ir}$ is a dummy variable equal to 1 if the manager i delegates in round r and 0 otherwise. δ_r is a set of round dummies and $50\%_i$, $80\%_i$ and $90\%_i$ are treatment dummies. Finally, X_i are participant controls and u_{ir} captures residual idiosyncratic determinants by participant i in round r.[21]

Table 1 shows the regression results for different specifications of the baseline model, and the results are robust to many alternative specifications.[22] Consistent with Figure 4, all treatment coefficients are negative and significant. Moreover, the coefficient for $80\%_i$ roughly double that of $50\%_i$ in all specifications (a statistically significant difference), while the coefficient of the $90\%_i$ is between the two. We confirm the convex pattern from Figure 4, that more accurate information leads to higher rates of centralization below the predicted threshold established, but seems to reverse in the 90% treatment. This relationship is robust to including demographic and risk preference controls as well as round dummies.

In column 2, we attempt to separate the direct effect of information quality on the manager's decision from the indirect effect of prior decisions. The decision to delegate is not affected by earnings from the previous round, but it is affected by the manager's previous decisions. It also shows that for every one unit change in the team heterogeneity, the log odds to delegate increase. The original treatment effects on the probability to delegate remained almost unchanged in model 2. This offers initial evidence of a weak relationship between team heterogeneity and the level of information, which we return to in the next section. It also shows that the organizational structure decision in the previous round has a positive and significant effect on current decentralization that reduces the magnitude of the direct treatment effect.[23] Finally, in the two rightmost columns, we divide the sample between the first eight rounds played in the Selector stage (model 3) and the last eight (model 4). Model 3 shows that the direct effect is higher initially, compared to model 2, while the indirect effect is lessened. It also depends weakly but significantly on the payoffs on the previos rounds. The opposite relationships appear in model 4, which suggests that managers successfully learn from their experience.[24]

[21]Standard errors are clustered by manager. Our main concern is the between-participants effect of information quality in the Selector Stage. Adding fixed effects in the regression eliminates the most stable participant types, which reduces effect sizes but preserves significance. As a robustness check, we jointly cluster the standard errors of the coefficient estimates by round and treatment to avoid correlations of the residuals at the session level not captured by the round fixed effects δ_r. Finally, we implement a double clustering, by participant and round-treatment clusters. The main results do not change in any of these alternate specifications.

[22]We replicate these results using OLS and probit models. We also see the same results using random effects with bootstrapped standard errors. These are available upon request.

[23]Model 2 in Table 1 includes the lags of the team heterogeneity, delegation decision and payoffs. While it may raise some concerns about multicollinearity, we observe that all the correlations (Pearson's Correlation Test and Spearman's Rank Test) between these variables are positive but modest ($\rho < 0.13$) in the Selector stage for managers. Moreover, the correlation between delegating and profits is not significant. In other words, there is sufficient variation across observations in the Selector Stage to obtain unbiased estimates.

[24]We find no gender differences in delegation, but delegating is positively and significantly correlated with risk seeking. We also see slightly more delegation in Spain sessions than those run in USA, with significantly more only in the 50% treatment.

Table 1: Organizational structure decision: probability to delegate in selector stage

