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On the origin of shared beliefs (and corporate culture)

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This article shows how corporate culture, in the sense of shared beliefs and values, originates (often unintentionally) through screening, self-sorting, and manager-directed joint learning. It shows that such culture will be stronger among more important employees and in older and more successful firms where employees make important decisions and the manager has strong beliefs. It further shows how a manager's beliefs influence culture, how culture persists despite turnover, and why the suggested link between culture and performance may be a case of inverse causality. It finally shows that, from an outsider's perspective, organizations may tend to overinvest in corporate culture.

1. Introduction

■ Members of the same organization often share similar beliefs and values. For example, a JetBlue employee is more likely to agree with another JetBlue employee than with a Delta Airlines employee on the importance of friendly customer service. A Microsoft employee is more likely to agree with another Microsoft employee than with an HP employee on the benefits of aggressive internal competition.[1] Such shared beliefs have important implications: Van den Steen (2010a) shows that shared beliefs lead to more delegation, less monitoring, higher utility (or satisfaction), higher execution effort (or motivation), faster coordination, less influence activities, and more communication, but also to less experimentation and less information collection.[2] That article argues that the reason why shared beliefs (and values) have such a pervasive influence is that they reduce or eliminate differences in objectives and thus eliminate, at the root, the agency problems that arise from such differences in objectives. For example, if a manager and her employee have similar beliefs, then the manager will be more comfortable to let the employee (who may

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[1] Appendix A gives a number of examples of such shared beliefs, drawn from the management literature and from personal experience.

[2] Note that homogeneity (or strong culture) has both costs and benefits. The benefits relate more to exploitation and are thus more immediate, whereas the costs relate more to exploration and are thus more distant.

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have more time or better local information) make the decision and will feel less of a need to monitor the employee. However, more similar beliefs also mean that neither the manager nor the employee needs to persuade the other, so that they have fewer incentives to collect information. And in an organization with similar beliefs, people will tend to do similar things so there is less experimentation. The results on effort, utility, and so forth, follow a similar logic. Given the wide range of implications, it should be no surprise that shared beliefs (and values) have received considerable attention in the management literature, under the heading of "corporate culture."

In this article, I show how—in a world with differing priors—organizations have an innate tendency to develop homogeneous beliefs through two general mechanisms, and I explore these mechanisms' implications and comparative statics. The first mechanism is that, when performance depends on correct decisions, people in an organization prefer to work with others who have beliefs that are similar to their own because such others "will do the right thing" from their perspective.[3] This gives rise to screening. Second, employees experience first-hand their firm's behavior and performance, which is an important source of learning. As all employees of one firm learn from the same source, their beliefs will converge over time. Shared experiences thus also lead to shared beliefs. I further show that these two mechanisms tend to be substitutes and explore under which conditions they also lead to homogeneity of values (in the sense of private benefits).

In terms of comparative statics, I show that homogeneity will be stronger in firms that are older, smaller, and more successful, in firms where employees make more important decisions, and in firms where the manager has stronger beliefs. Moreover, within a firm, homogeneity will be stronger among more important employees. When candidate-employees can self-sort, homogeneity will also be path dependent: the fact that current employees are similar to the manager will *cause* future hires to be more similar to the manager. As a consequence, the manager will be more selective for earlier hires and will care about the sequence in which employees are hired, often preferring to hire the more important employees first.

I then show that firms tend to overinvest in homogeneity from the perspective of an outsider, such as a social planner or a random investor. The reason is that the manager believes that she is right and thus values similarity in itself, independent of its objective costs and benefits. From the perspective of an outsider, however, some such investments in homogeneity are unproductive. This result continues to hold even when there are objective benefits or costs from homogeneity, such as improved delegation or less monitoring. The result also illustrates the difference between subjective and objective efficiency in a context with differing priors.[4]

Shared beliefs are often considered an important aspect of corporate culture (Donaldson and Lorsch, 1983; Schein, 1985; Kotter and Heskett, 1992; Nadler and Tushman, 1997) and the research in this article started in part as an attempt to formally understand Schein's theory on the sources of corporate culture as shared assumptions and values. It is then also reassuring that the mechanisms in this article match key observations on corporate culture. I show, in particular, that a manager has a considerable influence on her firm's shared beliefs, and that those shared beliefs may persist even after all the original members of the firm have left. An important mechanism in these results is manager-forced learning, that is, the fact that it is the manager—rather than the employees themselves—who chooses the experiments from which the employees learn. I show that such manager-forced learning allows one player's beliefs to shape another player's future actions in a way that looks *as if* the latter internalized the former's beliefs. I finally show that strong performance creates a strong culture. The ensuing correlation may give the misleading impression that it is strong culture that improves performance, as has been suggested by studies based on informal observations (Deal and Kennedy, 1982; Peters and Waterman, 1982), rather than the other way around.

[3] The first result of Appendix B shows that this holds true even when experimentation or diversity of actions is optimal: you then prefer to associate with people who agree with you on the optimal form of experimentation or diversity. This result assumes, however, that there is no need for effort and no other conflicts.

[4] As discussed in Section 2, subjective efficiency uses each player's own beliefs to determine his or her expected utility, whereas objective efficiency uses one "reference belief"—such as the belief of the social planner—for all players.

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I derive these results in the context of a firm with a manager and a group of employees who all have to choose actions that affect the firm's payoff and who all care about these firm profits. The players openly disagree on what actions are likely to improve the firm's profits. I study both the hiring process, which leads to screening, and how these participants learn from the firm's actions and outcomes. I also reinterpret the screening model in terms of shared values (as private benefits) and show that some of the screening results extend to that case. This exercise also gives some general insights into the distinctions between models with differing priors and models with private benefits.

□ **Literature.** From the perspective of this article, the economic literature on corporate culture can be divided broadly into two categories.[5] The first category of contributions—which includes Crémer (1993), Lazear (1995), and this article—are articles that define corporate culture as *shared beliefs* or *shared preferences*. These articles thus relate corporate culture (directly or indirectly) to real characteristics of people—in particular beliefs and preferences—and then consider the implications of these characteristics for, say, equilibrium selection and agency problems. The second category of economic contributions on corporate culture—which includes Kreps (1990) (and its important interpretation by Hermalin, 2001), Carrillo and Gromb (1999), and Rob and Zemsky (2002)—are articles that consider corporate culture purely as a form of *equilibrium selection* in a world with identical players. They consider a setting with multiple equilibria and then identify the selected equilibrium as the corporate culture.

These two views are related but at the same time quite different.[6] Van den Steen (2010a) shows that shared beliefs and preferences will, among other things, facilitate equilibrium selection. Moreover, these beliefs and values add predictability to the equilibrium selection because the selection will favor an equilibrium that is consistent with the players' shared beliefs and values. But the effects of shared beliefs go beyond equilibrium selection, as they also affect delegation, monitoring, communication, and so forth. Moreover, equilibrium selection only matters in settings with multiple equilibria. In the other direction, however, "culture as a selected equilibrium" goes beyond shared beliefs and values, as equilibrium selection can be driven by other factors. Driving on the left or on the right, for example, is an equilibrium selection that is historically driven by technological considerations (Kincaid, 1986) and that is currently further reinforced by the incentive effect of potential fines. But that raises an immediate follow-up question. Absent an explicit theory of equilibrium selection, "culture as a selected equilibrium" seems to have limited practical and empirical implications. It is also difficult to define the *strength* of a culture in this interpretation because, by definition, *all* players play *one* equilibrium. So this pushes quite naturally to microfoundations that may well lead back to shared beliefs and values.

The first category of economic literature—on "culture as shared beliefs and preferences," to which this article thus belongs—builds largely on the dominant definition in the psychology and management literature of culture as shared assumptions and values.[7] Although this view has a long history, such as Burns and Stalker (1961) and Donaldson and Lorsch (1983), it is usually associated most with the work of Schein (1985). Schein (1985), and later contributions such

[5] There are a few perspectives on culture that do not fit in either of these categories. For example, Arrow (1974) and Crémer, Garicano, and Prat (2007) study a definition of "culture as (language) code." Because perspectives such as "culture as code" are about phenomena that are distinct from and orthogonal to the focus of this article, I do not discuss them further in this literature overview. Furthermore, some contributions—such as Kreps's (1990) verbal discussion of "culture as a reputation for dealing with unforseen contingencies"—are difficult to assess absent a more detailed discussion or formalization of the ideas. For general and more complete overviews of the economic literature on corporate culture, see Hermalin (2001, 2007).

[6] I do not consider one view to be necessarily more or less correct than the other, especially not without regard to context. Culture is a complex and composite social phenomenon. As such, any one explanation is likely to be partial and to work better for some purposes than for others. My criterium is usefulness in a managerial context.

[7] Although there are other views on corporate culture in the management literature—as it is a complex and somewhat vague construct—Martin (1992), who promoted "ambiguity as the essence of organizational culture," notes that the vast majority of the literature interprets corporate cultures as shared beliefs and values.

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as Kotter and Heskett (1992) and Nadler and Tushman (1997), distinguishes between different levels of culture. The most visible, but most superficial, level is that of culture as a pattern of behavior or "visible artifacts." It is "the way things are done around here," the norms, the stories, the symbols. These behavioral patterns, however, reflect a deeper and more fundamental level of culture, which are the firm's shared assumptions and values. Crémer (1993), Lazear (1995), and this article all build on Schein (1985) as their starting point and try to flesh that work out in economic terms.

The current article tries to capture this perspective formally by interpreting "assumptions" as prior beliefs and interpreting "values" as private benefits. Crémer (1993), on the other hand, models culture as the share of information signals that are common among players in a team-theory model and shows how such shared information improves the alignment of actions (at the cost of less correct actions). Because his model is essentially about the benefits of homogeneity rather than its genesis, it is more related to Van den Steen (2010a) than to this article. In particular, it has no predictions on any of the effects considered in this article because the beliefs of the decision maker are irrelevant to the optimal sharing rule, because the importance of the decisions plays no role per se, and because there is no reason why the optimal homogeneity would depend on age or size. Lazear (1995), on the other hand, focuses explicitly on the dynamics of culture. He does not model the beliefs or values explicitly, but assumes that they are similar to genetic traits (alleles) and thus diffuse in a similar way. In particular, his basic assumption is that a meeting between two people is like a mating between two plants: it creates "offspring" that has some of the genetic traits from its parentage, with the likelihood of survival of the offspring depending on the fitness of the genetic traits. To derive his results, Lazear further assumes that homogeneity has a positive effect on profits and that management can manipulate fitness at some cost. Although this analysis achieves some very nice results, Hermalin (2001) points out that the absence of an underlying process is an issue. For one thing, it is difficult to see exactly what kind of process the assumptions capture: what are the alleles, what happens at the "meeting," what is the "offspring," what represents "fitness," and so forth. In particular, the model in this article does not fit Lazear's assumptions and would probably result in different dynamic paths, long-term distributions, and other outcomes. Moreover, being more explicit about the process allows the current article to derive new predictions. Some of the distinctive predictions of this article are that homogeneity will be stronger among more important employees, in firms where independent decision making is more important, in firms that have been successful in the past, and in firms with a manager with stronger beliefs; that the content of a firm's culture will be influenced by the beliefs and values of the founder or early leader; and that a manager will be more selective on early hires than on later hires.

The work in this article also builds on Van den Steen (2001, 2005) and Besley and Ghatak (2005), who show, independently, how sorting in the labor market can lead employees to hold beliefs or preferences that are similar to those of the firm's manager. In particular, Van den Steen (2001, 2005) studies the effect of "vision" defined as (strong) managerial beliefs about the right course of action for the firm, whereas Besley and Ghatak (2005) study the effect of "mission" defined as a private benefit from a particular course of action by the firm. Both show that employees will sort toward firms with a manager who has beliefs or private benefits that are similar to their own, and that such sorting can lead to higher effort levels. Whereas articles such as Rotemberg and Saloner (2000) and Besley and Ghatak (2005) assume that the employees' projects are chosen by the manager and then focus on the effort exerted by employees, Van den Steen (2001, 2005) explicitly endogenizes the project choice by employees and shows how—even without sorting—the manager's beliefs give *direction* to the firm by influencing the employees' decisions, and thus also lead to coordination. Sorting further reinforces this direction-setting effect, because it is "as if" the employees have internalized the manager's beliefs. By building on this direction setting of Van den Steen (2001, 2005), the current article links shared beliefs to observable similar behavior, which then further leads to the results in Van den Steen (2010a). However, neither Besley and Ghatak (2005) nor Van den Steen (2001, 2005) focuses on homogeneity per

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se, such as comparative statics, the efficient level of homogeneity, or implications for corporate culture.

This article is obviously also related to work on the costs and benefits of congruence, such as Aghion and Tirole (1997), Dewatripont and Tirole (1999), Dessein (2002), Prendergast (2007), and Marino, Matsusaka, and Zábojník (2008). In particular, if corporate culture were a simple choice variable, then such theories would also be theories of the origin of corporate culture. And even if culture is not a simple choice variable but can be influenced by management, these theories are relevant for when and where culture will be strong. Van den Steen (2010a) builds to a large extent on this literature.

