Antonio S. Mello
Martin E. Ruckes
University of Wisconsin–Madison

Team Composition*

This paper presents a model of team composition. Heterogeneous teams have a greater variety of information sources than homogeneous teams. If information and preferences can be expressed openly, heterogeneous teams reach better decisions. However, members of heterogeneous teams are more likely to diverge in their preferences with respect to courses of action, which is reflected in lower effort. Team leaders who are likely to be either uninformed or well informed about project payoffs prefer to form homogeneous teams. Authority vested in the team leader to replace a subordinate affects the sharing of information and may diminish the value of heterogeneous teams.

I. Introduction

Some firms actively promote heterogeneity when they make up workplace teams. Two advertisements can exemplify the way organizations use team selection to motivate performance. In the first, Goldman Sachs proclaims the following in bold letters: "The good news is great minds don't think alike. . . . We believe the best ideas come from a room full of differing opinions. With our substantial global resources, we're able to bring different minds and disciplines to the table. The result is out of the box thinking instead of conventional solutions" (*Economist*, February 2000). Bell Atlantic promotes achieving innovative thinking in a diverse working environment: "At Bell Atlantic we believe in the power of diversity and the power of the individual. It is individual thinking from a diverse group of people working together that provides fresh new ideas and gives us a competitive edge (*New York Times*, January 17, 2000).

Forming heterogeneous work units in organizations seems to make some sense. In a heterogeneous work group, members have significantly different backgrounds and experiences. Examples of differences might be demographic characteristics, such as age or sex; social background, including class and ethnic origin; or professional development, such as education

* We thank Werner DeBondt, Mathias Dewatripont, Martin Hellwig, Jos Jansen, Benny Moldovanu, Joachim von Rheinbaben, and Konrad Stahl for helpful discussions. Contact the corresponding author, Antonio Mello, at amello@bus.wisc.edu.

[*Journal of Business*, 2006, vol. 79, no. 3]

0021-9398/2006/7903-0001$10.00

and organizational tenure. Hoffman and Maier (1961) note that heterogeneity of backgrounds and experiences allows a group to draw on very different sources of information and enables it to identify superior alternatives in the decision process. This makes intuitive sense. Suppose that two people work together on a project; one has an engineering background and the other a business degree. The engineer is usually better informed about the technical details, whereas the partner with the business background has better knowledge about the project's economic feasibility. Similarly, a recent graduate just starting out may be more familiar with the latest academic work, and a more seasoned employee will be better acquainted with the practices the company has followed in the past and their results.

Not all firms seem to put the same emphasis on heterogeneity, though. Eisenhardt, Kahwajy, and Bourgeois (1997) find significant differences in the heterogeneity of the management boards of 12 technology-based companies in California's Silicon Valley. There is also some empirical evidence that the performance of heterogeneous groups is actually worse (see O'Reilly and Flatt 1989; Ancona and Caldwell 1992). Poorer performance in heterogeneous groups can occur because the differences among characteristics of group members are positively related to differences in their preferences. The members' different backgrounds and experiences in this case represent a weakness for the team.

Many arguments can be made for a strong association between differences in people's characteristics and differences in individual preferences. On the one hand, different individual preferences often lead to differences in personal characteristics. Most people, for example, do not decide on their professions at random, but make choices determined by their personal interests. Greater interest helps stimulate curiosity and makes learning easier, increasing the odds of professional success. An engineer is, on average, more interested in a high-tech innovation than someone with no technical training.

On the other hand, and perhaps more economically significant, different characteristics also lead to different interests. Young employees more often favor projects that allow them to be visible and demonstrate their abilities faster, and this makes them work hard to promote innovative ideas and novel applications. More senior staff prefer to stick to known practices and thus avoid placing their reputations at risk (see Prendergast and Stole 1996). Employees closer to retirement age have career concerns very different from those of younger employees, and such differences can lead to a collision of interest between the two generational groups (see Gibbons and Murphy 1992).

Empirical research also documents the dependence of behavior on personal characteristics. Bertrand and Schoar (2002) find that older managers, on average, act more conservatively than their younger counterparts and that managers with an MBA, on average, follow more aggressive strategies than those without.

We examine the influence of these factors on the optimal composition of

teams. The research framework is a simple two-person hierarchy in which a superior can select a subordinate who is similar in characteristics (homogeneous team) or a subordinate who has different characteristics (heterogeneous team). The superior decides on the project undertaken, and the subordinate is responsible for its implementation. Both team members are assumed to potentially receive information about the payoffs of the prospective projects. Since members in a heterogeneous team have access to different information sources, their information arrival is less correlated. This increases the likelihood that the group will choose a superior project. Good decision making also positively affects the subordinate's motivation to work hard in implementing the project. Members of a heterogeneous team may also prefer different projects, however, because different personal characteristics are associated with different interests. When a superior chooses a project not preferred by the subordinate, the subordinate is assumed to exert less effort to implement it.

Our analysis of the basic trade-off between access to more varied information sources and reduced implementation effort when team members' preferred projects are not the same yields a number of novel implications. One is that a heterogeneous team performs better only when the superior is either very likely or very unlikely to be informed about the payoffs of potential projects. A superior likely to be well informed needs the input from the subordinate less frequently and therefore minimizes the potential of reduced implementation effort by forming a homogeneous team. This may explain why some chief executive officers of corporations seem to prefer the company of "yes men." Yet, when the superior is likely to be uninformed, perhaps heading several work groups at the same time, even a subordinate with characteristics similar to those of the superior can contribute a lot to the decision, so a heterogeneous group is not needed. Another implication of the model is that the less likely it is that team members can obtain information about project payoffs, the more likely a heterogeneous team will be formed. In these situations, additional information is very valuable, and a heterogeneous team, on average, has more information than a homogeneous one.

We also analyze the effects of the superior's authority to replace the subordinate. At first glance, the possibility that a subordinate can be replaced would encourage experimenting with a heterogeneous team. The aim would be to gain a high level of information and then when preferences for projects diverge to replace the subordinate. When a subordinate who can speak freely is afraid that frankness might cause retaliation, though, serious obstacles to the free disclosure of information and preferences arise. It is then possible that a team of heterogeneous individuals might display an unusual degree of conformity, because the subordinate strategically withholds relevant information to protect himself or herself. If this is the case, the information advantage of a heterogeneous team vanishes. This is particularly detrimental when more information would greatly help the team to reach the right decision.

It is paradoxical that in these situations it is better to have a homogeneous team, which may lack access to varied information sources but has members whose preferences are aligned.