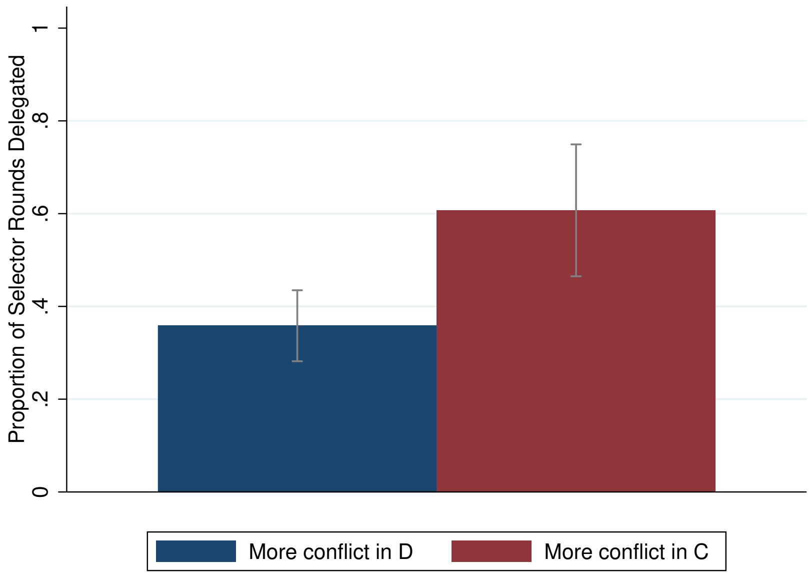
	Full Sample		Rounds 1-8	Rounds 9-16
	(1)	(2)	(3)	(4)
$20\%_i$	1.270***	0.933***	1.094***	0.814***
	(0.43)	(0.30)	(0.33)	(0.31)
$50\%_i$	0.552	0.481*	0.505	0.487
	(0.39)	(0.28)	(0.33)	(0.30)
$80\%_i$	-0.337	-0.236	-0.198	-0.256
	(0.44)	(0.33)	(0.35)	(0.32)
$Payoff_{ir-1}$		0.005	0.012*	-0.002
		(0.01)	(0.01)	(0.01)
$Dist.to.Opt_{ir-1}$		-0.013**	0.014**	0.012*
		(0.01)	(0.01)	(0.01)
$Delegation_{ir-1}$		2.058***	1.903***	2.194***
		(0.27)	(0.29)	(0.29)
$Constant$	-1.748**	-2.097***	-2.242***	-2.061***
	(0.54)	(0.49)	(0.53)	(0.54)
$RoundDummies$	Yes	Yes	Yes	Yes
$Demographics_i$	Yes	Yes	Yes	Yes
N. obs.	1888	1770	826	944
N. clusters	118	118	118	118
Pseudo R2	0.079	0.230	0.214	0.247

Notes. * p< 0.1; ** p<0.05; *** p<0.01. Logit regressions with standard errors clustered by manager. $k\%_i$ is a dummy variable taking value 1 if the manager knows each of the tasks with a probability k. $Decentralization_{ir}$ is a dummy variable taking value 1 if the manager i delegates in round r, $Payoffs_{ir}$ are the payoffs per round in experimental currency obtained by participant i in round r and $Dist.to.Opt_{ir}$ is the distance between positions selected by the participant i on round r and the optimal positions. The demographic controls are a dummy variable taking value 1 if Male, a dummy variable taking value 1 if the session was run in US and and a variable capturing different intervals of age.

Finally, we find that managers react to bad outcomes in the first two stages, which we define as either outcomes in which they realize that they made a mistake in centralized rounds, or outcomes that went against their preferences in the decentralized rounds. Bad outcomes in the first two stages influence delegation decisions in the Selector stage, as shown in Figure 5. Managers who realized more outcomes that went against their preferences in the forced delegation (centralized) stage delegated less (more) often in the Selector stage.

The evidence explored so far shows that in making their delegation decisions, managers respond to the level of information as well as their prior experiences. As information improves, managers centralize more often until they reach the predicted threshold of the model, where this pattern seems to reverse. Managers who see more conflicted outcomes in the early Centralized (Decentralized) stage will delegate more (less) in the Selector stage. We also find evidence

Figure 5: Effect of Conflict in Stages 1 and 2 on Selector Delegation



Notes. Percent of rounds delegated in Selector stage, based on whether the manager observed more outcomes against their preferences in either the first two stages, C or D.

that managers are learning as they depend more heavily on their prior organizational structure decisions in the later rounds of the Selector stage.