There is, finally, also a small but growing empirical literature on homogeneity. First, the management and psychology literature has studied how "fit" in terms of values and beliefs affects hiring and outcomes such as turnover and satisfaction (Judge and Bretz, 1992; Meglino, Ravlin, and Adkins, 1989; Chatman, 1991). These studies are typically based on psychological survey instruments. There is further an emerging literature in economics that uses observed variation in behavior to derive results on homogeneity in beliefs and values. Cronqvist, Low, and Nilsson (2007), for example, show that spin-offs have similar practices as the companies they are spun off from, whereas Dranove, Ramanarayanan, and, Rao (2006) show that doctors tend to sort according to medical approach or philosophy. Both these articles' results are consistent with the theory in this article.[8] Guiso, Sapienza, and Zingales (2006) also consider culture as prior beliefs in an empirical context.

□ **Contribution.** The key contribution of this article is to study why and when organizations (unintentionally) develop homogeneity and what these processes imply for comparative statics. An important step is the article's use of (shared) prior beliefs and (shared) private benefits as a way to capture the (shared) assumptions and values of the management and psychology literature. Once these elements are put in place, the basic homogeneity results are straightforward. The theory also makes new empirical predictions on when such homogeneity will be strong. Some new predictions are, for example, that more important employees and employees in firms where decision making is more important will have stronger shared beliefs, or that homogeneity of beliefs will be stronger in firms that have been successful in the past. Another new result is that homogeneity is path dependent and that firms tend to be too homogeneous. The article finally shows that the predictions of this model are consistent with informally observed facts on corporate culture. Because homogeneity affects the agency problem, this article provides a different perspective on the agency literature and how it relates to corporate culture.

The next section considers the screening model and shows that organizations on average overinvest in homogeneity. Section 3 extends the basic model to consider learning, showing both that most of the screening results also obtain by pure learning and that some new results obtain. Section 4 discusses implications for corporate culture. Section 5 discusses the interpretation of the screening model in terms of shared values, and Section 6 concludes. The appendices contain examples of shared beliefs, a general homogeneity result, and further screening and learning results, including the effect of effort and of outside options.

2. Screening

■ The most obvious source of homogeneity is screening in the hiring process. Proposition B1 in Appendix B shows in a very general model that, when performance depends on correct decisions rather than personal effort, people prefer to work with others who have beliefs that are identical to their own. The reason is that such others "make the right decisions." This is true even when there is a need for experimentation or diversity of actions, because you then agree on the

[8] Absent an extension with equilibrium selection, it is difficult to tell how they relate to culture as a selected equilibrium.

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optimal form of diversity or experimentation. It is therefore subjectively efficient for people with similar beliefs to seek each other out when forming organizations.

In this section, I study this source of homogeneity in more detail. In order to derive comparative statics and to study efficiency, I impose more structure than the model of Proposition B1. I will focus, in particular, on a setting in which a principal hires agents for a project. To take into account the cost of screening, I consider an explicit extensive-game form for the hiring process rather than an axiomatic matching solution.

□ **Model.** Consider a project with a manager M (denoted also as employee E_0) and two employees E_1 and E_2. (The employees will be hired from a set of potential employees L, as discussed later.) As part of the project, each employee E_i has to choose a course of action $\tilde{a}_i$ from the set $\{X, Y\}$ with respective payoffs ρ_X, ρ_Y. The overall project payoff R is a weighted sum of the individual payoffs, minus the screening cost d (that I detail below):

$$R = \sum_{i=0}^{2} \alpha_i \rho_{\tilde{a}_i} - d,$$

where $\alpha_i \geq 0$ denotes the contribution of employee E_i's payoff (with the manager as E_0).[9]

Whereas the true values of ρ_X and ρ_Y are unknown, each player has his or her own subjective beliefs. Let $r_{X,i}$ and $r_{Y,i}$ denote the expected values of ρ_X and ρ_Y according to some player i. A key assumption is that (it is common knowledge that) players have differing priors, that is, $r_{\cdot,i}$ and $r_{\cdot,j}$ may differ even though no player has private information. I will discuss this assumption in more detail at the end of this section. Because the players have differing priors but have no private information on ρ_X or ρ_Y, a player will not update her beliefs simply because she notices that someone else has different beliefs: each player believes that she is right and that those who disagree are wrong. Each player tries to maximize the project's total payoff R.[10]

Figure 1a shows the timeline of the game. Period 1 is the hiring process, which I discuss below. In period 2, players choose their actions. In period 3, the project payoffs are realized. Consider now the hiring process, shown in Figure 1b. A candidate for the first position gets drawn at random from an infinite set of potential candidates L. Empirically, the beliefs of the potential candidates are independently and identically distributed $r_{a,i} \overset{\text{i.i.d.}}{\sim} F$ for $a \in \{X, Y\}$ and $i \in L$, with F some nondegenerate distribution with support $S \subseteq \mathbb{R}$. Remember that F is not some kind of prior but simply the empirical distribution of (the means of) beliefs in the population. In particular, knowledge of F will not affect players' beliefs: each player interprets F as the distribution of how mistaken other players are in their beliefs. For the analysis in this section, only the manager's belief difference $\Delta_0 = |r_{X,M} - r_{Y,M}|$ will matter. Note that Δ_0 measures the strength of the manager's relative belief, that is, how strongly she believes that one action is better than the other. Beliefs are originally private information. However, after the candidate and his beliefs are drawn, the manager can learn—at a cost c to the project—what action is optimal according to this particular candidate. The manager then decides whether to hire this candidate or draw a new one. Once an employee is hired, the game moves on (either to the next employee position or to period 2 of the

[9] Most results extend with little modification to more general payoff functions, but the interactions among different decisions and the difficulty of deriving explicit analytical expressions complicate the proofs considerably.

[10] The results would also work if each employee tried to maximize the payoff of his own action whereas the manager cares about the overall project outcome R.

It is straightforward to endogenize these objectives. For example, for the case that each player cares about R, consider the following extension of the model. Assume that the project has two possible outcomes—success or failure—with payoffs 1 and 0, and that $\sum_{i=0}^{2} \alpha_i \rho_{\tilde{a}_i}$ is the probability of success (which requires some restrictions on F and the α_i). Assume further that the project's outcome is contractible (through *ex ante* Nash bargaining) but actions are not. Finally, each participant also has the option to do nothing (instead of choosing from $\{X, Y\}$), which gives the participant a private benefit ϵ—with ϵ arbitrarily small—and which causes a sure failure of the project. This setup would lead to contracts that pay an arbitrarily small amount upon success, and give indeed R as the employees' objective, up to a factor. To keep the analysis transparent, I simply impose the players' final objective as an assumption.

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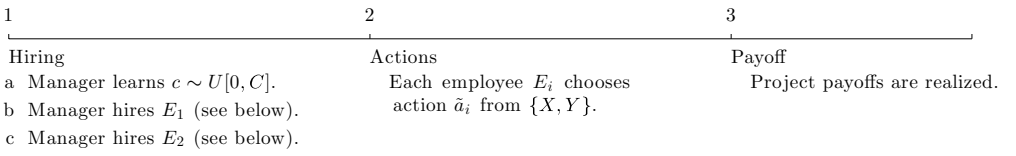
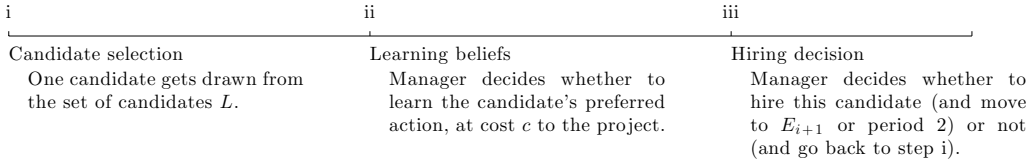
FIGURE 1

TIMELINE



a. Timeline of overall game



b. Timeline of hiring E_i

overall game). Note that hiring is position specific and that the manager cannot go back to earlier candidates. When necessary, I will assume that the empirical distribution of managerial beliefs is identical to that of the candidates, that is, it is as if the manager is drawn from L prior to the game. The cost c is a random variable from a uniform distribution $c \sim U[0, C]$. The manager (privately) learns this cost at the very start of the game. The cost d that was mentioned earlier is the sum of the costs c to learn the candidates' beliefs.

I will use throughout the following notation: $m_i = \frac{r_{X,i}+r_{Y,i}}{2}$, $\overline{m}_i = \max(r_{X,i}, r_{Y,i})$, and $\underline{m}_i = \min(r_{X,i}, r_{Y,i})$. To simplify the statement of the propositions, I will also assume that the employees' contributions to the firm's performance $\alpha_1, \alpha_2 > 0$.

The differing priors assumption. The model assumes that people can openly disagree, that is, they have differing priors.[11,12] Whereas Section 5 will discuss its role in this article, I discuss it here from a more general perspective.

Although the differing priors assumption is not mainstream, it does have a long tradition in economics, including articles such as Arrow (1964), Wilson (1968), Harrison and Kreps (1978), Varian (1989), Harris and Raviv (1993), Morris (1994), Yildiz (2003), Bolton, Scheinkman, and Xiong (2006), Boot, Gopalan, and Thakor (2006), and Geanakoplos (2009). The use of differing priors has been clearly on the rise, in part due to the growing popularity of behavioral economics, which often implicitly assumes differing priors. There is also a burgeoning empirical literature such as Chen, Hong, and Stein (2002) and Landier and Thesmar (2009). Finally, Hong and Stein (2007) argue that "disagreement models (...) represent the best horse on which to bet [as the future consensus model for behavioral finance]."

The assumption of (originally unbiased) differing priors captures the fact that people may have different "mental models" or "belief systems" or different "intuition," which may lead people with identical data to draw different conclusions. Consider, for example, someone's belief whether to trust a particular person or what will happen to the stock market. Such beliefs have immediate implications: whether to delegate a set of decisions to the assembly line workers depends on

[11] Obviously, the assumption in this article that players have no private information is extreme and made for analytical convenience. If players had both differing priors and private information, they would update their beliefs when encountering someone with whom they disagree, but disagreement would remain.

[12] For a more conceptual discussion of differing priors, see Morris (1995). Note that differing priors is *not* the same as private information that is impossible to communicate.

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whether you trust these workers. This kind of issue is repeated many times over in organizations. People disagree on how to design an organization, on what motivates people, on the likely path of technology, on how to deal with a difficult employee, on whether to trust a supplier, and so forth. Open disagreement is thus an issue in both strategic and day-to-day decision making. In effect, the fundamental role of "belief systems" or "mental models" in organizations has been stressed by academic studies of managers and managerial decision making (Donaldson and Lorsch, 1983; Schein, 1985).

An important question is why—if the decision is important—players do not simply discuss until they reach agreement. The answer is that the decision whether to use persuasion is a time and cost tradeoff, and in many cases persuasion is just not the right option. In particular, many of these beliefs are deeply engrained and difficult to change, whereas further data collection may be costly and time consuming.

A final question is where such differing priors would come from in a Bayesian framework. There are two ways to think about this. As the prior for this game is a posterior from earlier updating, (unconscious) bounded rationality will often lead to differing priors, even when starting from a common prior. Unconsciously forgetting some of the data used to update beliefs, for example, would do. A second—more philosophical and more controversial—argument is that people may be born with differing priors: in the absence of information there is no reason to agree. From that perspective, differing priors are perfectly consistent with a fully rational Bayesian paradigm: priors are just primitives of a model. In this article, I am completely agnostic about the source of the disagreement. I just believe that disagreement can be an important force in organizations and explore its potential consequences.

□ **Shared beliefs.** As the manager's payoff depends on her employees' actions, she will want to hire employees who make the "right" decisions from her perspective, that is, who share her beliefs.[13] And because the two employees are then each similar to the manager, they will also be similar to each other. Firms will thus be more homogeneous than society at large.

To formally study this idea, let me define the homogeneity of some group by the likelihood that two randomly selected members of that group agree on the best action. In other words, the homogeneity of a group G, with members indexed 1 through J, is defined as

$$H(G) = \frac{\sum_{i \in G} \sum_{j \in G, j \neq i} I_{\hat{a}_i = \hat{a}_j}}{J(J-1)},$$

where I is the indicator function and $\hat{a}_i$ is the action that i considers best. A nice aspect of this measure is that it directly relates to the probability that two randomly selected members will do the same thing and thus to "the way we do things around here" (which is one manifestation of corporate culture). Furthermore, Van den Steen (2010a) shows that this is a good measure to characterize, for example, the effect of homogeneity on monitoring and delegation among members of the group G. Van den Steen (2004) shows that measures of homogeneity based on a distance function give qualitatively similar results.

Using this measure of homogeneity, the following proposition then says that the firm's employees will be on average more homogeneous than the population of candidates L. Let $Z = \{E_1, E_2\}$ denote the set of employees, and remember that $\Delta_0 = |r_{X,M} - r_{Y,M}|$ denotes how strongly the manager (E_0) believes one action is better than the other.

[13] An interesting question is whether it would not be more effective to screen on willingness to work hard than on specific beliefs. The issue is that all firms have identical preferences over people who work hard, so that "working hard" will be directly reflected in the wage, whereas "having the right beliefs" not necessarily. The distinction is somewhat similar to that between vertical and horizontal differentiation in product markets. Appendix B discusses some complications for studying the wage structure in this setting. This is an interesting area for further research.

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Proposition 1. The expected level of homogeneity is higher among employees than among the population ($E[H(Z)] \geq E[H(L)]$) with strict inequality as long as the manager is not indifferent ($\Delta_0 > 0$).