It is possible to find ways to prevent the breakdown in communication between team members. We analyze several of these. One is simply to reverse the policy of granting replacement authority to the superior. This gives the subordinate a greater incentive to reveal his information, which helps to improve the quality of decisions. Another measure is to introduce some degree of ignorance on the part of the superior, for example, by purposely creating some distance between the superior and the issues relevant to the decision. This greater ignorance requires the superior to rely more on the subordinate's participation in the decision. This form of empowerment is especially important when it is necessary for the team to rely on more varied information for reaching the right decision.

The paper is organized as follows. Section II reviews the literature related to the topic of the paper. Section III contains the basic model and identifies the trade-off between a better-informed and diverse team and a more homogeneous and harmonious team. Section IV introduces the possibility of replacement to avoid differences in preferences and analyzes how this authority affects the flow of information and recruiting decisions. Section V presents concluding remarks.

II. Relevant Literature

Our work is related to the literatures on organization demographics and the economics of organizations. Since the 1980s, organization science has displayed an interest in the study of demography and the design of teams. Substantial field research indicates that the composition of teams has a significant influence on many outcomes. While most of the scholarly management work is exploratory in nature, the demographic composition of teams has been related to turnover (Pfeffer 1983; Wagner, Pfeffer, and O'Reilly 1984); to the incidence of disputes (Amason 1996), to team innovativeness (Ancona and Caldwell 1992), to the decision-making process in top-management teams (Eisenhardt et al. 1997), and to the strategic reorientation of firms (Wiersema and Bantel 1992). All these studies seem to imply that performance and the quality of work life in organizations depend on the interaction that occurs between and within different groups, as well as how that interaction relates to differences in the composition of teams.

In economics, some papers (like ours) explicitly address the composition of teams in organizations, but no research has so far attempted to link group heterogeneity and decision quality on the one hand and decision quality and implementation effort on the other. Cornell and Welch (1996), for example, argue that employers tend to recruit employees with the same cultural backgrounds as their own, since it is easier for them to assess the quality of applicants. Athey, Avery, and Zemsky (2000) show that, in hiring and pro-

moting, the success obtained in mentoring can be as important as talent, and they argue that mentoring is easier when the manager and the trainee have the same background. In contrast to these papers, our work focuses on how the degree of team heterogeneity contributes to problem solving. Athey et al. and Cornell and Welch also ignore the agency problems that often arise in work groups. This is not the case in the article by Friebel and Raith (2004), who analyze recruiting in an agency context when the recruiter and the recruitee compete for the same position. We consider agency conflicts at a different stage, after recruiting, which allows us to analyze the relationship between the level of heterogeneity of a team and the degree of conflicts of interest within the team.

Our work is complementary to recent research on corporate culture. An interesting example is the paper by Carrillo and Gromb (2002), who study how culture takes root and is disseminated in organizations. As they do, we find that team heterogeneity is especially suitable for dealing with dynamic and uncertain situations. The two papers also find that group members interact better if they share the same characteristics. Carrillo and Gromb, however, do not consider any incentive problems that may arise to affect the dynamics in groups.

In our analysis, communication occurs in a way similar to that in Prendergast (1993), who develops a model of communication in hierarchies in which subordinates are subject to subjective performance evaluation. Prendergast shows that subordinates will slant their reports to say what they think the superior wants to hear in order to receive favorable evaluations. We demonstrate that staff incentives to communicate information truthfully can be hampered even if subordinates' qualities are known to the superior. The reason is that withholding valuable information can be optimal if communication provides relevant information about the preferences of a subordinate with career concerns.

We find that formal authority is an important factor in explaining the degree of heterogeneity in teams. This makes the analysis of allocating authority an important element of our work. As in Aghion and Tirole (1997), we recognize the difference between formal and informal authority. Despite lower rank, a subordinate can sometimes decisively influence the superior's decision. In our model, as in Aghion and Tirole's, informal authority comes from being better informed (see also Dessein 2002). De Bijl (1994) studies the way strategic delegation of decision authority creates incentives to acquire information. We deal with a different kind of authority in many hierarchical relationships: the right to replace a subordinate. Limiting the level of authority of the superior can at times actually be in the best interest of the superior. In our case, this happens because limiting authority gives other team members greater incentives to disclose decision-relevant information when they are not likely to suffer negative consequences. We are then able to explain how the balance of authority between different members of a team affects both the composition of the team and the rules of engagement for them.

III. A Model of Recruiting in Organizations

In this section, we develop a model of interaction between a superior and a subordinate and identify the trade-offs that exist between collecting and sharing information of different sources and the degree of coincidence in preferences for different types of teams.

A. *Setup*

We consider a work unit with two members. Teams generally are not leaderless. Among the various alternatives for team leadership, the most common is a hierarchy. We consider a team with a superior, P (standing for principal), and one subordinate, A (standing for agent).[1]

It is natural to think of group members as individuals, with P as a higher-ranked individual (e.g., a division head or a CEO of a company) and A as the subordinate. The analysis can apply to groups as well as to members. For example, P could be the board of a company, and A could be either the CEO or the executive committee that is responsible for implementing the decisions reached by the board.

The team must decide whether to adopt a new project or to continue with the current operations. Both team members gather information on the payoffs of the new projects. After screening the projects, the team members may decide to communicate their findings. The principal P has the authority to decide the course of action after consulting with A. Once a new project has been selected, A is responsible for its implementation.

The members of the team are assumed to be risk-neutral.

Projects and payoffs.—There are at least three new projects, $n \geq 3$. The projects are ex ante identical but yield ex post different payoffs for the team members. To P, each project, $i \in \{1, \ldots, n\}$, yields a payoff η_i. His most preferred project yields $\eta > 0$. The team members' preferred projects may not coincide. Member P's payoff is lower if A's preferred project is implemented and it is not P's best project, $\eta_i = \mu\eta > 0$, where $\mu \in (0, 1)$. If no new project is selected, P obtains η_0, which for simplicity we set to zero. Member P also receives an additional amount $\kappa > 0$ if the project is implemented well by A. All profits are gross of any monetary compensation to A. All payoffs are assumed to be nonverifiable and therefore noncontractible.[2]

The payoff for the subordinate depends on three components: (1) his wage, (2) a private benefit associated with the project, and (3) the effort expended on implementing the project. With noncontractibility, the subordinate's wage, w, is constant and is assumed nonnegative. For A, a new project, i, yields a

1. Some form of recognized leadership is typically needed for teams to function properly. The consulting literature recognizes that in practice there are rarely teams without an explicitly identified hierarchy and that in relatively few circumstances will a leaderless team perform well (see, e.g., Katzenbach 1997).