5.2 Team composition

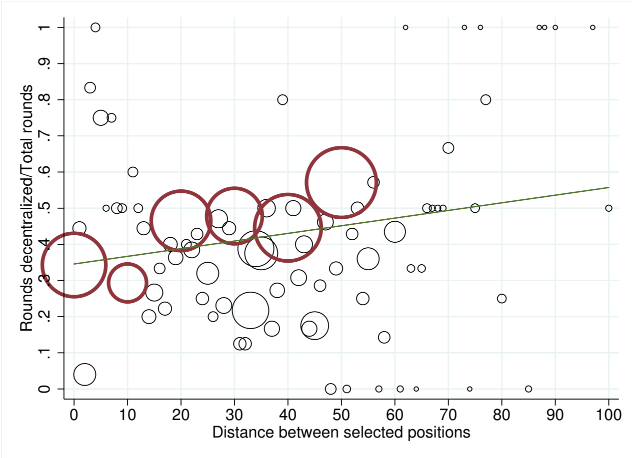
The optimum distances between positions predicted by the model are 16, 30, 38 and 40 in the centralized rounds for the 20, 50, 80 and 90% treatments respectively and 46 for all treatments in the decentralized rounds.[25] A brief overview of the data shows that the average distance between positions in the centralized and decentralized stages are 30.23 and 29.22, respectively. On aggregate, we see no clear or statistically significant difference. In the selector stage, the average distance between positions in the centralized rounds becomes 29.71 and 32.61 in the decentralized rounds (Mann-Whitney two-tail test, $p < 0.01$). This direction is in line with prediction 2, though not as large as predicted by the model. It also provides initial evidence that participants may be learning to play more optimally with experience, at least in the decentralized rounds. However, a pairwise signed rank test is suggestive but not conclusive given the repeated decisions made by each manager. We next explore more robust tests of the relationship between team composition, delegation and the manager's level of task uncertainty.

Figure 6 plots the percentage of decentralized rounds by the distance between positions in the Selector Stage. We use the frequency of observed heterogeneity to weight each observation,

[25]In this section, we use the distance between selected positions as a measure of the team heterogeneity. We are able to use this simplification because in 51% of the cases the positions selected are perfectly symmetric - $\theta_1 + \theta_2 = 100$ - around the ex-ante expected task, which takes the value of 50. Moreover, we get that in 73% of the rounds the positions are very close to be symmetric ($\theta_1 + \theta_2 \in [90, 110]$).

represented by marker diameter. Approximately 63% of the sample is captured by the clusters shown in bold. These clusters also contain 68% of the total number of decentralized rounds during the Selector Stage. The correlation shown by the linear trendline is approximately 0.1 and it is significant at the 5% level. At the same time, we see a concentration of perfectly homogeneous teams, which appears to a varying degree among all treatments.

FIGURE 6: DELEGATION AND TEAM HETEROGENEITY



Notes. Plot of the percentage of decentralized rounds in the Selector Stage (y-axis) by distance between worker positions (x-axis), along with a linear fit. The observations are weighted by the frequency of each chosen distance. The bold bubbles represent 63% of all rounds played on the Selector Stage.

Table 2 reports regression results that further test for correlation between delegation and team selection decisions.[26] Column 1 shows no direct relationship between delegation and team heterogeneity. Furthermore, the included treatment dummies have no direct effect on team heterogeneity once we control for the organizational structure. In column 2 we see that all lagged variables are significantly related to team heterogeneity even when we consider them together. This suggests that the prior delegation and distance from optimal positions impact current heterogeneity more than current delegation, while delegation itself may have an additive effect over time.

From Table 1, we know that there is a relationship between the delegation choice and both the lagged delegation decision and lagged team heterogeneity. As a consequence, the observed relationship between heterogeneity and delegation in Table 2 is not unexpected. Comparing results from Table 1 and Table 2 highlights different drivers of these two decisions. Beyond the fact that both decisions depend on the lagged decision of the individuals, the decision to delegate depends on the quality of information (the treatment variable), while for team heterogeneity this is not true. Finally, the last two columns split the selector stage in two halves. As in Table 1, we see evidence of learning. Model 3 suggest that agents are relying more on payoffs and their previous team heterogeneity decision since they may not have settled on their preferred organizational structure. Once they have determined their preferred structure, they do not rely

[26]These regression results are not intended to argue a causal relationship necessarily, as managers may have determined their team heterogeneity based on intended organization structure or vice versa.

further on prior payoffs but rather on their prior delegation decision (Model 4).