Proof. Because the payoffs from the two employees are additively separable, I can study the selection of these employees completely separately. Consider thus the hiring of one particular employee E_i. Following the traditional analysis for a search game, there are two possible equilibria. Either M never learns the candidate's beliefs and simply hires the first candidate. She then expects a payoff from employee E_i of $E[\alpha_i \rho_{\hat{a}_i}] = \alpha_i m_0$. Alternatively, M always learns the candidate's beliefs and hires a candidate only if that candidate agrees with M on the best action. In that case, M expects a payoff of $\alpha_i \overline{m}_0 - 2c$, where I use the fact that if a trial costs c and succeeds with probability θ, then the average cost to succeed is $\frac{c}{\theta}$. It follows that $\hat{a}_{E_i} = \hat{a}_M$ when $\alpha_i(\overline{m}_0 - m_0) \geq 2c$ or $\alpha_i \Delta_0 \geq 4c$, and $\hat{a}_{E_i}$ equals X and Y with equal probability otherwise.

Taking now the results for E_1 and E_2 together, it follows further that, with $\underline{\alpha} = \min(\alpha_1, \alpha_2)$,

$$E[H(Z)] = \int_0^{\min\left(\frac{\underline{\alpha}\Delta_0}{4}, C\right)} \frac{1}{C}\, du + \int_{\min\left(\frac{\underline{\alpha}\Delta_0}{4}, C\right)}^{C} \frac{1}{2C}\, du = \frac{1}{2} + \min\left(\frac{\underline{\alpha}\Delta_0}{8C}, \frac{1}{2}\right), \tag{1}$$

which is larger than $E[H(L)] = \frac{1}{2}$ and strictly so when $\Delta_0 > 0$. This proves the proposition.

The proof follows the suggested intuition: if c is sufficiently low, then M screens on her beliefs. Screening makes both employees choose the same action as M and thus as each other.

Although systematic empirical evidence is lacking, there is both anecdotal and case-based evidence that managers do hire employees with similar beliefs (Donaldson and Lorsch, 1983; Schein, 1985). This is further supported by the observation that firms spend considerable resources on personal interviews and give them a lot of weight, despite the fact that the available evidence implies that personal interviews have very low validity to assess a candidate's ability, and only allow to assess a candidate's "fit" (Arvey and Campion, 1982).

An interesting question is how a need for private effort by the employees would affect the results. Might this lead toward heterogeneity instead? Proposition B6 of Appendix B considers this question by introducing private effort into the above model. It shows that the basic homogeneity result still holds, although the manager will now also screen on the employee's optimism about the implemented action. The analysis thus clarifies how a need for effort requires a different type of screening than an attempt to influence decision making (which is the focus of this article): what matters for effort is the employee's absolute belief about the one action that gets implemented, whereas what matters for decision making is the employee's relative beliefs about the different potential actions. Whereas Proposition B6 still leads to homogeneity, the insights of Proposition B1 suggest that a need for effort *combined with* a need for diversified actions (e.g., exploration) may make heterogeneity optimal. Recent work by Prendergast (2006, 2009) formally derives some results in that direction for the case of private benefits. With differing priors, the earlier distinction between absolute and relative beliefs will then matter again: a combined need for effort and diversified action will lead more to some heterogeneity (around a common belief) when actions are substitutes, that is, when being optimistic about one action makes you pessimistic about the other, which is the same as saying that the absolute and relative beliefs are aligned. I also conjecture that it might then be optimal to split these activities over two separate firms and to focus each firm on one of the activities. Doing so combines economy-wide exploration with organizational homogeneity. This set of issues is an interesting area for further research.

Another interesting question is how these results are affected by the (implicit) assumption that the players are risk neutral. Whereas a formal analysis goes beyond this article, it seems that risk aversion would affect the results through at least three channels. A first effect is that, as long as all players care about the overall payoff and are all risk averse, all players will agree on the need for diversification. Hiring employees with beliefs that are similar to those of the manager will lead to the type of diversification that the manager wants. (This is essentially the same argument

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as that in Proposition B1 why homogeneity of beliefs may be optimal even when there is a need for experimentation.) A second effect is that, if players care more about their own payoff than about the firm's payoff, the manager may want to hire employees with somewhat diverse beliefs so that their diverse action choices diversify the risk. A third effect is on the level of the individual action: when actions differ in their riskiness, the manager now prefers the lower-risk actions and she prefers all employees to choose low-risk actions, so that the manager now screens along a second dimension for employees with beliefs similar to her own. Taking these three mechanisms together, the overall result seems to be that a manager's risk aversion may reduce the tendency toward homogeneity if employees care about their own payoff rather than the firm's payoff.

□ **Determinants of homogeneity.** If firms are more homogeneous than society at large, which firms will be most homogeneous?

To answer this, let $\Delta_0 = |r_{X,M} - r_{Y,M}|$ denote again the strength of the manager's belief, that is, how strongly she prefers one action over the other. The following proposition then says that homogeneity will be stronger in firms where employees make important decisions, where the manager has strong beliefs, and where screening is cheap.

Proposition 2a. The expected level of homogeneity among employees $E[H(Z)]$ increases in the importance of employee decisions, α_1 and α_2, and in the manager's conviction Δ_0, and decreases in the cost of screening C.

Proof. Following equation (1) in the proof of Proposition 1, $E[H(Z)]$ decreases (weakly, and in part of the parameter space strictly) in C and increases (weakly, and in part of the parameter space strictly) in Δ_0 and $\underline{\alpha}$. As $\underline{\alpha} = \min(\alpha_1, \alpha_2)$, it, and thus $E[H(Z)]$, increases in α_1 and α_2.[14]

Consider first the result that $E[H(Z)]$ increases in α_1 and α_2. Remember that α_i denotes the contribution of player i's actions to the overall result. This captures both how many decisions the player controls and how important each of these decisions is to the firm's success. The intuition for this comparative static is that employees who make more, and more important, decisions have a larger impact on the manager's utility, increasing her gain from screening, and thus making the manager more selective. As each employee is then more similar to the manager, employees are also more similar to each other. The empirical implication is that consulting firms or advertising firms, where employees typically make many and important decisions, will be more homogeneous (on relevant dimensions) than an assembly plant, where employees just execute prespecified tasks.

The effect of Δ_0 comes from the fact that a manager with more pronounced beliefs cares more about what an employee does, which makes her more selective. This result captures the observation that firms with a clear set of shared beliefs were often founded by a manager with strong beliefs (Donaldson and Lorsch, 1983).

The comparative static on C, finally, predicts that homogeneity will be stronger along belief dimensions that are easier to observe through behavior or through other visible signs. Note that if the manager believes that some visible sign such as background or educational institution is a good indication of beliefs, then she will want to hire people who have a background that is similar to her own.

A small variation on Proposition 2a says that, *within a firm*, homogeneity will be stronger among employees who make more important decisions. This result requires a firm with more than two employees, and thus requires a small modification to the model. To that purpose, consider the earlier model, but let the firm have J employees, and let $Z = \{E_1, \ldots, E_J\}$. The following proposition says that subsets of the firm that consist of more important employees will be more homogeneous.

[14] The fact that $E[H(Z)]$ depends on $\underline{\alpha}$ (instead of directly on α_1 and α_2) contains no useful economics: it is simply caused by the fact that the cost c is the same for E_1 and E_2. If that cost were position specific, then $E[H(Z)]$ would depend directly on both α_1 and α_2.

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Proposition 2b. For any subset $z \subset Z$ with two or more employees, $E[H(z)]$ increases in α_i for $i \in z$.

Proof. This follows from the proof of Proposition 2a.

Given that α_i captures both the number of decisions that i controls and the importance of each of these decisions, this predicts that management will be more homogeneous than rank-and-file employees, and that employees in the "core" activities of the firm will be more homogeneous than those in peripheral units. In professional firms, for example, the professional staff will be more homogenous than the support staff. Homogeneity will also be stronger among product designers, whose decisions have an important influence on firm success, than in the accounts payable department, which performs a purely routine function.

□ **Self-sorting.** Whereas the above analysis focuses exclusively on screening of potential employees by the manager, self-sorting by the potential employees themselves is an equally important phenomenon. In particular, as employees' utility depends on the actions—and thus on the beliefs—of their manager and colleagues, some people may *prefer* not to work for a specific firm (Van den Steen, 2005). Especially in firms with a strong set of beliefs, such self-sorting seems to be quite prevalent (Collins and Porras, 1994).

Self-sorting has a number of interesting implications. In this section, I will show the following two points. First, and most importantly, beliefs will be path dependent in the sense that the first hire having beliefs that are similar to those of the manager increases the likelihood that the second hire will also be similar to the manager. Second, the manager will be more selective on earlier employees than on later employees and may want to hire the more important employees first.

To study these issues formally, I extend the earlier model with an outside option for the employees. In particular, all potential candidates have an outside option w. The candidates can exercise their outside option at any point in time (i.e., at the start of any stage or substage), but have a lexicographic preference to exercise the option earlier, that is, when indifferent they prefer to exercise earlier. Moreover, all potential candidates observe the preferred action of already-hired employees. To simplify the analysis, I assume that $\alpha_0 = 0$ and $\Delta_0 < C$. Only those candidates who have not yet exercised their outside option can be considered for a position. Assume finally that the manager can choose, prior to learning c, in which sequence to fill positions.

The following proposition then says that the manager will hire first the important employees and will, even for equally important employees, be more selective on these early hires. Moreover, there is path dependence: the first hire being similar to the manager makes the second hire more likely to be similar to the manager. Remember that $\hat{a}_i$ denotes the action that i considers best.

Proposition 3. In any equilibrium, $\alpha_1 \geq \alpha_2$. Moreover, M is strictly more likely to screen when hiring E_1 than when hiring E_2 (even when $\alpha_1 = \alpha_2$). Finally, $P[\hat{a}_{E_2} = \hat{a}_M \mid \hat{a}_{E_1} = \hat{a}_M] > P[\hat{a}_{E_2} = \hat{a}_M \mid \hat{a}_{E_1} \neq \hat{a}_M]$.

Proof. Consider first the hiring of E_2 by M. For M, the hiring of E_2 is independent of E_1. Let $\tilde{L}$ denote the subset of L that has not yet exercised the outside option, and let θ denote the likelihood that a randomly drawn candidate from $\tilde{L}$ thinks $\hat{a}_M$ is best. M will screen when hiring E_2 iff $\alpha_2\overline{m}_0 - \frac{c}{\theta} \geq \alpha_2(\theta\overline{m}_0 + (1-\theta)\underline{m}_0)$ or if $\alpha_2\theta(1-\theta)\Delta_0 \geq c$ or if $\theta(1-\theta) \geq \frac{c}{\alpha_2\Delta_0}$.

Consider now the decision of potential candidates to apply for E_2. (Note that as $\alpha_0 = 0$, this depends only on $\hat{a}_{E_1}$.) Any candidate i with $\overline{m}_i \leq w$ will for sure prefer his outside option and thus not apply. Denote the remaining set of potential candidates as $\check{L}$. Consider now any potential candidate $k \in \check{L}$. If $\hat{a}_k = \hat{a}_{E_1}$ then k expects payoff $\overline{m}_k > w$ upon getting hired, and will thus always apply (because—from his perspective [given that he does not know c]—there is always some probability that he might get hired, and applying is costless). A candidate with $\hat{a}_k \neq \hat{a}_{E_1}$ gets payoff $\alpha_1\underline{m}_k + \alpha_2\overline{m}_k$ upon getting hired, and will thus apply iff $w < \alpha_1\underline{m}_k + \alpha_2\overline{m}_k$. Let τ denote the proportion of the $\hat{a}_k \neq \hat{a}_{E_1}$ players in $\check{L}$ who will apply, and thus $\hat{\theta} = 1/(1+\tau)$ the fraction

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of applications for whom $\hat{a}_k = \hat{a}_{E_1}$. Then $\theta(1-\theta) = \hat{\theta}(1-\hat{\theta}) = \frac{\tau}{1+\tau}\frac{1}{1+\tau} = \frac{\tau}{(1+\tau)^2}$. Note now the following. First, by symmetry, $\theta(1-\theta)$ is the same (for a given τ) whether $\hat{a}_{E_1} = \hat{a}_M$ or not. Second, self-sorting depends only on α_1 and α_2 (and the distributions) but not on c, Δ_0, or what happened for E_1. These also imply that screening by the manager for E_2 is independent of whether he screened for E_1 and of whether he happened to hire a player with his own beliefs or not. It only depends on the parameters. Finally, note that if $\alpha_1 < \alpha_2$ then switching the two decreases the RHS of $w < \alpha_1 \underline{m}_k + \alpha_2 \overline{m}_k$ and thus increases the proportion of players with $\hat{a}_k = \hat{a}_{E_1}$.

It follows now that

(i) for $\frac{\tau}{(1+\tau)^2} = \theta(1-\theta) \geq \frac{c}{\alpha_2 \Delta_0}$, there is perfect screening by M, whereas
(ii) for $\frac{\tau}{(1+\tau)^2} = \theta(1-\theta) < \frac{c}{\alpha_2 \Delta_0}$, there is no screening by M, only self-sorting.