2. While allowing for performance-related contracts mitigates the incentive problems we describe, it generally does not resolve them.

private benefit of $b_i > 0$ if the project is implemented well and zero otherwise. The private benefit includes, for example, acquisition of human capital and differential treatment resulting from signaling of competence. In the case of the status quo, that is, if no new project is chosen, A's private benefit is b_0; if the preferred project is selected, it is b_+. If the team members' preferred projects do not coincide, P's preferred project yields private benefits to A of $b_- \in (0, b_+)$.

Individual A's effort in implementing the project is measured by the probability of its success, $e \in [0, 1]$. Expending effort is costly: A incurs a nonmonetary cost given by an increasing and strictly convex function $C(e)$. His expected utility is then $u(e) = E[b] \cdot e - C(e) + w$. For convenience, $C(e)$ is assumed to lead to a unique interior solution, $e^* \in (0, 1)$. A necessary and sufficient condition for this is that $E[b] = C'(e)$.

If A expects the private benefit to be b_+, his optimal effort choice satisfies $b_+ = C'(e)$. We denote this effort level by e_+ and A's corresponding utility level by u_+. Analogously, we define e_- and u_- as well as e_0 and u_0 as the effort and utility levels if A expects the private benefit to be b_- and b_0, respectively. It holds that $e_-, e_0 \in (0, e_+)$ and $u_-, u_0 \in (0, u_+)$.

Information acquisition and divergence of preferences.—Information about each project's payoff is potentially available from two different sources, Y and Z. When P screens the new projects, she obtains information about her payoffs from source Y with probability $\alpha q \in (0, 1)$, at no cost. She does not obtain any information from source Z. An informed P can learn her own payoffs received from each project accurately.

Individual A also gathers information, and this allows him to learn about his benefits. This occurs with probability $q \in (0, 1)$. The information A gathers can be used to select a project.

To collect information, A has access to one of two sources of information. To characterize differences in the degree of heterogeneity of teams, we introduce two types of subordinates, A_Y and A_Z. Subordinate A_Y is assumed to have access to information source Y and A_Z to source Z. Individuals with similar characteristics are more likely to use related information sources. People with similar training rely on the same overall body of knowledge; individuals with a long and similar organizational tenure have the same sort of information by which they can judge new opportunities. Individual A_Y has characteristics relatively similar to those of P. It is then natural to assume further that the information arrival of two individuals who access the same source is more highly correlated when the sources themselves provide valuable information with a probability of less than one. For simplicity, we assume that information arrival for an A_Y type is perfectly correlated to that of P; that is, if $\alpha > 1$, A_Y obtains information only if P also obtains information. Perfect correlation of signal arrival is not necessary for the results but makes the analysis much simpler. The information arrival for a type A_Z individual is assumed independent of that of P. Here, some level of correlation could also

be assumed. What is important is that there is a higher correlation between A_Y and P than between A_Z and P.

Differences in characteristics are associated not only with different information sources but also with different preferences. For example, P may be close to retirement, and A_Z may have just finished his education. Because their professional perspectives are significantly different, it is likely that they prefer different projects. Consistent with this, P and A_Z are less likely to prefer the same project than P and A_Y. Specifically, we assume that preferred projects of P and A_Z are the same with probability $r \in (0, 1)$ and those of P and A_Y are the same with probability one.

We make a few parametrical assumptions to simplify the exposition. To avoid an unnecessary analysis of A's participation decision, we assume that his utility is above his reservation utility in all cases and that $w = 0$.[3] We also assume that the payoff of a project is not too low compared to the effect of exerting low effort, $(1 - \mu)\eta > \kappa(e_+ - e_-)$. This rules out A forcing P to choose P's less favored project because she expects low effort from A, although the results are unchanged if this assumption is relaxed. We also assume that if P does not have any information, she does not choose a new project and always stays with the current operations. This means that the expected profit from all projects is lower than the status quo profit, κe_0. Subordinate A also prefers the current operations to a randomly selected new project.

Communication.—Following the screening of the projects, A may propose a project to P before P selects a project. If an informed proposal is forwarded, this provides valuable information to P. She can learn about the proposed project's payoffs for her after receiving a recommendation from A if she has not obtained a signal on her own. That is, by listening to and reflecting on the subordinate's informed proposal, P can see the pros and cons of this alternative. If a proposal is made without any information, P does not learn anything about her payoff from the proposed alternative. Analogously, we assume that A is able to obtain information about his own benefits following P's informed selection of a project.

Sequence of actions.—The timing of the decisions is illustrated in figure 1. At [1] P hires A, and the two form a team. When P is indifferent between the two types of subordinates, A_Z is hired. At [2] the parties privately collect information about the payoffs of the alternative projects. At [3] P invites A to make a proposal; A may decide to do so or not. He can stay silent (or say nothing of relevance). When A is indifferent between proposing a project to P and not doing so, he is assumed to make a proposal. At [4] P chooses a

3. At first glance, this might suggest that one way to improve performance is to employ two subordinates of different types and give A_Z the task of collecting information and A_Y the responsibility of implementing the project. There are many reasons this may not be effective. For example, even a low fixed cost of collecting information would make this alternative arrangement suboptimal. A subordinate hired solely to collect information cannot be motivated to do so since his benefits are unrelated to the obtaining of information. More generally, if the member responsible for collecting information needs to share data with the member responsible for moving forward with the decision, problems with biased communication will not disappear.

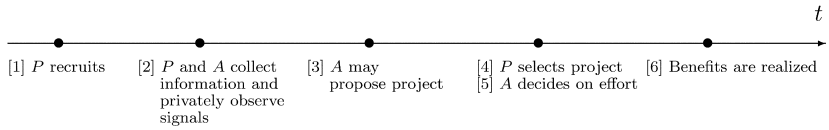

FIG. 1.—Timing of decisions

project (either one of the new alternatives or the status quo project). Her choice reflects her own information and preferences. She may obtain information directly or from listening to *A*'s recommendation. At [5] *A* decides on the effort he will expend to implement the selected project, and at [6], following completion, the benefits to both parties are realized.

All parameters of the model are assumed to be common knowledge. As usual, we proceed backward in the analysis. In the next subsection we analyze *P*'s hiring decision and relate team composition to decision quality and implementation effort exerted.

B. Analysis

We start by looking at the communication between *A* and *P*. In a team composed of A_Y and *P* (a homogeneous team), there is no divergence of preferences, and A_Y sees no problem in conveying his preferred project to *P*. In a team composed of A_Z and *P* (a heterogeneous team), A_Z does not know whether *P* is informed. He knows that if *P* has received a signal on her own, she ignores his recommendation. If *P* is not informed, however, she is better off adopting A_Z's proposal.[4] When *P* is not informed and does not obtain a signal from communicating with A_Z, she chooses to continue with the current project and her payoff is lower. Understanding that a recommended project is sometimes adopted motivates A_Z to reveal his choice to *P*. She always welcomes a proposal by A_Z, since communication never reduces her payoff and sometimes improves it.[5] A formal proof of this result is omitted since it is straightforward.