Table 2: Team selection: distance from optimal positions in selector stage

	Full Sample		Rounds 1-8	Rounds 9-16
	(1)	(2)	(3)	(4)
$Delegation_{ir}$	-2.599	0.625	1.150	0.134
	(1.76)	(0.77)	(1.42)	(0.91)
$Payoff_{ir-1}$		-0.046**	0.104***	0.008
		(0.02)	(0.04)	(0.04)
$Dist.to.Opt_{ir-1}$		0.641***	0.595***	0.689***
		(0.04)	(0.05)	(0.05)
$Delegation_{ir-1}$		-2.153***	-2.848*	-1.432*
		(0.95)	(1.50)	(0.80)
Constant	15.927***	8.228***	10.252***	5.868**
	(3.75)	(2.17)	(2.32)	(2.37)
$TreatmentDummies$	Yes	Yes	Yes	Yes
$RoundDummies$	Yes	Yes	Yes	Yes
$Demographics_i$	Yes	Yes	Yes	Yes
N. obs.	1888	1770	826	944
N. clusters	118	118	118	118
R^2	0.041	0.444	0.417	0.478

Notes. * p< 0.1; ** p<0.05; *** p<0.01. OLS estimation with standard errors clustered by manager. $Delegation_{ir}$ is a dummy variable taking value 1 if the manager i delegates in round r, $Payoffs_{ir}$ are the payoffs per round in experimental currency obtained by participant i in round r and $Dist.to.Opt_{ir}$ is the distance between positions selected by the participant i on round r. Demographic controls are identical to those in Table 1.

In examining team selection more closely, we find a curiously high number of perfectly homogeneous teams, $\theta_1 = \theta_2 = 50$, particularly in the 80% and 90% treatments, in which about 11% of teams are perfectly homogeneous. Note that when a manager selects such a team, the delegation decision no longer matters for the final outcome. This decision greatly simplifies a manager's problem, but limits them to a minimum expected payment per round. Some managers may see this strategy as a safe option when they are unable or unwilling to find the optimal team composition.

This raises more questions: how do managers end up playing this strategy and why is it more prevalent in environments with low uncertainty? Looking at behavior over rounds, it is clear that participants react to conflict outcomes, as they did for the delegation task.[27] To explore this effect we regress team heterogeneity on lagged heterogeneity, lagged bad outcomes (using a dummy variable), and an interaction term. The marginal effects of these regressions are shown in the appendix.

[27]We focus here on the first two stages to isolate their reactions on a situation where managers could only vary their team composition. We include cases when the distance between positions is not equal to zero in round $t-1$. However, the results using the full sample do not change, since those selecting perfectly homogeneous teams persist in this strategy.

In all treatments, both in centralized and decentralized rounds, we see a pattern in which managers with more heterogeneous teams respond to bad outcomes by selecting more homogeneous teams. Note that this phenomenon may be triggered by low payoffs even when managers play the optimal strategies as a consequence of the random realization of the tasks in the game. Although the likelihood of low payoffs when managers choose the optimal positions is lower, it may be enough to drive team selection away from the optimal strategy.

What exactly is causing managers to reduce heterogeneity in response to bad outcomes? One explanation is that we are observing something akin to loss aversion [Kahneman and Tversky, 1979; Kőszegi and Rabin, 2006]. However, the exhibited behavior is also potentially consistent with Selten's learning direction theory [Selten and Buchta, 1999; Selten and Stoecker, 1986], in which an errant behavior is corrected for by moving farther in the opposite direction to the prior wrong action. While learning direction theory cannot explain the fact that we see the strongest reactions in the direction of more homogeneity when this is further in the "wrong" direction from optimum, we cannot conclusively rule out either explanation.