This argument proves already the last part of the proposition. In particular, if the parameters are such that there is perfect screening by M for E_2, then $P[\hat{a}_{E_2} = \hat{a}_M \mid \hat{a}_{E_1} = \hat{a}_M, c] = P[\hat{a}_{E_2} = \hat{a}_M \mid \hat{a}_{E_1} \neq \hat{a}_M, c]$. If the parameters are such that there is only self-sorting, then evidently $P[\hat{a}_{E_2} = \hat{a}_M \mid \hat{a}_{E_1} = \hat{a}_M, c] > P[\hat{a}_{E_2} = \hat{a}_M \mid \hat{a}_{E_1} \neq \hat{a}_M, c]$. Taking expectations over c implies the last part of the proposition.

Consider next the hiring of E_1. As E_1 candidates do not observe the manager's preferences, any self-sorting will affect X types and Y types in symmetric ways, so that now $\theta = .5$. In case (i) (for E_2), the decision to screen on E_1 will affect the cost of screening ($\frac{c}{\theta}$) for E_2. Let this gain be denoted A; then M will screen if $\alpha_1 \overline{m}_0 + A - 2c \geq \alpha_1 m_0$ or if $\alpha_1 \Delta_0 + 2A \geq 4c$ or if $\frac{1}{4} + \frac{A}{2\alpha_1 \Delta_0} \geq \frac{c}{\alpha_1 \Delta_0}$. In case (ii), the decision to screen on E_1 will affect the self-sorting for E_2. Let this gain be denoted B; then M will screen if $\alpha_1 \overline{m}_0 + B - 2c \geq \alpha_1 m_0$ or if $\alpha_1 \Delta_0 + 2B \geq 4c$ or if $\frac{1}{4} + \frac{B}{2\alpha_1 \Delta_0} \geq \frac{c}{\alpha_1 \Delta_0}$. As $\frac{1}{4} \geq \theta(1-\theta)$, the second part of the proposition follows from the first. So we are left to show that $\alpha_1 \geq \alpha_2$.

I now show that, if $\alpha_1 < \alpha_2$, the manager is better off switching the order. Consider first the case that M originally screens for both E_1 and E_2. If he switches the order of hiring and keeps screening for both, then expected project success remains unchanged but the switch between α_1 and α_2 reduces the cost of screening through the improved self-sorting for E_2. (Moreover, M can potentially improve profits further by not screening anymore for E_2.) In the case that he originally does not screen for either E_1 or E_2, switching the order, while still not screening gives exactly the same profit. But M can sometimes improve profits by starting to screen for E_1 after the switch. In the case that he originally screens for E_1 but not for E_2, it will be strictly optimal to keep doing so after the switch, but expected profits will be strictly higher because he now screens for the more important of the two positions. Consider finally the case that he originally screens only for E_2. Note that the cost of screening is $\frac{1}{2}(\frac{c}{\hat{\theta}} + \frac{c}{(1-\hat{\theta})}) = \frac{c}{2\theta(1-\theta)} > 2c$. It follows that switching the order and screening only for E_1 will reduce the cost of screening. It preserves the direct benefits of screening for the player on which he screens. But it increases the overall benefits because there is now the B gain for E_2. So it improves total expected profits. This concludes the proposition.

Intuitively, once the firm hires E_1, it becomes more attractive to potential candidates who agree with E_1. Such self-sorting can be very attractive to the manager, as it allows her to get the "right" employees without spending time and money on screening. As important employees cause more self-sorting (because they have more impact on the outcome), the manager prefers to hire the more important employee first. If she makes sure that this first employee is of the right type, then she can let self-sorting do the rest. This makes, on its turn, the manager more selective for the first position.

The interaction between screening and self-sorting is ambiguous, however. On the one hand, self-sorting makes screening more effective, as the likelihood of getting a good type upon rejecting a bad type is high. On the other hand, self-sorting makes screening less necessary (or useful), as self-sorting itself improves the base rate of candidates. The second effect dominates in the current setup, so that self-sorting reduces screening. Whereas other settings may differ in this respect, the results that self-sorting increases homogeneity, that it introduces path dependence,

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and that it makes the manager care about the sequence in which employees are hired seem to be robust.

Two remarks are in order. First, self-sorting may actually be more powerful than screening by the manager, as it is generally easier for a new candidate to get a sense for the organization than it is for the organization to look into the mind of the candidate. Second, much self-sorting actually takes place through turnover during the early stages of employment. As a consequence, self-sorting can also be quite costly, as much of the match-specific investments get made in exactly that period.

These observations on self-sorting of employees quite naturally raise a closely related question: which player would want to become the CEO? Van den Steen (2010c) and (2010b) both show that it is the person with strong beliefs and a large stake who will become, in equilibrium, the principal. First of all, keeping income constant, a person with stronger beliefs about X versus Y (i.e., with high Δ_i) cares more about the choice and is thus willing to pay more for control. Second, keeping beliefs constant, a person with a larger stake cares more about the choice and is thus willing to pay more for control. One would expect the results in this article to be very similar. In particular, the benefit of being the principal is the implicit control that comes from being able to choose the employees (in the screening model) and from being able to direct learning (in the learning model). As a consequence, when—in this article's model—two players have an equal stake in the project, the player with the higher $\Delta_i = |r_{X,i} - r_{Y,i}|$ will be willing to pay most to become the principal. When the stakes in the project also differ, the willingness to pay depends on a combination of a player's stake and the strength of her beliefs Δ_i. This is an interesting area for further research.

□ **Overinvestment in homogeneity.** Given that both screening and self-sorting can be very expensive, do organizations end up with the right level of homogeneity? I will argue here that *from an outsider's perspective* organizations actually tend to overinvest in homogeneity. The reason is that the manager cares about homogeneity for its own good, as she fundamentally believes that she is right and thus that people who think like her will make better decisions. However, from the perspective of an outsider—who may disagree with the manager—the manager will invest in screening that delivers on average little more than an unproductive rearrangement of people. In fact, I will show something more than this: that the firm will overinvest in homogeneity even when such homogeneity has benefits. In particular, I will consider an extension where the manager can centralize decisions at some cost. Homogeneous organizations will then be more decentralized—as I will show—so that homogeneity saves on centralization costs. Despite these benefits of homogeneity, the firm still overinvests in homogeneity (from an outsider's perspective).

To state this result formally, let me first clarify the different approaches to efficiency in a world with differing priors. In particular, the presence of multiple priors raises the question as to what the right prior belief is to determine the efficiency of an allocation. There are fundamentally two approaches, which each have their own use. The first approach—called "subjective efficiency"—measures each person's utility using his or her own prior belief. In this subjective sense, one allocation is more efficient than another if each player considers him- or herself at least as well off (and some strictly better off) under the first allocation than under the second. This notion of efficiency is most useful for positive analysis. It is the efficiency of the first welfare theorem.[15]

The second approach—called "objective efficiency"—measures everyone's utility using the same "reference belief," which is the belief of the social planner, the academic observer, or the overall principal, and which is for some reason considered to be the "right" prior. This objective approach is most useful for normative analysis, and I will use it here as it captures how investors and academic researchers will evaluate organizational behavior.

[15] For example, in a pure exchange economy where differences in utilities are partially due to differing priors, the first and second welfare theorems only hold if Pareto efficiency is meant as "subjective efficiency" in the sense above. The welfare theorems do not hold for "objective efficiency" under (nontrivial) differing priors.

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This objective efficiency, however, can be sensitive to the belief that is chosen as the reference belief. One possible approach, that I will use here, is to try to show that a certain efficiency ranking holds for any possible choice of reference belief. (An alternative approach could be to draw the reference belief from some distribution and then take expectations over this distribution.)

So I want to determine whether the organization invests too much, too little, or just enough in homogeneity. The approach I take here is to study whether a social planner would want to change, on average over all possible managers, the managers' incentives to screen. In particular, assume that the social planner can subsidize or tax the managers' cost of screening, making it γc instead of c, and then compensate the organization by making a lump-sum transfer in the amount of the expected subsidy or tax. Would the social planner choose $\gamma = 1$, which means that the manager has on average the right incentives, or not?

Let me first start with the basic model, that is, the model without any centralization or decentralization decisions. I will show here that *any* social planner with *any* set of reference beliefs about the payoff, $(\hat{\rho}_X, \hat{\rho}_Y)$, would choose $\gamma > 1$, as he thinks that the manager invests on average too much in screening. As I mentioned earlier, I will assume here, for simplicity and symmetry, that the empirical distribution of the manager's beliefs is as though the manager were also drawn from L, that is, $r_{X,M}, r_{Y,M} \overset{\text{i.i.d.}}{\sim} F$. With $\hat{\gamma}$ denoting the social planner's choice of γ, the following proposition then says that the social planner wants to tax c to reduce the manager's incentives to screen.

Proposition 4. For any reference belief $\hat{\rho} = (\hat{\rho}_X, \hat{\rho}_Y)$, the optimal cost multiplier $\hat{\gamma} > 1$.

Proof. Let $\hat{m} = \frac{\hat{\rho}_X + \hat{\rho}_Y}{2}$. Pick some γ and condition on Δ_0. When $\frac{\alpha_i \Delta_0}{4\gamma} \leq C$, the organization's expected profit from position E_i, denoted R_i, according to the social planner, is

$$\begin{aligned} E[R_i] &= \int_0^{\frac{\alpha_i \Delta_0}{4\gamma}} (\alpha_i \frac{\hat{\rho}_X + \hat{\rho}_Y}{2} - 2\gamma u) \frac{1}{C}\, du + \int_{\frac{\alpha_i \Delta_0}{4\gamma}}^{C} \alpha_i \hat{m} \frac{1}{C}\, du + \int_0^{\frac{\alpha_i \Delta_0}{4\gamma}} 2(\gamma - 1) u \frac{1}{C}\, du \\ &= \alpha_i \hat{m} - \frac{1}{C} \left(\frac{\alpha_i \Delta_0}{4\gamma} \right)^2, \end{aligned}$$

where the last term of the first line is the lump-sum tax refund. This $E[R_i]$ increases in γ. When $\frac{\alpha_i \Delta_0}{4\gamma} > C$, $E[R_i]$ is independent of γ. It follows that the unconditional expectation also increases in γ, so that $\hat{\gamma} > 1$, which proves the proposition.

To now show that organizations tend to overinvest even when the manager has other ways to control employees' behavior, consider the following variation on the model. Assume that in stage 2, prior to the action choice, the manager can centralize decisions at some cost. In particular, at cost I, the manager can actually choose (or force) both employees' decisions. This cost is a random variable $I \sim U[0, 1]$, drawn at the same time as c. Assume for simplicity that $C = 1$, $\alpha_1 = \alpha_2 = \alpha$, and that F has full support. It turns out that, in this case, homogeneity reduces the need for centralization (Van den Steen, 2010a). Nevertheless, the following proposition says that the firm will still invest on average too much in homogeneity.

Proposition 5. For any set of reference beliefs $\hat{\rho} = (\hat{\rho}_X, \hat{\rho}_Y)$, $\hat{\gamma} > 1$.

Proof. Let $\hat{m} = \frac{\hat{\rho}_X + \hat{\rho}_Y}{2}$ and note that screening and centralization will be mutually exclusive (as both are costly and have the same result). M will screen iff $I \geq 4\gamma c$ and $\alpha \Delta_0 \geq 4\gamma c$, and will centralize if $4\gamma c \geq I$ and $\alpha \Delta_0 \geq I$.

When $\alpha \Delta_0 < 1$ and $\frac{\alpha \Delta_0}{4\gamma} < 1$, $E[R] = \int_0^{\alpha \Delta_0} [\int_{\frac{I}{4\gamma}}^1 (\hat{m} - I)\, dc]\, dI + \int_0^{\frac{\alpha \Delta_0}{4\gamma}} [\int_{4\gamma c}^1 (\hat{m} - 4c)\, dI]\, dc + \int_{\alpha \Delta_0}^1 \int_{\frac{\alpha \Delta_0}{4\gamma}}^1 \hat{m}\, dc\, dI$, where the first term is for when M centralizes, the second term for when M screens, and the third for when M does neither. The second term includes the lump-sum payment to compensate for the tax or subsidy (so that the cost is $4c$ instead of $4\gamma c$). Some algebra gives $\frac{dE[R]}{d\gamma} = \frac{(\alpha \Delta_0)^2}{12\gamma^3}(3 - \gamma \alpha \Delta_0 - 2\alpha \Delta_0)$ so that $\hat{\gamma} > 1$ in this case.

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The same is true when $\alpha\Delta_0 \geq 1$, or $\frac{\alpha\Delta_0}{4\gamma} \geq 1$, or both. For example, if $\alpha\Delta_0 \geq 1$ and $4\gamma > 1$, $E[R] = \int_0^1 [\int_0^{\frac{I}{4\gamma}} (\hat{m} - 4c)\, dc + \int_{\frac{I}{4\gamma}}^1 (\hat{m} - I)\, dc]\, dI$, and algebra gives $\frac{dE[R]}{d\gamma} = \frac{1}{12\gamma^3}(1 - \gamma)$ so that $\hat{\gamma} = 1$. Taking expectations over Δ_0 completes the proof.

Despite the fact that homogeneity saves on centralization costs, the investment level is thus on average still too high. This holds more in general: the manager always perceives an additional subjective benefit of employees following her/his beliefs over and above the objective cost/benefit tradeoff.

However, this result does not necessarily imply that the financial markets will evaluate culture negatively. In particular, there will also be sorting in the financial markets: active investors will be more likely to invest in firms that agree with their own subjective beliefs.[16] Such investors will thus perceive a similar subjective benefit from screening and learning as the manager. The overinvestment result does hold though for randomly selected outsiders. Index investors would thus be more likely than active investors to consider a firm's culture as being too strong. This seems to be a new empirical prediction.