LEMMA 1. If a subordinate, *A*, obtains information, he always proposes his preferred project to the superior, *P*.

We now proceed by looking at the formation of teams of different types. Suppose that a type A_Y is hired. Using lemma 1, we can write *P*'s expected utility when A_Y is employed, Π_Y, as

$$\Pi_Y = \max\{\alpha, 1\}q(\eta + \kappa e_+) + (1 - \max\{\alpha, 1\}q)\kappa e_0. \tag{1}$$

The probability that both agents are informed is given by αq or q, depending on whether α is higher or lower than one. When the team is informed, *P*'s

4. Note that an uninformed *P* relies on A_Z's recommendation rather than selecting a new project randomly even if this has an intrinsic value of only $\mu\eta$.

5. This is in contrast to the situation in Milgrom (1988), where the subordinate's influence activities are wasteful.

expected payoff is $\eta + \kappa e_+$; when both agents are uninformed, P's payoff is $0 + \kappa e_0$.

Suppose next that a type A_Z is hired. As P and A_Z have different preferences with some positive probability, conflicts of interest may occur. From lemma 1, P's expected utility when A_Z is hired, Π_Z, can be written as

$$\Pi_Z = \alpha q\{\eta + \kappa[re_+ + (1 - r)e_-]\} + (1 - \alpha q)q[r\eta + (1 - r)\mu\eta + \kappa e_+] + (1 - \alpha q)(1 - q)\kappa e_0. \quad (2)$$

If P is informed, she selects her preferred project. She chooses the subordinate's preferred project if she is not informed but A_Z has information. If none of the agents obtains information, the status quo is selected.

The critical hypothesis in our work is that a heterogeneous team is more often informed than a homogeneous team, because its members gather information from different sources. The performance of heterogeneous teams may suffer, however, because, as we have noted, the team members' preferences are less aligned. While with more varied information sources heterogeneous teams perform better, inherent divergences of interest manifest themselves in a lower level of effort in heterogeneous teams. These conclusions are not always correct, however.

REMARK 1. A homogeneous team may lead to a higher expected intrinsic profit than a heterogeneous team. A heterogeneous team may show a higher expected level of effort than a homogeneous team.

A simple example illustrates this point. Suppose that $\alpha = 0.5$, $q = 0.4$, $\eta = 10$, $e_+ = 0.75$, $e_- = e_0 = 0.25$, $r = 0.5$, and $\mu = 0.2$. The expected intrinsic value created by a homogeneous team is 4, thus higher than the intrinsic value of 3.92 created by a heterogeneous team. Although there is a higher probability of information overlap between the members in a homogeneous team, the discrepancy between P's selected project and the one proposed by A_Z can lead to a higher intrinsic payoff in a homogeneous group.

When interests are somewhat aligned, a decision based on better information increases the expected effort from A_Z. This can be seen for sufficiently high values of r. With the values presumed, the expected effort displayed is 0.55 for a homogeneous team, lower than the expected effort of 0.57 for a heterogeneous team. Therefore, when the members of heterogeneous teams have strong although not perfectly aligned preferences, the effect of a richer pool of information reinforces the incentives resulting from better-informed decisions, which translates into more effort.

By comparing Π_Z with the expected profit when A_Y is hired, Π_Y, P decides whom to hire. A simple statement on the organization's recruiting policy is as follows.

PROPOSITION 1. The principal P hires A_Z if $\Pi_Z - \Pi_Y \geq 0$. This is given, if and only if

$$0 \leq -\alpha q(1-r)\kappa(e_+ - e_-) + (1-\alpha q)q[r\eta + (1-r)\mu\eta + \kappa(e_+ - e_0)] - \max\{0,\ 1-\alpha\}q[\eta + \kappa(e_+ - e_0)]. \tag{3}$$

Otherwise P hires A_Y.

Hiring A_Z depends on how much value P assigns to A_Z's input during the project selection phase compared to the expected costs of a disagreement during the project implementation phase. Several propositions help clarify which effects matter when the type of team is chosen.

First, how is the hiring choice affected by parameter α or P's ability to screen projects? Note that α can be a function of P's job design as well. If, for example, P's other tasks are closely related to the choice of projects, α is high. Conversely, one could expect that when P is overloaded with many unrelated tasks, α is relatively low.

PROPOSITION 2. For $\alpha < 1$, the set of remaining parameters that favor forming a heterogeneous team is weakly greater, the higher the α. For $\alpha > 1$, the set of remaining parameters that favor forming a heterogeneous team is strictly smaller, the higher the α. For α close to zero or close to its maximum value, $1/q$, a homogeneous team is formed for all sets of remaining parameters.

Proof. For the proof of the first part of the proposition, the first derivative is computed and its sign determined:

$$\frac{\partial(\Pi_Z - \Pi_Y)}{\partial\alpha} = \begin{cases} q(1-r)[(1-\mu)\eta - \kappa(e_+ - e_-)] \\ \quad + q(1-q)[r\eta + (1-r)\mu\eta + \kappa(e_+ - e_0)] > 0 & \alpha < 1 \\ -q(1-r)\kappa(e_+ - e_-) - q^2[r\eta + (1-r)\mu\eta + \kappa(e_+ - e_0)] < 0 & \alpha > 1. \end{cases}$$

To determine the sign in the case of $\alpha < 1$, the assumption of the relative sizes of η and $\kappa(e_+ - e_-)$ is used.

The second part of the proposition is proved at the values of $\Pi_Z - \Pi_Y$ as specified:

$$\lim_{\alpha\to 0} \Pi_Z - \Pi_Y = -q(1-r)(1-\mu)\eta < 0,$$

$$\lim_{\alpha\to 1/q} \Pi_Z - \Pi_Y = -(1-r)\kappa(e_+ - e_-) < 0.$$

QED

Whether an increase in P's ability to screen projects (i.e., an increase in α) favors the formation of a homogeneous or a heterogeneous team depends on which type of team makes better use of the change in α. When A has little information, P's ability to gather information is useful. An additional piece

of information is used in a heterogeneous team with probability $1 - q$ and in a homogeneous team either with probability one ($\alpha > 1$) or with probability zero ($\alpha < 1$). It is this significant difference when A_Y is recruited that drives the result. When P knows better which project is best (α close to $1/q > 1$), she decides to recruit A mainly for his effort rather than for his input in the decision-making process. Perhaps surprising is that a P who relies heavily on A's information input also prefers to recruit a subordinate similar to her, A_Y. The reason is that A_Y provides important additional information to a less competent or a disengaged P. Conversely, when P's ability and job design allow her to collect information with a probability similar to that of the subordinate, she is more inclined to form a heterogeneous team.