Overall, then, managers are choosing slightly more heterogeneous teams in decentralized groups. This allows them to minimize the potential for incentive conflict and encourages more frequent switching of tasks between workers.[28] However, we also see evidence of managers reacting to conflict by reducing heterogeneity, sometimes removing it completely. Such reactions suggest that some managers react impulsively to bad outcomes, which we investigate in the next section.

5.3 Managerial Characteristics

The evidence thus far suggests that the benchmark model's predictions find some support, but with quite a lot of noise in the data. This suggests that there may be identifiable differences between managers, which could better explain our results. In this section we examine the extent to which risk preferences and cognitive ability drive differences in manager behavior. Specifically, we compare delegation and team selection choices by low ability (CRT $= 0$) and high ability (CRT > 0) managers.[29]

In our data, 60 managers answered zero questions correctly, 31 answered one question, 21 answered two, and 7 answered all three questions correctly. Thus, our managers are split nearly in half by separating positive scores from zero scores. We then classify managers as more risk averse (EG choice ≤ 4) or more risk tolerant (EG > 4). This again splits our managers nearly

[28] The dynamic nature of the experimental setting creates a dependence of workers' decisions on their history of play, which represents a challenge to simple interpretation of our coefficients. For a more conservative view, we regress each manager's average distance between positions in the Selector stage on the total number of delegated rounds chosen. The correlation between these two variables is positive and significant, with the impact of delegating one round more associated with an increase in worker heterogeneity of 0.86. When we split the Selector stage in half, we see that the relationship grows over time. As before, treatment has no impact on team heterogeneity.

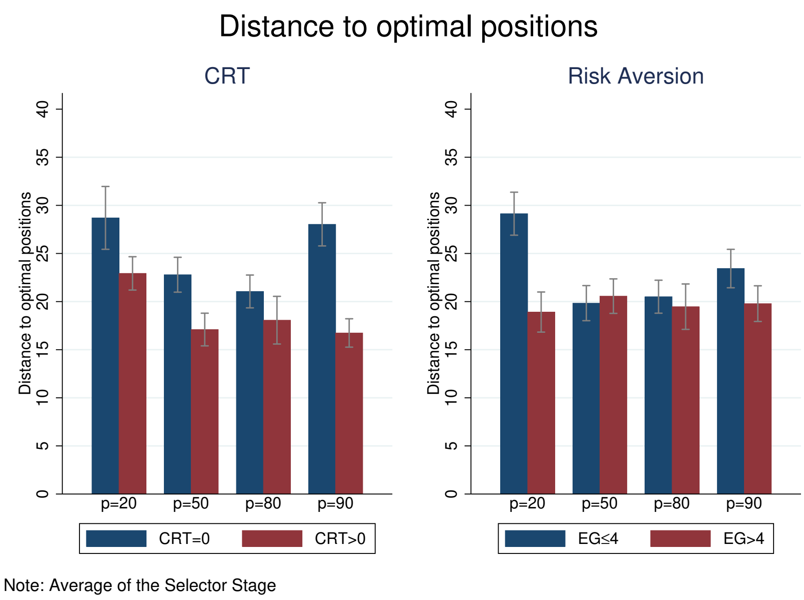
[29] We follow Brañas-Garza, García-Muñoz and González [2012] and Corgnet, Hernán-González, Kujal and Porter [2014] in pooling CRT scores above zero, as a correct answer on any of the three questions indicates some ability to override one's initial impulse.

in half with treatments well-balanced.[30] Like many prior studies, we find positive but relatively modest correlation between high CRT and more risk tolerant managers ($\rho = 0.23$, $p < 0.001$ using a two-tailed t-test).

Recall Figure 2 in section 3, which shows that reducing team heterogeneity increases the regions in which managers experience conflict. However, in the previous section we show that It may be that managers have strong intuition to reduce heterogeneity to shield from future bad outcomes, but this actually exacerbates their likelihood to experience conflict. Those managers who can resist this intuitive reaction may perform better. To address this, we examine team selection choices of high performing and low performing managers on the CRT, as well as managers more or less prone to risk aversion.