3. Shared experience

■ Once employees are hired, a second homogeneity mechanism kicks in. In particular, employees experience first-hand the firm's actions and successes. Such experience will influence their beliefs.[17] As all employees have the same experiences, their beliefs will converge even though they begin with differing priors. In other words, shared experiences breed shared beliefs.

Because employees of different firms will have different experiences, however, and because first-hand experiences are difficult to communicate,[18] beliefs will converge within firms but not (or less so) across firms. So there will be more within-firm homogeneity than across-firm homogeneity.

I will study here both the mechanism and the comparative statics of such homogeneity through shared experiences, using a slight modification of the model of Section 2 to allow for learning. After extending the basic homogeneity result to this context, I show that most of the comparative statics of screening also extend *if* the manager can affect the employees' learning. Under that condition, I also derive an important new comparative static: firms that have been successful in the past will be more homogeneous.

Whereas the model in this section is a two-period model, an earlier working paper (Van den Steen, 2004) derived analogous results in an infinite-horizon multiarmed bandit model. I use here the simpler model to increase transparency.

□ **Model.** The model in this section makes a few small modifications to the model of Section 2 to allow employees to learn from the firm's experience. Remember that each player started the game with a subjective belief about ρ_a (but without having any private information), with player i's expectation of ρ_a denoted as $r_{a,i}$. Players may openly disagree—that is, it is common knowledge that sometimes $r_{a,i} \neq r_{a,j}$—so that a player will not update his belief just because he notices that someone else disagrees. These subjective beliefs $r_{a,i}$ were distributed according to some nondegenerate distribution F. Knowledge of F does not affect or change a player's belief: each player considers his belief as the right one and interprets F as information about how other players are mistaken in their beliefs.

To capture learning, I now add a new element: the true return of the actions will sometimes be revealed and players will be able to learn from that. In particular, the manager will choose

[16] I thank a referee for this nice insight.

[17] With differing priors, employees are Bayesian rational in the usual way.

[18] The idea that first-hand experience is difficult to match is, for example, captured in the old saying "Tell me and I will forget; Show me and I will remember; Involve me and I will understand" (variously attributed to Confucius, Aristoteles, and one of my former teacher's uncles).

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her action first, before the employees do, and the employees observe the manager's action and its payoff so that the employees can learn from the performance of M's action.

Obviously, the empirical distribution of the true returns ρ_a will now play a role. Assume that these true returns are distributed according to some nondegenerate distribution G (which support a superset of Fs to make the model consistent). The players are obviously *not* aware that the ρ_a are distributed according to G: they believe that the distribution is according to their prior belief.[19] As both F and G are empirical distributions, they can in principle be completely unrelated. Typically, however, the prior beliefs will have some relation to the distribution of underlying values.[20] I will therefore at times assume—for simplicity and symmetry—that the true returns ρ_a and the expectations of the prior beliefs happen to have the same distribution, that is, $G = F$, but I will be very explicit when I make that assumption. To consider the pure learning case, assume finally that $c = \infty$, so that there is no screening.

□ **Shared beliefs.** I now first show that the result of Proposition 1 extends to this context: employees of the same firm will have shared beliefs, so that firms are more homogeneous than society at large. There is a small complication, as there are two possible reference points: the original labor pool L (who have not learned from anyone) and the employees of other firms (who have learned, but from other managers). In what follows, I will consider both.

Let $Z = \{E_1, E_2\}$ denote again the set of employees. The following proposition says that homogeneity is higher among employees than among the candidates.

Proposition 1′a. The expected level of homogeneity is higher among the firm's employees than within the pool of potential employees: $E[H(Z)] > E[H(L)]$.

Proof. Denoting the manager's outcome as ρ, the probability that E_1 and E_2 agree on the optimal course of action is the probability that the two employees agree that the manager's action is best plus the probability that the two employees agree that the other action is best, that is, $F(\rho)^2 + [1 - F(\rho)]^2$. Let H denote the distribution that $G(\rho)$ induces on the values of $F(\rho) \in [0, 1]$. (If $G = F$ then H is the uniform distribution on $[0, 1]$.) Taking the expectation over the manager's action's payoff then gives the expected probability of agreement

$$E[H(Z)] = \int_{\rho} F(u)^2 + [1 - F(u)]^2 \, dG(u) = \int_0^1 v^2 + (1 - v)^2 \, dH(v) > \frac{1}{2} = E[H(L)],$$

where I use the fact that $v^2 + (1 - v)^2 \geq /.5$ on $[0, 1]$ with equality iff $v = .5$.

Note that shared experience creates homogeneity in two—opposite—ways. On the one hand, if the experience was good, then each employee's opinion of that particular action improves, which increases the likelihood that two employees will agree on that action being the optimal course of action. On the other hand, if the experience was bad, then each employee's opinion of that particular action gets worse, which increases the likelihood that they will agree on the other action. For an alternative intuition for the learning result, note that the players would always agree if their beliefs were perfectly correlated. What learning does is increase the correlation between the employees' beliefs.

As mentioned above, an alternative reference point is to compare within-firm homogeneity to across-firm homogeneity. To that purpose, consider two firms, f and g, which each have a manager and two employees. Let $E_{i,h}$ denote employee i of firm h. The two firms are completely identical except for the identity of managers and employees, who are all randomly drawn from L. The employees of a firm observe the actions and outcomes of their own manager, but not those of the other manager. Let $Z_s = (E_{1,h}, E_{2,h})$ denote two employees of the same firm and

[19] This distribution of returns G is thus *not* some form of prior distribution in a Bayesian sense but an empirical distribution that is introduced for the sole purpose of the analysis.

[20] An important reason for this is that the priors in any period are posteriors from earlier periods and will thus often—through updating—reflect some information about the true returns.

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$Z_d = (E_{i,f}, E_{j,g})$, where possibly $i = j$ denote two employees of different firms. The following proposition then says that employees of the same firm are more likely to agree than employees of different firms.

Proposition 1′b. $E[H(Z_s)] > E[H(Z_d)]$.

Proof. The proof of Proposition 1′a implies $E[H(Z_s)] > 1/2$. Consider then two employees of different firms. If their managers undertake the same action then it is as though they were in the same firm. If their managers undertake different actions then, denoting the outcome of one manager ρ and of the other manager $\check{\rho}$, the probability of agreement is $F(\rho)(1 - F(\check{\rho})) + F(\check{\rho})(1 - F(\rho))$. The overall probability of agreement is then

$$E[H(Z_d)] = \frac{1}{2}E[H(Z_s)] + \frac{1}{2}[2\int F(u)\,dG(u)\int (1 - F(u))\,dG(u)] = \frac{1}{2}E[H(Z_s)] + (V - V^2),$$

where $V = \int F(u)\,dG(u) \leq 1$, so that $E[H(Z_d)] \leq E[H(Z_s)]/2 + 1/4 < E[H(Z_s)]$, which proves the proposition.

It would be interesting to see how this learning mechanism compares to screening. Obviously, a direct comparison in terms of their effect depends completely on the parameters of the setting, such as the cost of screening and the effectiveness of learning. But there is one interesting way in which the mechanisms seem to differ more systematically.[21] In particular, screening generates (weakly) more homogeneity between the manager and an employee than between two employees. In the setup of Section 2, for example, if $\max(\alpha_1, \alpha_2) > \frac{4c}{\Delta_0} > \min(\alpha_1, \alpha_2)$, then the more important employee will always agree with the manager, whereas the two employees will agree only half the time. In the learning model, on the other hand, an employee is as likely to agree with the manager as with another employee. More research is needed to see whether this effect is completely robust.

□ **Determinants of homogeneity.** Consider now again the question of what determines homogeneity, that is, under which conditions firms are more likely to have shared beliefs. The basic learning model above delivers a limited number of comparative statics. In particular, Propositions B4 and B5 of Appendix B use two small variations on that model to show that homogeneity will be stronger in older firms and in settings where the manager's experience is easier to communicate or observe. The latter suggests that shared beliefs will be especially prevalent in small organizations where communication flows easily.

Things get substantially more interesting when the manager can affect whether employees learn from her experience. In particular, I will show that most of the comparative statics of screening extend, and that, moreover, successful organizations will be more likely to develop shared beliefs. In other words, success breeds homogeneity.

To derive these results, assume that an employee learns from the manager's experience only if the firm invests in communication (which can also be interpreted as training or socialization). In particular, the manager decides at the end of period 1, after learning her payoff, whether to communicate the first-period outcome to each employee, at a cost k per employee to the firm.[22] This cost k is a random variable $k \sim U[0, K]$, it is common to all employees, and it is drawn at the start of period 1.

For reasons that become clear below, I will now allow players to choose among $N \geq 2$ actions. As before, action a's payoff ρ_a is unknown, whereas its expected payoff according to player i is empirically distributed according to $r_{a,i} \overset{\text{i.i.d.}}{\sim} F$ for $i \in L$, and its true value has (unknown to the players) an empirical distribution $\rho_a \overset{\text{i.i.d.}}{\sim} G$.

[21] I thank the editor for this suggestion.

[22] I assume a cost per employee rather than a lump-sum communication cost, because typically this type of communication is very personal. In particular, for the shared beliefs to be distinctive, the information must be easier to communicate within the organization than beyond and will thus typically be soft information that gets transferred either through personal experience (for example, in a coaching-like relationship) or through personal trusted communication.

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The following proposition says that nearly all comparative statics of Proposition 2 extend to this case.[23] In particular, homogeneity will be high when employee decisions are important and when communication is easy. Moveover, within a firm, homogeneity will be stronger among more important employees. For the second part of the proposition, assume as before that there are J employees and $Z = \{E_1, \ldots, E_J\}$.

Proposition 2′. The expected level of homogeneity $E[H(Z)]$ increases in the importance of employee decisions α_1 and α_2, and decreases in the cost of communication K. For any subset of employees $z \subset Z$ with two or more employees, the expected level of homogeneity $E[H(z)]$ increases in the importance of the decisions α_i by its employees $i \in z$.

Proof. Consider first the manager's decision to invest in communication. Let A denote the set of actions, $\bar{r}_M = \frac{\sum_{a \in A} r_{a,M}}{N}$ the average payoff according to M (after having learned the payoff of her chosen action $\tilde{a}_M$), and $\breve{\bar{r}}_M = \frac{\sum_{a \in A \setminus \{\tilde{a}_M\}} r_{a,M}}{N-1}$ the average payoff according to M of all but her chosen action. If the employee does not get any information about the payoff, he takes (from M's perspective) a random action, with expected payoff $\bar{r}_M$.[24] If the first-period payoff is ρ and the employee does observe that payoff, then he chooses that action with probability $F(\rho)^{N-1}$ and some other action, with expected payoff $\breve{\bar{r}}_M$, with complementary probability. It follows that M's expected continuation payoff for E_i is then $\alpha_i(\rho F(\rho)^{N-1} + \breve{\bar{r}}_M(1 - F(\rho)^{N-1}))$. So M's gain from having E_i observe M's action and outcome is

$$S_i = \alpha_i \left(\rho F(\rho)^{N-1} + \breve{\bar{r}}_M(1 - F(\rho)^{N-1}) - \frac{\rho}{N} - \frac{(N-1)\breve{\bar{r}}_M}{N} \right) = \alpha_i(\rho - \breve{\bar{r}}_M) \left(F(\rho)^{N-1} - \frac{1}{N} \right).$$

As M communicates to E_i iff $S_i \geq k$, E_i will learn with probability $q_i(\rho) = P[S_i \geq k]$. Let $\check{\rho}$ be defined as $F(\check{\rho})^{N-1} = \frac{1}{N}$ and let $\rho_0 = \min(\check{\rho}, \breve{\bar{r}}_M)$ and $\rho_1 = \max(\check{\rho}, \breve{\bar{r}}_M)$. Then $q_i(\rho)$ is (semistrictly) quasiconvex in ρ with $q_i(\rho) = 0$ for $\rho \in [\rho_0, \rho_1]$, and $q_i(\rho)$ increases in α_i and decreases in K.

Note that the probability that two employees agree is $\frac{1}{N}$ unless *both* observe the manager's action and performance. Let $q(\rho) = \min_i q_i(\rho)$, then

$$\begin{aligned} E[H(Z)] &= \int_\rho \left(q(\rho) \left[F(\rho)^{2(N-1)} + \frac{1}{N-1} \left[1 - F(\rho)^{N-1} \right]^2 \right] + (1 - q(\rho)) \frac{1}{N} \right) g(\rho)\, d\rho \\ &= \frac{1}{N} + \frac{N}{N-1} \int_\rho q(\rho) \left(F(\rho)^{(N-1)} - \frac{1}{N} \right)^2 dG(\rho). \end{aligned}$$

This proves the first half of the proposition as $q(\rho)$ increases in α_1 and α_2 and decreases in K. The second half is analogous.

As with screening, the intuition is that the manager cares more about employees learning when these employees make important decisions and when learning is cheap. Investments to make sure that employees hold the "right" beliefs indirectly generate homogeneity. The comparative static in K suggests that homogeneity will be stronger in smaller firms because employees in smaller firms learn more easily about the firm's successes and failures.