Next, we analyze how team composition depends on q. A higher q means that the arrival of information for both agents is more likely. A plausible interpretation is that q measures the overall availability of information about the projects and thus the degree of uncertainty in the environment. Teams operating in stable environments have high q's, and those in uncertain and dynamic environments have low q's.

PROPOSITION 3. Either a homogeneous team is formed, irrespective of the size of q, or a heterogeneous team is formed up to a certain q, $\hat{q} \in (0, \min\{1, 1/\alpha\})$. After that, a homogeneous team is formed, $q > \hat{q}$.

Proof. The first two derivatives of $\Pi_Z - \Pi_Y$ with respect to q are given by

$$\frac{\partial(\Pi_Z - \Pi_Y)}{\partial q} = -\alpha(1 - r)\kappa(e_+ - e_-) + (1 - 2\alpha q)[r\eta + (1 - r)\mu\eta + \kappa(e_+ - e_0)] - \max\{0, 1 - \alpha\}[\eta + \kappa(e_+ - e_0)],$$

$$\frac{\partial^2(\Pi_Z - \Pi_Y)}{\partial q^2} = -2\alpha[r\eta + (1 - r)\mu\eta + \kappa(e_+ - e_0)] < 0.$$

The difference $\Pi_Z - \Pi_Y$ is strictly concave in q and $\lim_{q \to 0} \Pi_Z - \Pi_Y = 0$. In addition, $\Pi_Z - \Pi_Y$ is negative as q approaches its maximum value (one for $\alpha \leq 1$ and $1/\alpha$ for $\alpha > 1$). Thus $\Pi_Z - \Pi_Y$ is negative over the whole range of admissible q or positive up to a certain level of q and negative otherwise. Which of the two prevails depends on the sign of $\partial(\Pi_Z - \Pi_Y)/\partial q$ at $q = 0$. It is straightforward to show that this value can be positive or negative. QED

In uncertain and changing environments (low q), a heterogeneous team is more valuable because the information collected by an A_Z is particularly important to complement P's information. If the probability that P can obtain information is low, a homogeneous team is always the preferred alternative.

This result implies that firms operating in more uncertain environments should tend to fill managerial positions with people from outside the orga-

nization. Firms in stable environments, however, should prefer to recruit managers from within the organization.[6]

The parameter η provides a measure of the value of the preferred project to P; it represents the importance of choosing the best project from her viewpoint. One could then conjecture that P would prefer to form a heterogeneous team when making an informed decision is very important. As proposition 3 implies, this is not always the case. When the loss associated with diverging preferences between P and A_Z is great (small μ), it outweighs a heterogeneous team's benefit of a less correlated information arrival.

IV. Replacement and Turnover

Heterogeneity in teams amplifies the variety of information necessary for decision making but may create problems in implementing decisions. The value added by more varied information in heterogeneous teams contrasts with the potential loss of effort when preferences diverge. So how is team composition affected when the superior has the authority to replace dissenting members in a team? Replacement can take the form of firing, demotion, reduction of responsibilities, or transfer to a different job.

The authority to replace the subordinate gives P more flexibility to deal with diverging preferences. But it also has negative implications for communication between the parties if replacement of A means a reduction in his utility. We show that the threat of being replaced induces strategic behavior by a subordinate who wants to protect his career. While communication always occurs when there is no penalty for speaking one's mind, the possibility of replacement changes the incentives to recommend projects; communication becomes more limited. Discretion is the optimal choice for subordinates who wish to avoid standing out in an open conflict of interest. This outcome can be especially negative in decisions that require better information.

6. An example of these different needs occurred recently. In December 2002, two large companies announced almost simultaneously the departure of their respective CEOs. The first, Allianz, Europe's biggest insurance company, chose a long-term insider to replace its CEO. According to the analysts, the new CEO was expected to speed up the integration of the banking and insurance divisions and press on with recovery of the groups' traditional insurance business ("Diekmann focuses on recovery," *Financial Times*, December 19, 2002). The second, Vodafone, the world's largest mobile operator, announced the replacement of Sir Christopher Gent, who had led the company through a period of impressive growth, by an outsider, a move that suggested to many analysts that the firm needed a change in direction to deal with the fiercely competitive telecommunications environment ("Departure of Sir Christopher Gent consolidates change at Vodafone," *Financial Times*, December 19, 2002). A short time later, at another telecommunications firm, Ericsson, an industry outsider was actually chosen to succeed the incumbent CEO ("Outsider named as new Ericsson chief," *Financial Times*, February 7, 2003). Telecommunications is a highly uncertain sector, subject to radical changes motivated by excess capacity, technology, and regulatory risk. Telecommunications companies have to reinvent themselves to stay alive and prosper. Insurance, on the other hand, faces little technological uncertainty and operates in a reasonably stable environment. Cost cutting and operating efficiencies are the key drivers of profits, and the best people to perform them are those who know the firms inside and out.

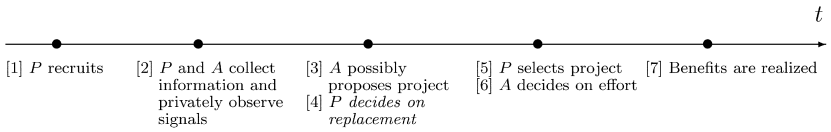

FIG. 2.—Timing of decisions

We build on the model in the previous section by adding the assumption that the superior can now replace the subordinate at a cost before the project is implemented. The cost of replacement might represent losses from delay of the project, search for a replacement, and the time a newly hired team member takes to become familiar with the tasks of managing the project. Upon replacement, if a project is implemented well, the additional payoffs are $\gamma\kappa$ instead of κ, with $\gamma \in [0, 1]$. For $\gamma = 1$, the cost of replacement is zero.

We also assume that if replacement occurs, the newly hired subordinate does not obtain any information. This is the case if the new subordinate is not yet familiar enough with the new position to acquire new information. Then if the superior has concluded that she must replace a subordinate, the reason is that she knows which project she prefers. Also, if P is indifferent between replacing and keeping the subordinate, she retains the initial subordinate.[7] The utility of a replaced A is assumed to be at the level of his reservation utility of zero.

The possibility that a team member may be replaced adds one more step to the sequence (see fig. 2).

After having replaced the original A, P's payoff depends on whether she is informed and on the type of the newly hired subordinate. Table 1 presents P's payoffs. Because a new hire does not gather information, the team has no information if P is uninformed. In this case, P's payoff is given in the first line in the table. The second line shows P's payoff when she is informed. Because the payoffs occur after replacement, all entries in the table take into account the loss from replacement. From the table it is clear that P never strictly prefers to replace the initial subordinate by a type A_Z subordinate; a type A_Y will exert at least as much effort as a type A_Z. Without loss of generality, we assume that the second hire will be a type A_Y, such as someone from within the organization.