We see in Figure 7 that high ability managers do significantly better in their team selection decisions in all treatments. Note in particular the large deviation by low ability managers in the 90% treatment. This result is driven largely by these managers choosing perfectly homogeneous teams, more so than in any other treatment. This seems contradictory, but because these managers faced reduced uncertainty, they were more likely to observe realized conflict in each round - they were more able to recognize when workers made decisions against their will. Similarly, we see that managers more accepting of risk select teams closer to the benchmark predictions, though these differences are significant only in the highest and lowest information treatments.

FIGURE 7: TEAM SELECTION BY COGNITIVE ABILITY IN EACH TREATMENT

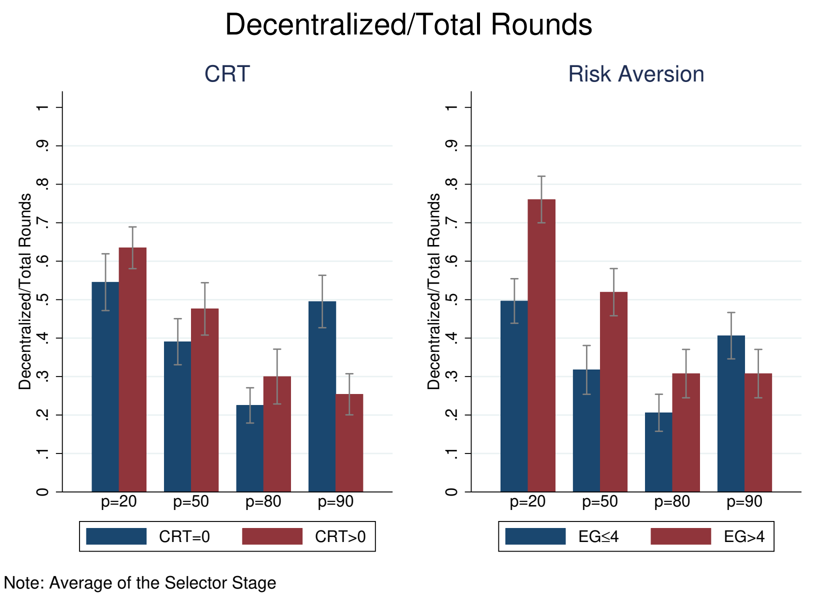


Notes. Plot of the average distance from the optimal positions in the Selector stage of each treatment, based on (a) manager performance on the CRT and (b) the EG choice.

[30]Dividing the risk measure into EG ≤ 3 vs EG > 3 also divides the data relatively equally, but leaves large between-treatment asymmetries. We therefore decided before conducting data analyses to use the break along an EG choice of 4. The results do not differ noticeably from what we report here.

These differences in performance appear just as strongly in the delegation task, but now we see risk tolerance play a larger relative role. Figure 8 (a) shows that high ability managers delegate more frequently in every treatment except for the 90% condition. Recall that the latter is the one treatment in which centralization is optimal, yet here we see a significantly higher rate of delegation by low ability managers, both compared to high ability managers in the same treatment and other low ability managers in the 80% and 50% treatments. In figure 8 (b), we see that risk tolerance has a larger positive effect in all treatments except the 90% condition.

Figure 8: Delegation by Cognitive Ability in Each Treatment



Notes. Plot of the percentage of delegation in the Selector stage of each treatment, based on (a) manager performance on the CRT and (b) EG choice.

To examine the individual impacts of these behavioral traits more formally, we next turn to regression results. Table 3 reports the effects of risk and CRT measures on each manager's delegation and team selection decisions in the Selector stage. Model 1 examines the effects of risk preference and cognitive ability on delegation, controlling for demographic characteristics, round, and treatment. Model 2 adds lags for payoffs, team composition, and delegation. In both specifications, we see that managers more willing to accept risk delegate more, though we lose significance once lags are included.[31] The dependent variable in the right-hand columns is a team's combined distance from optimal positions, measured for each round of the Selector stage. We find that high ability managers choose teams closer to optimal, but once we include cognitive ability, risk preferences no longer have a significant impact on team selection, though their coefficients are in the expected direction.