An analogous proof also shows that $E[H(Z_s)] - E[H(Z_d)]$ increases in α_1 and α_2 and decreases in K. In other words, within-firm homogeneity also increases relative to across-firm homogeneity when α_1 and α_2 increase and K decreases.

Performance and homogeneity (or culture). Consider now the prediction that success breeds homogeneity. Let ρ denote the payoff of the manager's action and assume for simplicity that F

[23] A full analysis of the impact of the manager's conviction (Δ_0) is not easily done with the current apparatus.

[24] When the employee does not observe any first-period action, that by itself allows him to make inferences about ρ (as it says that the manager likely did not invest). However, because employees' beliefs are symmetric *ex ante* and the employee does not know the manager's action, the employee's action will still be random from M's perspective.

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has full support. The following proposition then says that only the most successful firms will attain a certain level of homogeneity.[25]

Proposition 9a. For any number of actions $N > 2$, there exist cutoff levels $\hat{H}$ and $\hat{\rho}$ such that the expected homogeneity $E[H(Z)] > \hat{H}$ if and only if the manager's payoff $\rho > \hat{\rho}$.

Proof. From the proof of Proposition 2′, it follows that for any N, there exist $\rho_0 \leq \rho_1$ such that $E[H(Z)]_{\rho=\tilde{\rho}}$ is strictly decreasing in $\tilde{\rho}$ for $\tilde{\rho} < \rho_0$ and strictly increasing for $\tilde{\rho} > \rho_1$ with

$$E[H(Z)]_{\rho=\tilde{\rho}} = \frac{1}{N} + \frac{N}{N-1} q(\tilde{\rho}) \left(F(\tilde{\rho})^{(N-1)} - \frac{1}{N} \right)^2,$$

where $q(\rho) = \min_i P[\alpha_i(\rho - \breve{r}_M)(F(\rho)^{N-1} - \frac{1}{N}) \geq k]$, so that $\lim_{\tilde{\rho}\to\infty} E[H(Z)]_{\rho=\tilde{\rho}} = \frac{1}{N} + \frac{N}{N-1}(1 - \frac{1}{N})^2 = 1$ and $\lim_{\tilde{\rho}\to-\infty} E[H(Z)]_{\rho=\tilde{\rho}} = \frac{1}{N} + \frac{N}{N-1}(\frac{1}{N})^2 = \frac{1}{N-1}$. For any N, let $\hat{H} = \frac{1}{N-1}$ and let $\hat{\rho}$ be defined by $\frac{1}{N} + \frac{N}{N-1} q(\hat{\rho})(F(\hat{\rho})^{(N-1)} - \frac{1}{N})^2 = \hat{H}$ for $\hat{\rho} > \rho_1$. This concludes the proposition.

The intuition is that, for reasons that I will explain immediately, extreme experiences generate agreement on the right course of action, but positive extreme experiences have more effect than negative extreme experiences. Moreover, the homogeneity effect vanishes for negative extreme experiences as N increases, which is not the case for positive extreme experiences.

There are actually two effects that generate homogeneity here. First, extreme results will lead to more agreement even without any extra investments by the manager. In particular, an extremely high payoff makes it very likely that all employees agree that this is the right course of action, whereas an extremely low payoff makes it very likely that all employees agree that this cannot be the best action, reducing the choice set to $N - 1$ actions and thus also increasing the probability of agreement.

The second effect is that the manager is more likely to invest in communication when the payoff is extreme. By such investments he tries to make sure that, if the payoff was high, the employee undertakes that action, or, if the payoff was low, the employee avoids that action. More communication will increase agreement.

Both these effects are asymmetric in the sense that they are stronger for high payoffs than for low payoffs. In particular, agreement on what action is best leads directly to similar actions, whereas agreement on what action is worst only reduces the choice to the remaining $N - 1$ actions. Similarly, the manager gains much more from telling an employee what to do than from telling him what not to do, because the latter leaves $N - 1$ actions to choose from. As a consequence, extreme successes create more homogeneity than extreme failures.[26] And only firms with a very successful manager will be very homogeneous.

But there is more. In particular, something similar holds for employee (rather than the manager's) performance: only employees of homogeneous firms will have a high average performance, even though homogeneity has itself no performance benefits.

Proposition 9b. For any $N > 2$ and for $i \in \{1, 2\}$, there exists cutoff levels $\hat{R}$ and $\hat{H}$, such that the expected performance of employee i $E[\rho_{\tilde{a}_i}] \geq \hat{R}$ if and only if the expected level of homogeneity $E[H(Z)] \geq \hat{H}$.

[25] Proposition 9b shows that a similar result also holds for the relationship between homogeneity and employee performance.

[26] This result may seem counterintuitive. Suppose, for example, that the outcome is drawn from a two-point distribution: payoff 100 with probability .9999 and zero otherwise. Remembering a bad outcome may then seem worth more than remembering a good one. This is incorrect, however: once you know an action with payoff 100, you can take that action forever, and you will never get 0. Lee and Van den Steen (2010) relate this to firms' focus on best practice.

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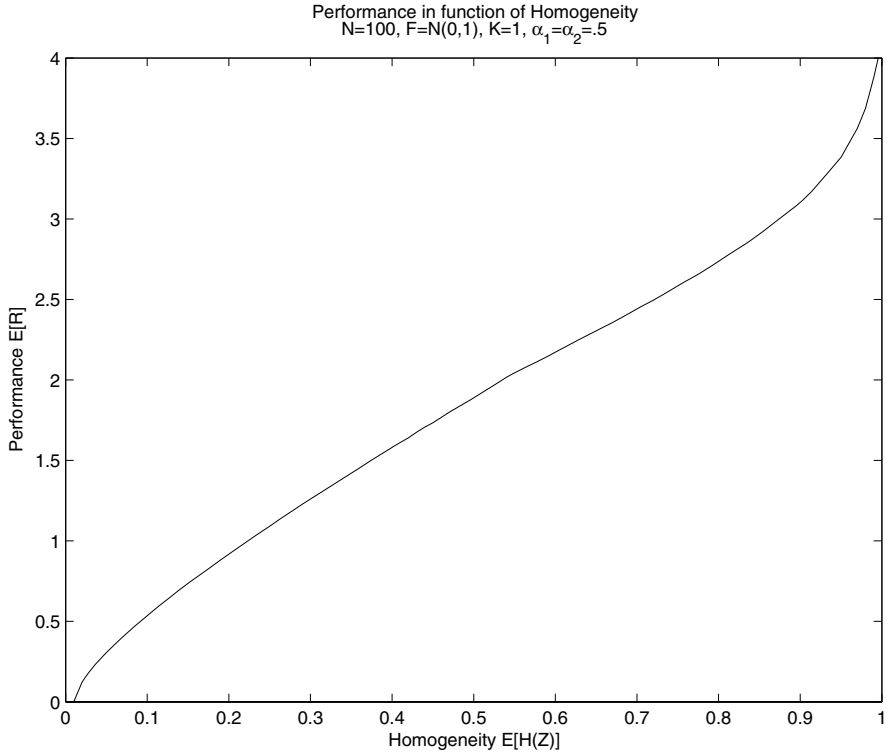
FIGURE 2

PERFORMANCE IN FUNCTION OF HOMOGENEITY



Proof. Note that the expected performance of E_i as a function of the manager's payoff ρ equals

$$E[\rho_{\tilde{a}_i}] = q_i(\rho)[\rho F^{N-1}(\rho) + (1 - F^{N-1}(\rho))\mu_G] + (1 - q_i(\rho))\frac{\rho + (N-1)\mu_G}{N},$$

where μ_G denotes the expected value of G. This function strictly increases in ρ when $\rho > \max(\mu_G, \check{\rho})$, where $\check{\rho}$ is defined, as before, $F^{N-1}(\check{\rho}) = \frac{1}{N}$. Given the $\hat{\rho}$ of Proposition 9a, let $\hat{\hat{\rho}} = \max(\hat{\rho}, \check{\rho}, \mu_G)$, and let $\hat{H}$ now be defined such that $\hat{H} = \frac{1}{N} + \frac{N}{N-1}q(\hat{\hat{\rho}})(F(\hat{\hat{\rho}})^{(N-1)} - \frac{1}{N})^2$ and let $\hat{R} = q_i(\hat{\hat{\rho}})[\hat{\hat{\rho}}F^{N-1}(\hat{\hat{\rho}}) + (1 - F^{N-1}(\hat{\hat{\rho}}))\mu_G] + (1 - q_i(\hat{\hat{\rho}}))\frac{\hat{\hat{\rho}}+(N-1)\mu_G}{N}$. Combining this with the proof of Proposition 9a implies the proposition.

The intuition is that both homogeneity and employee performance are driven by the performance of the manager. This omitted factor then causes a correlation between the two even though there is no causality in either direction. This is important because, historically, the interest in corporate culture has been driven largely by its suggested impact on corporate performance. In particular, works such as Deal and Kennedy (1982), Peters and Waterman (1982), and Collins and Porras (1994) have popularized the notion that strong culture is a driver of good performance. Although Van den Steen (2010a) shows that homogeneity has a real impact on performance, the current analysis also implies that the issue of inverse causality looms large when assessing the relationship between culture and performance.

Moreover, in this model, the employees' performance lags the measure of homogeneity. It follows that the approach of Kotter and Heskett (1992) to regress lagged performance on a measure of cultural strength does not solve this causality issue.

Figure 2 shows, for a typical set of parameters, how strong the relation between culture and employee performance in this model actually is. With such a strong correlation, it is understandable

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that people get struck by the strong cultures of extreme performers. It is then tempting to conclude that culture causes strong performance. This inverse causality issue questions the inferences that can be drawn from simple correlation or regression analyses, such as those by Kotter and Heskett (1992), and any interpretation of the relationship between culture and performance that is based on informal observations, such as Deal and Kennedy (1982).

□ **The interaction between screening and learning.** With both screening and learning creating homogeneity, a natural question is how these two mechanisms interact. On the one hand, both mechanisms achieve the same purpose, which suggests that they would be substitutes, that is, that the gains from screening are reduced when there is already learning and the other way around. On the other hand, however, learning changes the employee's beliefs in a way that may potentially make it cheaper to find an employee with the right beliefs (after learning). This suggests that screening and learning could sometimes be complements. As there are many possible ways in which screening and learning can be combined, a complete answer to this question is outside the scope of this article. Instead, I will show for one simple setting that the first effect dominates so that learning and screening are indeed substitutes (wherever it matters).

Consider, in particular, the setup of this Section 3 but now with the following timeline. First, the manager chooses her action and observes the outcome. Second, based on this observed payoff, the manager then decides whether this payoff will be communicated to all future employees. As before, such communication costs k per employee. Third, the manager hires the firm's employees. In hiring these employees, she can decide whether to screen on beliefs or not. The cost of observing beliefs is c per potential employee, again as before. Finally, the hired employees simultaneously undertake their actions. This sequence—with the manager deciding on learning before the actual hiring of employees—captures, for example, a setting where communication comes in the form of training programs and job design, which have to be planned and implemented up-front and cannot be changed easily on the fly. Many strong-culture organizations, for example, have considerable introductory training programs with attention to the firm's history and general philosophy.

For this setting, the following proposition says that screening and learning are substitutes from the manager's perspective wherever it matters.

Proposition 10. Wherever it may be potentially optimal to invest in both, the gains from screening (resp. learning) are lower when the firm already invests in learning (resp. screening) than when it does not.

Proof. Note first that as the employees' payoffs are independent, it suffices to consider one employee, say employee 1. Assume wlog. that the manager chooses $\tilde{a}_M = X$ as her action (which implies that the manager knows ρ_X and that $r_{Y,M}$ is a second-order statistic). Denote, to be consistent with before, $\rho_X = \rho$.

Consider now first the case that $\rho \geq r_{Y,M}$. The expected payoff without any screening or learning equals $R_{1,\emptyset} = \frac{\rho + r_{Y,M}}{2}$. The payoff from screening, from learning, and from both, respectively, equal $R_{1,S} = \rho - 2c$, $R_{1,L} = \rho F(\rho) + r_{Y,M}(1 - F(\rho)) - k$, and $R_{1,SL} = \rho - \frac{c}{F(\rho)} - k$.

It follows that the gain from screening (without learning) equals $R_{1,S} - R_{1,\emptyset} = \frac{\rho - r_{Y,M}}{2} - 2c$ whereas the gain from screening after learning equals $R_{1,SL} - R_{1,L} = (\rho - r_{Y,M})(1 - F(\rho)) - \frac{c}{F(\rho)}$. Screening and learning are substitutes iff $(R_{1,SL} - R_{1,L}) - (R_{1,S} - R_{1,\emptyset}) \leq 0$ or $[(\rho - r_{Y,M})(1 - F(\rho)) - \frac{c}{F(\rho)}] - [\frac{\rho - r_{Y,M}}{2} - 2c] \leq 0$ or $(\frac{\rho - r_{Y,M}}{2} - \frac{c}{F(\rho)})(1 - 2F(\rho)) \leq 0$.

I now show that this inequality holds whenever it may be optimal to invest in both learning and screening. Consider first the case that $F(\rho) \leq \frac{1}{2}$. In that case, it will never be optimal to invest in both learning and screening because the gain from learning upon screening equals $R_{1,SL} - R_{1,S} = \frac{c}{F(\rho)}(2F(\rho) - 1) - k < 0$.