The principal P decides to replace the subordinate first hired if the benefits of keeping him are lower than the benefits of firing him and recruiting a type A_Y. This happens if differences in the preferences of P and A_Z reduce P's payoff significantly as a result of the anticipation of a low effort level by A_Z.

7. One could assume that a low fixed cost is associated with replacement.

TABLE 1 ***P*'s Payoffs (Replacement)**

	Type of New Hire	
	A_Y	A_Z
No information	$\gamma\kappa e_0$	$\gamma\kappa e_0$
Information	$\eta + \gamma\kappa e_+$	$\eta + \gamma\kappa[re_+ + (1 - r)e_-]$

Consider first initial employment of a type A_Y. Because there are no conflicts of interest between P and A_Y, an A_Y is never replaced. Therefore, the option of replacement does not change P's expected payoff from hiring a type A_Y, as given in equation (1).

If instead a type A_Z is first employed, his replacement is, in general, dependent on whether he proposes a project to P and also on the payoffs from the project proposed. An informed A_Z chooses to make a proposal if his expected utility is higher than if he does not make a proposal. Recall that P can tell whether A_Z picks a project randomly, and so A_Z's adoption of such a strategy does have the same effect as not making a proposal. Proposing a project has clear trade-offs. As before, the benefit occurs when P does not get a signal on her own. Then A_Z's proposal is the project selected, and the utility of both agents increases. Revealing one's information is potentially costly because it may reveal that there is a conflict of interest. This may lead to an increased probability of replacement and hence reduced utility. If the change is great, the subordinate may decide to keep his information to himself. The superior's reaction to A_Z's communication is summarized in lemma 2.

LEMMA 2. If a type A_Z subordinate proposes a project to P, he is not replaced if P does not receive information. He is replaced if P receives information, the proposed project is not the superior's preferred project, and $\gamma > e_-/e_+$. If a type A_Z subordinate does not propose a project to P, he is not replaced if P does not receive information. He is replaced if P obtains information and $\gamma > [re_+ + (1 - r)e_-]/e_+$.

Proof. Consider that an initially employed subordinate A_Z proposes a project to P. If P does not receive information, there is no reason to replace the subordinate, since A_Z is going to exert the maximum effort, e_+. The same holds when P receives information and the preferred projects coincide. If P has information and the preferred projects do not coincide, P anticipates a lower-than-maximum effort by A_Z. Then the payoff of retaining A_Z is $\eta + \kappa e_-$, which is lower than the payoff when A_Z is replaced, $\eta + \gamma\kappa e_+$, if $\gamma > e_-/e_+$.

Consider now that A_Z does not propose a project. If he is retained, P chooses the project using her information only. We differentiate between (1) P being informed and (2) P being uninformed. (1) If P is informed, the initial subordinate is informed too, because P has an incentive to communicate with A_Z. Then P can expect a payoff of $\eta + \kappa[re_+ + (1 - r)e_-]$, as compared to the payoff when the subordinate is replaced, $\eta + \gamma\kappa e_+$. If $\gamma > [re_+ + (1 -$

TABLE 2 Informed A_Z's Payoffs: Low Replacement Cost

	Probability		
	αqr	$\alpha q(1-r)$	$1-\alpha q$
No proposal	0	0	u_0
Proposal	u_+	0	u_+

$r)e_-]/e_+$, the expected payoff from replacing the subordinate is higher. (2) If P is uninformed, she selects the status quo. A replacement will not increase P's payoffs. QED

Henceforth, we call $\gamma > [re_+ + (1-r)e_-]/e_+$ the low replacement cost, $\gamma \in (e_-/e_+,\ [re_+ + (1-r)e_-]/e_+]$ the intermediate replacement cost, and $\gamma \leq e_-/e_+$ the high replacement cost. Because replacement is never optimal when the cost of replacement is high, the analysis of this case is identical to that in Section III. For this reason, we omit the analysis under the high replacement cost and focus on the cases of low and intermediate replacement costs.

Low replacement cost.—In the case of a low cost of replacement, staying silent and refraining from proposing a project puts the subordinate's job in jeopardy. When P is informed, a decision by A_Z not to make a proposal is sufficient to remove him. Making a proposal may save A_Z his job if P realizes that both agree on the same project. The expected benefits to an informed A_Z in various possible situations are summarized in table 2.

It is straightforward to see that the possibility of replacement at a low cost encourages P to experiment more with the formation of a heterogeneous team. The reason is that her expected payoffs of hiring A_Z rise when replacement is possible, whereas her expected payoffs of employing A_Y remain unchanged.

PROPOSITION 4. If the replacement cost is low, the superior's authority to replace the subordinate fosters the formation of a heterogeneous team.

Intermediate replacement cost.—In the case of an intermediate cost of replacement, A_Z's decision is not immediate in that no replacement occurs if A makes no proposal. Thus proposing a project increases the subordinate's risk of replacement, which is costly to A_Z, because A_Z's utility is lower in case of a replacement. The expected benefits of an informed A_Z are summarized in table 3.

When A_Z decides whether to propose a project, he compares the benefits of making a proposal with the benefits of staying silent. Proposition 5 relates A_Z's communication strategy to team composition.

TABLE 3 Informed A_Z's Payoffs: Intermediate Replacement Cost

	Probability		
	αqr	$\alpha q(1-r)$	$1-\alpha q$
No proposal γ	u_+	u_-	u_0
Proposal	u_+	0	u_+

PROPOSITION 5. Suppose that the replacement cost is at an intermediate level. Then a homogeneous team is always formed for

$$\alpha q > \frac{u_+ - u_0}{u_+ - u_0 + (1 - r)u_-} \in (0, 1).$$

If

$$\alpha q \leq \frac{u_+ - u_0}{u_+ - u_0 + (1 - r)u_-},$$

providing the superior with the authority to replace the subordinate fosters the formation of a heterogeneous team.

Proof. It follows from table 3 that an informed A_Z will propose a project if and only if

$$\alpha q \leq \frac{u_+ - u_0}{u_+ - u_0 + (1 - r)u_-}.$$

If this holds, Π_Z is higher when P has the option to replace the subordinate. If αq is above the cutoff level, A_Z's silence eliminates all benefits of a heterogeneous team over a homogeneous one. Then Π_Z drops to $\alpha q\{\eta + \kappa[re_+ + (1 - r)e_-]\} + (1 - \alpha q)\kappa e_0$, which is strictly lower than Π_Y. QED

It is now clear that if A_Z obtains information, he proposes a project only if the expected gain from convincing P to adopt his preferred project is greater than the expected loss from potentially being replaced. The ability to convince P depends on P's being uninformed. Thus P's ability to generate informative signals is a major factor in the communication between P and A_Z. This result is different from that obtained by Friebel and Raith (2004), who argue that it can be more difficult for a subordinate to work for an incompetent superior, because the superior reacts to the constant challenge posed by the better-informed subordinate. In our case, working with a more knowledgeable superior is more difficult, not less, because the subordinate's position is more often in danger. It is this danger that makes him stay strategically silent.