These differences combine to create meaningful differences in manager payoffs. Figure 9 shows that low ability and more risk averse managers are significantly farther below their

[31]Interestingly, high cognitive ability does not appear to have an effect on the delegation task when controlling for risk and treatments. In fact, if we remove treatment dummies, high CRT managers do significantly better in delegating when optimal, even controlling for risk. The data are distorted by the 90% treatment, in which we see the fewest high CRT managers.

Table 3: Managerial Decisions, Risk Preference, and Cognitive Ability

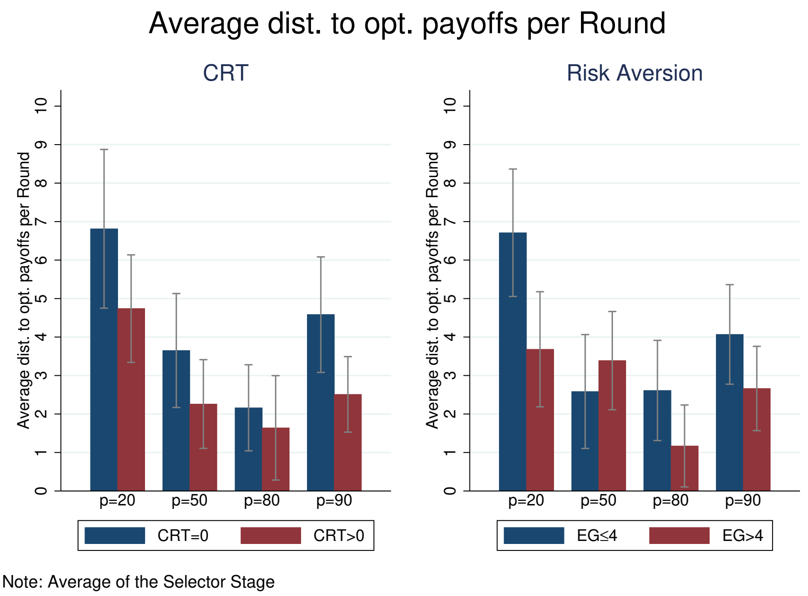
	Delegation		Dist. to Optimal Positions	
	(1)	(2)	(3)	(4)
$Delegation_{ir}$			-2.622	0.526
			(1.66)	(0.76)
$EG > 4_i$	0.534*	0.356	-1.603	-0.361
	(0.32)	(0.23)	(2.36)	(0.89)
$CRT > 0_i$	-0.244	-0.311	-6.628***	-2.638***
	(0.32)	(0.22)	(2.46)	(1.00)
$Payoff_{ir-1}$		0.004		-0.047**
		(0.01)		(0.02)
$Dist.to.Opt_{ir-1}$		-0.014**		0.624***
		(0.01)		(0.04)
$Delegation_{ir-1}$		2.028***		-2.174**
		(0.26)		(0.83)
Constant	-1.811***	-2.029***	19.670***	9.919***
	(0.57)	(0.50)	(4.00)	(2.36)
Controls	Yes	Yes	Yes	Yes
Treatment Dummies	Yes	Yes	Yes	Yes
Round Dummies	Yes	Yes	Yes	Yes
N	1888	1770	1888	1770
r2	0.087	0.234	0.083	0.450

Notes. * p< 0.1; ** p<0.05; *** p<0.01. Models 1 and 2 use logistic regression with standard error clustered by manager. Models 3 and 4 use OLS estimation with standard errors clustered by manager. $Delegation_{ir}$ is a dummy variable taking value 1 if the manager delegates in that round, $EG > 4_i$ and $CRT > 0_i$ are risk and CRT measures for manager i. Also included are one-round lagged variables for payoffs ($Payoff_{ir}$), distance to optimal positions ($Dist.to.Opt_{ir}$), and delegation decision ($Delegation_{ir}$). Controls are identical to those in Table 1.

maximal earnings. In particular, note that low ability managers are nearly 2 ECU farther away in both the best and worst information conditions. Likewise, risk averse managers lag their counterparts by about 3 ECU in the 20% condition. These per-round differences in payoffs amount to high ability managers earning the equivalent of more than two additional rounds of play. The low ability types are so far behind, its as if they stopped the experiment early. Similar results are seen when comparing more and less risk tolerant agents.