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Consider next the case that $F(\rho) > \frac{1}{2}$. Note that it is only worth investing in both learning and screening if $R_{1,SL} - R_{1,\emptyset} = \rho - \frac{c}{F(\rho)} - k - \frac{\rho + r_{Y,M}}{2} = \frac{\rho - r_{Y,M}}{2} - \frac{c}{F(\rho)} - k > 0$, which requires that $\frac{\rho - r_{Y,M}}{2} - \frac{c}{F(\rho)} > 0$. But combined with $F(\rho) > \frac{1}{2}$, this implies that screening and learning are indeed substitutes.

The case for $\rho < r_{Y,M}$ is completely analogous.

Although this shows that learning and screening are substitutes in this setting and in the relevant range, this result may not be entirely robust. As pointed out earlier, if learning is imperfect then it may have the effect of improving in expectation (in terms of *ex post* beliefs) the pool of candidates and thus make screening more attractive. This is a topic for further research. The key conclusion of this section is thus not so much that learning and screening are substitutes, but that there are two counteracting effects and that the substituting effect tends to dominate the complementary effect. I now turn to some results about the content of a firm's culture.

4. Corporate culture

■ When studying corporate culture in the sense of shared beliefs and values, it is important to distinguish two dimensions. The first dimension is the strength of the culture, that is, the degree to which these beliefs and values are shared. It is this cultural strength that has been the focus of this article and that has also received the most attention in the literature on corporate culture. But—whereas cultural strength has an impact on firm performance (Van den Steen, 2010a)—it is the second dimension which often seems to have the larger impact on firm performance: the *content* of the culture, that is, *what* these people believe and value. In what follows, I now consider this article's implications for the content of corporate culture. I show, in particular, that the manager has an important influence on the content of her firm's culture and that a firm's culture tends to persist over time, even when all original members of the firm have left. The working paper Van den Steen (2004) also shows why different firms may develop different cultures and why cultures may be suboptimal even when firms have unlimited opportunity to learn from experience.[27]

□ **The manager's influence on culture.** To capture the content dimension of "corporate culture as shared beliefs," I would like to define a firm's culture to be that course of action on which most employees agree as the best course of action (at the point in time when they have to choose an action). With a finite number of employees, however, such action may not exist. I will therefore formally define a course of action a_c to be the firm's culture if the probability—over the distribution of employee beliefs—that two employees agree on a_c as the best course of action is higher than the probability that they agree on any other particular action. As the number of employees goes to infinity, this definition almost surely coincides with the action on which most employees agree as the best course of action.

My first result is then that a firm's culture is influenced by its manager's beliefs. I will show in particular that—under reasonable conditions—the manager's action $\tilde{a}_M$ is more likely than any other action to become the firm's culture (i.e., the belief most likely to be shared). In the screening model, this is trivial because the manager screens according to her prior beliefs. The interesting result here is that it also holds in the pure learning model (if $G = F$, a condition to which I return after the proposition). This is actually somewhat surprising: the manager's beliefs are drawn completely independent of the employees' beliefs and of the true underlying return.

[27] These two outcomes are both applications of Rothschild's (1974) result for multiarmed bandits that the optimal policy will eventually settle on an action but not necessarily on the best action. The reason is that experimentation and learning require choosing actions that have a low expected payoff (in order to learn more about their true payoff), which makes them costly. At some point, the cost of such experimentation exceeds its expected benefits and the optimal policy will thus stop experimenting before the true payoffs are known. This may cause firms to end up with a suboptimal culture and different firms to develop different cultures, even though they have unlimited opportunity to learn.

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At first sight, there is thus really no reason to expect that the fact that the manager chooses about which actions employees learn has any influence on what actions the employees consider best. The result here, however, says essentially that forced learning makes you more likely to settle on that action. Note that, in contrast to earlier results which all related to the strength of culture, this result is indeed about the content of culture.

To see this result formally, consider the basic learning model of Section 3 with $N \geq 2$. The following proposition says that $\tilde{a}_M$ is more likely than any other action to become the firm's most shared belief.

Proposition 11. If $G = F$, then $P[a_c = \tilde{a}_M] \geq P[a_c = a]$ for any $a \neq \tilde{a}_M$, with strict inequality for $N > 2$.

Proof. Let ρ be the payoff of $\tilde{a}_M$. The likelihood that two employees agree on $\tilde{a}_M$ as the best action is $\int_\rho F(\rho)^{2(N-1)}\, dG(\rho) = \int_0^1 u^{2(N-1)}\, dH(\rho)$, where H is the distribution that G induces on the values of F. The likelihood that two employees agree on any *particular* other action is $\int_\rho [\frac{1-F(\rho)^{N-1}}{N-1}]^2\, dG(\rho) = \int_0^1 \frac{(1-u^{N-1})^2}{(N-1)^2}\, dH(\rho)$. If $G = F$ then H is the uniform distribution and these two likelihoods become, respectively, $\frac{1}{2N-1}$ and $\frac{2}{N(2N-1)}$, which proves the proposition.

The condition that $G = F$ is needed to exclude the following possibility: if players tend to be extremely optimistic (in the sense that F considerably first-order stochastically dominates G), then any action that is undertaken will tend to disappoint and thus become less likely to be chosen by anyone else. The condition $F = G$, which seems very reasonable, eliminates this by ensuring that the players' beliefs have some reasonable relationship to the underlying true values.

These results on the manager's influence are important because the most prominent researchers who identified corporate culture with shared beliefs have also stressed the role of the founder or early leader in the formation of an organization's culture (Donaldson and Lorsch, 1983; Schein, 1985; Kotter and Heskett, 1992).

This result also raises some questions on the effect of managerial turnover. For example, when should a board select an internal versus an external candidate for the job of CEO? This article suggests that a cultural change may require the selection of an outsider with a very different belief system. This is consistent with the management literature on change, which suggests that CEO replacement with an outsider is the most effective way to change corporate culture (Kotter and Heskett, 1992). But, obviously, the appointment of an outsider does not necessarily or automatically lead to a change of culture, for two reasons. First of all, when no change in culture is attempted, firms are often very careful to make sure the outsider has beliefs and values that are consistent with those of the organization. Second, the outsider CEO may fail to change the culture and then actually be the one to leave.

A second implication of the article is that such appointment of a new CEO with different beliefs will lead to turnover, through both selection and self-sorting. Whereas there are many informal and case-based stories along these lines, there is also some more systematic evidence for this prediction. In particular, Hayes, Oyer, and Schaefer (2006) show that the likelihood of top management turnover increases markedly around times of CEO turnover.

□ **Persistence over time.** A closely related phenomenon is the persistence of that culture over time, even when all original members of the organization are gone. This phenomenon is one of the things that make organizational culture so intriguing: it is as if culture exists independent of the people in the organization, as if the organization itself has some personality or identity. I will now show that culture is indeed persistent in the models of this article.

Persistence is straightforward in an overlapping-generations extension of the screening model: managers hire employees in their own image, who on their turn hire the next generation in the same image, and so forth. More interesting is again the result that persistence also obtains in the pure learning model, through manager-forced learning. Consider, in particular, two generations of the learning model of Section 3 with $N \geq 2$. Assume that one of the employees of the first generation becomes the manager in the second generation (and the employees of the second

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generation are new draws from L). Denote by $\tilde{a}_{M(1)}$ the action of the first-generation manager. I will show that, under reasonable conditions, second-generation employees are more likely to agree on $\tilde{a}_{M(1)}$ as the best action than on any other action. In fact, this result also holds after an arbitrary number of generations in an overlapping-generations model where individuals are employees in their first period, and managers in their second period, and then leave: the nth-generation employees are more likely to agree on the very first manager's action choice than on any other action.

This result is quite remarkable, given that the first-generation manager's prior is completely independent of the underlying performance and other players' priors, and given that the second-generation employees never overlapped with the first-generation manager. It shows how a player's actions can be systematically influenced by forced learning, that is, by exposing the player to experiments chosen by someone else.

To analyze this effect formally, consider the model of Section 3 with $N \geq 2$ but repeated twice. The first of these two stages is exactly the same as specified in Section 3. After this first stage, one of the employees gets picked at random to be the second-generation's manager. (The other employee disappears from the game.) The second stage is then also exactly like the model of Section 3, with the two second-generation employees drawn at random from L. To eliminate considerations of strategic experimentation (given that players have been reduced to taking only one action in each role), I will assume here that any player learns the payoffs of her actions as an employee only after she has chosen her action as a manager.[28] Let $a_{c(2)}$ then denote the firm's culture in period 2, that is, the action on which the second-generation employees are most likely to agree (at the time they have to choose their actions), $\tilde{a}_{M(1)}$ the action of the first-generation manager, and $\tilde{a}_{M(2)}$ the action of the second-generation manager.

Proposition 12. If $G = F$ then $P[a_{c(2)} = \tilde{a}_{M(1)}] \geq P[a_{c(2)} = a]$ for any $a \neq \tilde{a}_{M(1)}$, with strict inequality when $N > 2$.

Proof. Given the proof of Proposition 11, it suffices to show $P[\tilde{a}_{M(2)} = \tilde{a}_{M(1)}] \geq P[\tilde{a}_{M(2)} = a]$, with strict inequality when $N > 2$. With A the set of actions, M_2 the second manager, and $r_{a,M(2)}M_2$'s prior belief about action a at the start of the game (prior to him having taken action as an employee), condition on the returns $\{\rho_a\}_{a \in A}$, and assume wlog. that $\tilde{a}_{M(1)} = a_N$ with $\rho_{\tilde{a}_{M(1)}} = \rho$. To determine the probability that $\tilde{a}_{M(2)} = a_N$, note that this can happen in two different ways. The first possibility is that ρ is larger than all M_2's remaining prior beliefs, that is, $\rho \geq r_{a_n,M(2)}$ for $n = 1, \ldots, N-1$. In that case, he will undertake a_N both as an employee and as a manager. The second possibility is that ρ is smaller than one of M_2's remaining prior beliefs but larger than all others, and that the true return of that one action is also smaller than ρ. In that case, M_2 will undertake that one action as an employee, then learn that it is actually worse than a_N, and then undertake a_N as a manager. The total probability is thus $F(\rho)^{N-1} + (N-1)(1-F(\rho))F(\rho)^{N-2}F(\rho)$. The unconditional probability is then

$$P[\tilde{a}_{M(2)} = \tilde{a}_{M(1)}] = \int F(\rho)^{N-1} + (N-1)(1-F(\rho))F(\rho)^{N-1}\, d\rho = \frac{2}{N+1},$$

whereas $P[\tilde{a}_{M(2)} = a] = \frac{1-P[\tilde{a}_{M(2)}=\tilde{a}_{M(1)}]}{N-1}$ so that $P[\tilde{a}_{M(2)} = a] < P[\tilde{a}_{M(2)} = \tilde{a}_{M(1)}]$ iff $P[\tilde{a}_{M(2)} = \tilde{a}_{M(1)}] > \frac{1}{N}$. The proposition follows.

This result can also be obtained in a general infinite-horizon overlapping-generations model, in the sense that T generations down the road, two random employees are more likely to agree on the first manager's action than on any other action.

This result is consistent with Baron, Burton, and Hannan (1999), who show that the founders' influence on the firm's behavior persists even after they have left the firm.

[28] See Van den Steen (2004) for a similar persistence result in a model with strategic experimentation.

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5. Shared values

■ Whereas the model and analysis were formulated in terms of shared beliefs, some of the insights—at least related to screening—also extend to shared values in the sense of private benefits. In fact, it is possible to reinterpret the screening model of Section 2 in terms of private benefits. Although the resulting theory is more limited in its applications and does require some less standard assumptions on private benefits, it does show how such extension works in principle and suggests some ways of how values and beliefs may differ in this context.

Consider, in particular, the following reinterpretation of the model. Let R^i be player i's private benefit that measures his satisfaction with a particular aspect of the organization, say the formality of social interactions. In this extension, each player will maximize his private benefits. Each project participant chooses a way of acting—an action $a \in \{X, Y\}$—and all these actions affect R^i. To capture this, let $r_{X,i}$ and $r_{Y,i}$ denote i's utility from actions X and Y—which correspond to behaving formally (X) or informally (Y) in the aforementioned application—and assume that they are drawn according to $r_{a,i} \overset{\text{i.i.d.}}{\sim} F$. Player i's overall private benefit R^i is then determined as follows:

$$R^i = \sum_{j \in 0,1,2} \alpha_j r_{\tilde{a}_j,i} - d,$$

where $\tilde{a}_j$ is the action choice by E_j, $r_{\tilde{a}_j,i}$ is i's evaluation of E_j's behavior $\tilde{a}_j$, and d captures the screening cost that player i incurs. I will assume that only the manager incurs screening costs so that $d = 0$ for all $i \neq M$. The timing and the rest of the game are identical to that of Section 2.

It is now straightforward to see that the following screening results extend directly to this case:

- Homogeneity will be higher within than across organizations.
- Homogeneity increases in the strength of preference of the manager and increases when it is easier to determine a player's preference.

Note, however, that these private benefits are quite different from many of the usual private benefits in economic models. In particular, in order to obtain homogeneity, the manager must agree with some potential employees in their private preferences over actions. This condition is implicit in the assumption that $r_{a,i} \overset{\text{i.i.d.}}{\sim} F$. But this condition is typically violated for the most common private benefit/cost in economic models, private effort.