If communication fails, however, there is no more advantage in forming a heterogeneous group. This shows that giving the superior authority in personnel matters and allowing her to discipline members who might express divergent preferences can stifle the formation of heterogeneous teams. Thus the potential advantage of heterogeneous teams vanishes if the superior is close to the decision or ex ante there is little decision uncertainty. This conclusion may help explain why homogeneous teams tend to prevail in low-uncertainty environments or when the team leader is well informed.

A number of measures can help prevent a breakdown of communication.

PROPOSITION 6. If the replacement cost is at an intermediate level, it may be optimal not to allow the superior to replace the subordinate.

Proof. Consider the example $\alpha = 1$, $q = 0.75$, $\eta = 10$, $\kappa = 10$, $\mu =$

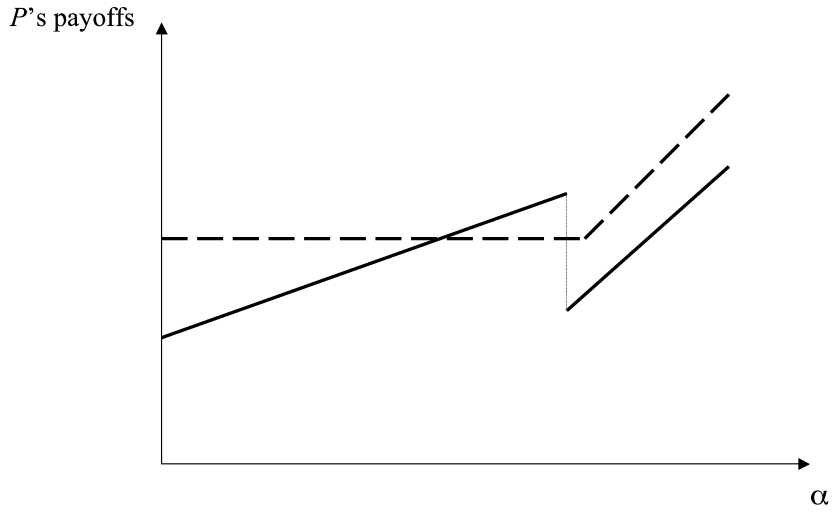

FIG. 3.—*P*'s payoffs for homogeneous and heterogeneous teams. The dashed line depicts the payoff for a homogeneous team and the solid line the payoff for a heterogeneous team.

0.5, $r = 0.5$, $b_+ = 3$, $b_- = b_0 = 2$, $C(e) = 2e^2$, and $\gamma = 0.75$. In these circumstances u_+, u_-, and u_0 are given by 1.13, 0.50, and 0.50, respectively. If *P* has the authority to replace the subordinate, this induces A_Z to remain silent rather than propose a project (proposition 5). It is then optimal to hire A_Y, which results in a payoff of 14.375 to *P*. Eliminating *P*'s replacement authority makes A_Z issue a proposal whenever possible. Then employing A_Z is optimal in that it yields a payoff of 15.625 to *P*. QED

This result implies that the authority to penalize should not always be in the hands of the immediate superior. Instead, it is better to give this authority to someone who is neither directly affected by a possible conflict of interest in the team nor less informed about such a conflict.

Another way to improve communication between A_Z and *P* is to put more distance between *P* and the issues being decided.

PROPOSITION 7. If the replacement cost is at an intermediate level, it may be optimal to diminish the probability that the superior obtains information.

Proof. Consider the example in the proof of proposition 6. Reducing α to 20/21 makes A_Z propose a project whenever he has information. The reduction increases the payoff of hiring an A_Z to 15.346, which makes it optimal to employ him rather than an A_Y. QED

Keeping the superior at a distance from the operations lowers α deliberately. Some distance or a certain degree of ignorance can be better than more knowledge, because a lower α increases the subordinate's willingness to communicate, which produces higher expected payoffs. Figure 3 displays the relationship between α and the superior's payoffs for both types of teams.

The superior's payoffs as a function of α for a heterogeneous team are represented by the solid line, and it is straightforward to see that reducing α may elevate payoffs. Our argument provides an additional reason for strategic ignorance on the part of the principal in an agency relationship. In Crémer (1995), for example, reducing the amount of information available enhances the principal's possibilities to commit to a particular course of action. In Aghion and Tirole (1997), ignorance increases an agent's incentive to acquire information.

Consider now the issue of turnover in differently composed teams. It follows immediately from the previous analysis that heterogeneous teams have higher turnover rates.

PROPOSITION 8. If an A_Y subordinate is hired, he is never replaced. In some parameter constellations, an A_Z subordinate is hired and replaced with positive probability.

This result is consistent with the findings of several studies in the organization literature for different countries and different working environments (see, e.g., McCain, O'Reilly, and Pfeffer 1983; Wagner et al. 1984; Wiersema and Bird 1993).[8]

Given that a heterogeneous team is formed, a small increase (decline) in the costs of replacement may lead to a significant decline (increase) in personnel turnover. Two factors influence the change in the rate of turnover. One is the cost of replacement, and the other is the flow of communication in the hierarchy. At one point, an increase in the cost of replacement makes an informed superior refrain from replacing the subordinate if he does not make a proposal, which reduces turnover. This behavior allows the subordinate to conceal his information more often without risking replacement, which in turn reduces turnover further. As described, from an ex ante perspective, this behavior has a negative effect on the likelihood that a heterogeneous team is formed at all.

Finally, what can be said about the expected level of effort in a heterogeneous team when replacement occurs? In general, replacement raises the level of effort in the organization. With replacement, the superior gets rid of members who, because of conflicts of interest, are expected to exert low levels of effort. Therefore, the average effort expended by the A_Z types who remain in the organization is higher than the effort expended by the entire population of A_Z types. Note that replacement may not eliminate low effort entirely, because replacement does not always occur if A_Z obtains his information only through P and the preferred projects do not coincide.

8. These studies have an explorative rather than exhaustive nature. For example, Wagner et al. (1984) study the turnover in top-management teams of 31 manufacturing firms in the United States. Demographic similarity is approximated by the coefficient of variation of an individual distance measure to the other team members on the basis of entry dates. Controlling for absolute and relative profitability, team size, and firm age, they find that teams characterized by a higher degree of demographic similarity in 1976 displayed a significantly lower turnover during the four subsequent years.