The data, then, show somewhat weak support for the benchmark model's predictions. When we consider behavioral characteristics, though, we see that cognitive ability and risk tolerance greatly increase managerial success in this complex environment. As predicted, higher cognitive ability lends greater support to the team selection task by rewarding managers who resist the intuitive urge to reduce heterogeneity in response to a single bad outcome. Risk tolerance translates more strongly to the delegation task, benefiting managers more willing to rely on their workers' better information.

Figure 9: Average Payoffs by Cognitive Ability in Each Treatment



Notes. Plot of the distance between optimal and average realized payoffs (in ECU) in the Selector stage of each treatment, based on (a) manager performance on the CRT and (b) EG choice.

6 Conclusion

Our study highlights the interrelatedness of personnel and institutional decisions in organizations. It also shows how difficult managerial decisions can be when multiple facets must be considered at once. Given the prevalence of managers outside the lab who control both hiring and delegation, it is critical to understand this link. To the extent that managers differ in their abilities, can we identify personal characteristics that drive these differences?

To begin exploring these questions, we develop and experimentally tested a benchmark model of managerial decision making in which managers chose their team's personnel and decision structure in concert. As in organizations outside the lab, we see substantial heterogeneity in managerial decisions. While we see lower levels of delegation than predicted, we do find some reassuring evidence: Managers respond to growing task uncertainty by delegating more, in line with the model using fixed team positions. We also see more diverse teams selected in decentralized versus centralized teams, as predicted.

Interestingly, our data suggest that cognitive ability and risk tolerance may be complementary, in that they impact different dimensions of managerial decision making. High-CRT managers are able to resist impulsive, seemingly defensive, reactions to probabilistically unlikely outcomes. However, we find that managers who struggle with making intuitive choices overreact to bad outcomes, and better feedback actually *exacerbates* the problem. As uncertainty declines, the effect becomes more evident. This result reinforces the difficulty that managers face; as they are tasked with making many decisions under varying degrees of time pressure, the ability to reflect on each decision becomes even more important.

Managers more willing to accept risk show greater willingness to delegate when optimal.[32] Here, we offer a novel contribution to the study of risk in organizational settings. While risk tolerance has been linked to entrepreneurial and executive success, our study is the first to offer a causal link from individual risk tolerance to organizational structure itself.

Our model is best seen as a step towards better understanding the complexities of managerial and organizational decision making. We theoretically capture two important characteristics of managerial decision making and the data suggest that many of the tensions in the model have real impact on behavior. The experimental data also highlight just how difficult it can be to handle two such critical decisions. Our results suggest that choosing the right team is critical, and even reduces the harm of choosing a suboptimal organizational structure. Some of the managers in our study do not appear to improve with experience. In the experiment, this costs them a noticeable amount in payoff reduction. Outside the lab, we may even see worse results for many managers: most people unable to effectively manage these tasks may not keep their job or receive a second chance.

The findings here point to several areas for future research. For one, how does organizational communication affect the dynamic between team selection and delegation? Recent theoretical research mentioned above places communication technologies front and center, and for good reason. Incorporating such channels into our framework will allow us to more directly connect to this work. Additionally, our static model fails to account for the dynamics underlying managerial behavior, such as learning and the effects of feedback. Incorporating such dynamics may allow us to comment on the nature on how these decisions evolve within organizations. There are many other managerial characteristics that impact decision making connected to these dynamic phenomena, including overconfidence, locus of control, and social preferences. Each deserves study in order to advance our understanding of how individuals can impact the structure and function of institutions.

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[32] Again, here, it is important to mention that high-CRT managers seem to perform better on the delegation task as well, though the effect falls short of conventional levels of statistical significance due to the 90% treatment.

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