V. Summary and Final Remarks

We have analyzed salient factors that determine the composition of teams. Teams composed of individuals with different characteristics have the potential to reach better decisions because they access more varied information sources. Heterogeneous groups also have a higher propensity for preferring different projects.

Heterogeneous teams generally have an advantage over homogeneous ones in highly uncertain situations and when the stakes in the decisions are high. The team leader's ability to handle and familiarity with the issues at hand also affect the composition of the team. Leaders at the extremes of the scale, either very good or knowledgeable on the one hand or incompetent or ignorant on the other hand, tend to form homogeneous groups. Leaders between these extremes benefit significantly from the input of less correlated information arrival and therefore prefer heterogeneous groups.

Firms can avoid negative consequences caused by the divergence of preferences by giving the team leader authority to change the composition of the team in case of a conflict of interest. Because replacement is harmful, team members respond to the threat of replacement by staying quiet. Ultimately, the threat of replacement can promote conformance, which eliminates the benefits of heterogeneous teams. Still, heterogeneous groups display higher turnover.

To improve communication within a team, it may be optimal to curtail the team leader's authority. Doing so may help both to boost team performance and to enhance the utility of the team members. Alternatively, communication can be enhanced if some sort of ignorance or distance in the leader's job, in relation to the issues discussed, is present.

This work is an exploratory step toward a more general theory of team composition. It provides a theoretical framework that is consistent with many empirical findings in the organization science and psychology literature. Heterogeneous teams have been found to have higher turnover rates than homogeneous teams (Pfeffer 1983; Wagner et al. 1984). Heterogeneous teams' performance results appear inconsistent. Some studies report that heterogeneous teams outperform homogeneous teams (Hoffman and Maier 1961; Hoffman 1978; Nemeth 1986; Jackson 1992). Others conclude that homogeneous teams avoid the problems associated with poor communication and excessive conflict that often plague heterogeneous teams (Steiner 1972; O'Reilly and Flatt 1989; Ancona and Caldwell 1992). Our work is a first step forward to reconcile these seemingly inconsistent findings.

References

Aghion, Philippe, and Jean Tirole. 1997. Formal and real authority in organizations. *Journal of Political Economy* 105:1–29.

Amason, Allen C. 1996. Distinguishing the effects of functional and dysfunctional conflict on

strategic decision making: Resolving a paradox for top management teams. *Academy of Management Journal* 39:123–48.
Ancona, Deborah G., and David F. Caldwell. 1992. Demography and design: Predictors of new product team performance. *Organization Science* 3:321–41.
Athey, Susan, Christopher Avery, and Peter B. Zemsky. 2000. Mentoring and diversity. *American Economic Review* 90:765–86.
Bertrand, Marianne, and Antoinette Schoar. 2002. Managing with style: The effect of managers on firm policies. Working Paper no. 4280-02, Massachusetts Institute of Technology, Sloan School of Management.
Carrillo, Juan D., and Denis Gromb. 2002. Culture in organizations: Inertia and uniformity. Discussion Paper no. 3613, Centre for Economic Policy Research, London.
Cornell, Bradford, and Ivo Welch. 1996. Culture, information, and screening discrimination. *Journal of Political Economy* 104:542–71.
Crémer, Jacques. 1995. Arm's-length relationships. *Quarterly Journal of Economics* 110:275–95.
De Bijl, Paul W. J. 1994. Delegation of responsibility in organizations. Discussion Paper no. 9469, Tilburg University, Center for Economic Research.
Dessein, Wouter. 2002. Authority and communication in organizations. *Review of Economic Studies* 69:811–38.
Eisenhardt, Kathleen M., Jean L. Kahwajy, and L. J. Bourgeois III. 1997. Conflict and strategic choice: How top management teams disagree. *California Management Review* 39 (Winter): 42–62.
Friebel, Guido, and Michael A. Raith. 2004. Abuse of authority and hierarchical communication. *Rand Journal of Economics* 35 (Summer): 224–44.
Gibbons, Robert S., and Kevin J. Murphy. 1992. Optimal incentive contracts in the presence of career concerns: Theory and evidence. *Journal of Political Economy* 100:468–505.
Hoffman, L. Richard. 1978. The group problem-solving process. In *Group processes*, ed. L. Berkowitz. New York: Academic Press.
Hoffman, L. Richard, and Norman R. F. Maier. 1961. Quality and acceptance of problem solutions by members of homogeneous and heterogeneous groups. *Journal of Abnormal and Social Psychology* 62:401–7.
Jackson, Susan E. 1992. Team composition in organizational settings: Issues in managing an increasingly diverse workforce. In *Group process and productivity*, ed. Stephen Worchel, Wendy Wood, and Jeffrey A. Simpson. Newbury Park, CA: Sage.
Katzenbach, Jon R. 1997. The myth of the top management team. *Harvard Business Review* (November–December), pp. 83–91.
McCain, Bruce E., Charles A. O'Reilly, and Jeffrey Pfeffer. 1983. The effects of departmental demography on turnover: The case of a university. *Academy of Management Journal* 26: 626–41.
Milgrom, Paul R. 1988. Employment contracts, influence activities, and efficient organization design. *Journal of Political Economy* 96:42–60.
Nemeth, Charlan. 1986. Differential contributions of majority and minority influence. *Psychological Review* 93:23–32.
O'Reilly, Charles A., and Sylvia Flatt. 1989. Executive team demography: Organizational innovation and firm performance. Unpublished manuscript, University of California, Berkeley.
Pfeffer, Jeffrey. 1983. Organizational demography. In *Research in organizational behavior*, vol. 5, ed. Larry L. Cummings and Barry M. Staw. Greenwich, CT: JAI.
Prendergast, Canice. 1993. A theory of "yes men." *American Economic Review* 83:757–70.
Prendergast, Canice, and Lars Stole. 1996. Impetuous youngsters and jaded oldtimers: Acquiring a reputation for learning. *Journal of Political Economy* 104:1105–34.
Steiner, Ivan D. 1972. *Group process and productivity*. San Diego: Academic Press.
Wagner, W. Gary, Jeffrey Pfeffer, and Charles A. O'Reilly III. 1984. Organizational demography and turnover in top-management groups. *Administrative Science Quarterly* 29:74–92.
Wiersema, Margarethe F., and Karen A. Bantel. 1992. Top management team demography and corporate strategic change. *Academy of Management Journal* 35:91–121.
Wiersema, Margarethe F., and Allan Bird. 1993. Organizational demography in Japanese firms: Group heterogeneity, individual dissimilarity, and top management team turnover. *Organization Science* 5:996–1025.