There is also a very important *empirical* distinction between the belief-based and the private benefits-based models: whereas the beliefs are typically about how actions affect firm payoffs and performance, the private benefits are (by definition) about things other than firm payoffs. Apart from its empirical relevance, this distinction also matters for the results. In particular, the fact that beliefs were about the effect of actions on performance was the driving factor for the results that homogeneity would be stronger among more important employees and in firms where employees make more important decisions, and for the result that (with self-sorting) managers will try to hire more important employees first and be more selective for these early hires. To recover these results in this context with private benefits requires the additional assumption that, although the actions are about private benefits that are unrelated to firm payoffs, their importance is nevertheless correlated to the importance of the player's payoff-relevant actions. Under that assumption, we also get the following importance-dependent results.

- Homogeneity increases in the importance of the players' actions.
- Homogeneity will be path dependent and the manager will prefer to hire more important employees first (and be more selective for these early employees).

Obviously, none of the learning results obtain in this context with private benefits because these learning results depend on beliefs changing with experience. In particular, a very

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important result that does not obtain anymore is that homogeneity will be stronger in firms with higher performance. This also excludes the alternative interpretation of the correlation between performance and culture. This private benefits model also does not consider the tradeoff between private preferences, on the one hand, and making the right decisions for the project's success, on the other. This is obviously an important issue from an economic and practical perspective, but it requires a more elaborate model. This consideration was not a limitation for the belief-based model because the latter was from the start about the firm's profits.

Overall, whereas the model can be usefully interpreted from the perspective of "values as private benefits," such interpretation does run into some limitations and other issues. Because the issues that arise here are, in my experience, quite common, it is worth spelling them out in some more generality. First of all, there is no (mathematical) equivalence between differing priors and private benefits in settings where either the players' beliefs may change over the course of the game or where the players can contract on income or incentives (or, more generally, where the relationship between actions and utilities may change). There is also no mathematical equivalence between differing priors and a model that has both private benefits and (nonprivate) firm profits, which is obviously an important limitation. Second, even in settings where they may be (mathematically) equivalent, assumptions that are very reasonable for differing priors may not fit private benefits and vice versa. For example, inverse correlation is a very unlikely assumption for beliefs but is very reasonable for private benefits. Third, the belief-based models often have empirical implications in terms of firm payoffs that cannot be obtained with private benefits (because they are private). Fourth, more in general, beliefs and preferences refer to different things and will focus the attention and empirical research differently. The latter three points are all related to the fact that the value of economic models is not in the mathematics itself, but in the meaning and interpretation of the mathematics.

6. Conclusion

■ This article shows that organizations have an innate tendency to develop homogeneity, in the sense of shared beliefs (and shared values), through two mechanisms. On the one hand, people prefer to work with others who have similar beliefs, as such others will make the right decisions. This leads to screening. On the other hand, people of the same organization share experiences, which also leads to shared beliefs. The importance of these results derives to a large extent from the fact that shared beliefs and values are considered a core component of corporate culture. Indeed, many of the results in this article match more informal observations in the literature on corporate culture. Van den Steen (2010a) shows that such homogeneity or corporate culture has very pervasive performance effects.

I derive comparative statics on when homogeneity will be particularly pronounced: homogeneity will be stronger in firms that are older and more successful, in firms where employees make more important decisions, and in firms where the manager has stronger beliefs. Moreover, within a firm, homogeneity will be stronger among more important employees. The result that success may lead to homogeneity of beliefs suggests an inverse causality explanation for the relationship between culture and performance.

When candidate-employees can self-sort, homogeneity will also be path dependent: the fact that current employees are similar to the manager will *cause* future hires to be more similar to the manager. As a consequence, the manager will be more selective for earlier hires and will care about the sequence in which employees are hired, often preferring to hire the more important employees first. I also show that, from an outsider's perspective, organizations tend to overinvest in homogeneity.

I also consider the implications for the *content* of these beliefs. I show that the original manager has an important influence on her firm's culture, and that her influence will be felt long after she and her original employees have left.

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I finally also interpret the model in terms of private preferences rather than differing priors. The outcome is double edged. On the one hand, some of the results can be meaningfully translated from one context to the other. On the other hand, however, some important results do not obtain, are subject to limitations, or require unusual assumptions. This illustrates that a mathematical equivalence does not necessarily imply a meaningful equivalence and suggests that there is real value from modelling explicitly with differing priors. I hope that this article can contribute to our understanding of both corporate culture and of the role and effects of disagreement.

Appendix A

□ **Shared beliefs and culture.** Even though the idea of corporate culture as shared beliefs and assumptions is well established in the literature (Donaldson and Lorsch, 1983; Schein, 1985; Kotter and Heskett, 1992; Crémer, 1993; Lazear, 1995), it is probably useful to make the idea more concrete by way of examples. To that purpose, this appendix presents some concrete examples drawn from case studies in the management literature and from personal experience.

The first example is based on my personal experience in the Belgian offices of two large management consulting firms, L and M. These two consulting firms competed directly in the Belgian market and were very similar in terms of clients, the schools from which they hired, and the type of studies they conducted. Despite these structural similarities, they were also a study in contrasts. M consultants generally shared a belief that "if you cannot show it in the numbers, then it is probably not there." As a consequence, using client quotes for a presentation was a no-no, an admission of failure. Client presentations were based nearly completely on numbers. Spreadsheets were a consultant's best friend. At L, on the contrary, client interviews were considered to be among the most important data of the whole study. Numbers, on the other hand, were given much less weight, as "anyone knows that you can always find the numbers to prove your point." As a consequence, presentations were mainly based on verbal arguments and often contained numerous client quotes. In line with their belief in numbers, M consultants also tended to believe in tough performance targets and in pay-for-performance as a key solution to many client problems. Internally, this was reflected in very frequent and very detailed performance evaluations, and in a strict up-or-out policy. L, on the contrary, was more focused on culture and mentality change as ways to solve client problems, and was internally also much "softer" and much more informal when it came to performance evaluations. L did not have an official up-or-out policy in place, and argued that up-or-out was an ineffective way to motivate people. There was, finally, also a strong belief in M that there is one best way of doing things. Any study starts with a search in the knowledge database and with reading the relevant "practice documents" that describe the best way to approach a certain problem. There is a "one Firm policy" that says that all offices and locations should follow the same rules and policies. Even the format of the slides is decided globally in a centralized committee. L consultants, on the contrary, believed in an individualized approach to problems and were fond of saying that "we have as many strategies as we have consultants."

A second rich description of shared beliefs as corporate culture comes from Schein (1985). He studies in detail two companies, which he denotes as "Action" and "Multi", and describes the beliefs and assumptions that are shared by managers of each company. Managers at "Action," for example, shared the belief that truth can only be discovered through debate and through getting buy-in from others. Moreover, they believed that the individual is ultimately the source of ideas and that individuals are capable of taking responsibility and doing the right thing. As a consequence, debate and a spirited fight were considered important, whereas employees had little respect for hierarchy. Managers at "Multi," on the contrary, believed that truth comes from expertise and experience, and that the strength of an organization derives from the expertness of the respective job occupants. As a consequence, managers were very respectful of hierarchy, whereas debate was avoided because debate meant disrespect for expertise. Both groups of managers believed that their company was like a family, but for Action managers that meant that they believed that others would love you and take care of you even if they disagreed with you, whereas for Multi managers that meant that managers were like parents and their subordinates like their children: parents will take care of children, and children will obey their parents.

Another interesting source on this topic is the study by Donaldson and Lorsch (1983) on top management decision making. Based on a number of in-depth case studies, they identify managerial beliefs as one of the critical factors in such decision making. They show how the managements of different companies hold very different beliefs about things such as the desirability of debt, the necessity and optimal level of growth, and the desirability of corporate diversification. Some companies believe that the way to get good people is to offer high pay, whereas others believe that, instead, growth opportunities are key and that good pay follows good performance. Indeed, Donaldson and Lorsch (1983) identify beliefs as to what "drives" people as a distinguishing characteristic for many firms. Whereas some companies believe in "managing by the numbers" others believe that you should *not* manage "like a detached investment banker." In some cases, these beliefs were stated in contrast to the practice of others, such as one company that did not "believe in firing a manager if he makes a mistake, like at ITT."

Peters and Waterman (1982), finally, conclude that people in their "excellent" companies share "a belief in the importance of informality to enhance communication" and "a belief that most members of the organization should be innovators."

Personal informal observation also suggests that shared beliefs are strong in academia. Economists generally seem to believe that, for research to be effective, one should abstract from other aspects that have no direct impact on the

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phenomenon under study. The fundamental belief is that human actions are a bit like physical phenomena, and can be studied in isolation. Sociologists, on the contrary, often believe that human action is fundamentally different from physical phenomena, that human action is "embedded" in social relationships and that it is simply impossible to separate that action from its context. Many believe that the action only exists as part of the context, and that the two are therefore inseparable. A statement "all else equal" is then met with the reply that "all else is never equal."

Appendix B

□ **Extensions and further results**

A general homogeneity result. Let there be J players who undertake a joint project. In the context of that project, each player j has to take an action $\tilde{a}_j \in A$, with A the action space. The overall payoff of the project is $R(\tilde{a}_1, \ldots, \tilde{a}_j, \ldots, \tilde{a}_J, s)$, where $s \in S$ is the true (but unknown) state of the world. I allow both A and S to be any (measurable) space. The true state s is unknown, but all players have subjective beliefs about it. These beliefs may differ but are commonly known, that is, players have differing priors. Assume that each player's payoff is a fixed share α_i of the overall payoff $R(\tilde{a}_1, \ldots, \tilde{a}_j, \ldots, \tilde{a}_J, s)$. The decisions are noncontractible and are taken simultaneously. I also make the following assumption.

Assumption B1. For any belief by player i about s, there exists a set of actions that maximize $E_i[R]$. For any set of beliefs (by the set of players) about s, there exists a Nash equilibrium. Players coordinate on a (subjectively) Pareto-dominant equilibrium whenever one exists.

A sufficient condition for the first part of the assumption is that A is compact and $E_i[R]$ continuous in the actions. A sufficient condition for the second part is that A is a nonempty compact convex subset of a Euclidean space, and the $E_i[R]$ are continuous (in all actions) and strictly quasiconcave (in their own action). Except for the conditions to satisfy this assumption, I impose no assumptions on R.

Proposition B1. Under Assumption B1, each player is (subjectively) better off when all other players have beliefs identical to his own, than when some or all other players hold different beliefs.

Proof. Consider wlog. player 1. Fix any belief for player 1. Let $\hat{\mathbf{a}} = (\hat{a}_1, \ldots, \hat{a}_J)$ be a set of actions that maximize $E_1[R]$ under that belief. Consider now first the case that all players have beliefs that are identical to that of player 1. I claim that $\hat{\mathbf{a}} = (\hat{a}_1, \ldots, \hat{a}_J)$ is a (subjectively) Pareto-dominant Nash equilibrium. That it is a Nash equilibrium follows from the fact that for $\hat{\mathbf{a}}_{-i}$ given, $\hat{a}_i$ maximizes $E_i[R]$ and thus $\alpha_i E_i[R]$. Furthermore, if this were not a Pareto-dominant equilibrium, then there existed some equilibrium that gives everyone a weakly higher payoff and at least one player a strictly higher payoff. This would correspond to a set of actions that give a strictly higher $E_i[R]$ than $\hat{\mathbf{a}}$, contradicting the definition of $\hat{\mathbf{a}}$. It follows that, under Assumption B1, whenever all players have the same beliefs as player 1, then the latter's payoff is $E_1[R(\hat{\mathbf{a}})]$.

But now the proposition follows immediately by the following argument. Fix any set of beliefs for the other players. Let $\check{\mathbf{a}}$ be the actions of any Nash equilibrium that corresponds to this set of beliefs. If $E_1[R(\check{\mathbf{a}})] > E_1[R(\hat{\mathbf{a}})]$, then that contradicts the definition of $\hat{\mathbf{a}}$ above. This proves the proposition.

On the one hand, this result is very strong, as it says that it is *always* better to associate with people with beliefs that are identical to your own. This holds true even if you believe, for example, that experimentation or diversity of actions is optimal: you simply prefer to associate with people who agree with you on the optimal form of experimentation or diversity. On the other hand, the result does not imply (local) monotonicity, which requires some more specific assumptions. Moreover, the result would be different if experimentation must be combined with personal effort. In that case, you may prefer someone who really believes in that other course of action and thus invests a lot of personal effort in it.

Note, finally, that the above formulation and result can be adapted to conclude that it is optimal to work with others with values (i.e., utility functions) that are identical to your own, as long as utility is defined over social imputations.

Basic homogeneity results for N actions. This subsection extends the basic homogeneity results for a setting with more than two actions. So consider the basic model but now with N actions $\{X_1, \ldots, X_N\}$ where action X_k has payoff ρ_k and player i's belief about ρ_k is denoted $r_{k,i}$.

Consider now first the screening model. The following proposition says that the firm's employees will again be on average more homogeneous than the population of candidates L. In particular, the proof of the proposition shows that the manager will hire employees who will choose one out of a set of her most preferred actions. As the employees' actions are from a smaller set than the actions of the potential labor pool, employees are more likely to agree.[29]

For the statement of the proposition and proof, let $Z = \{E_1, E_2\}$ denote the set of employees, let Y_n denote the actions X_k but ordered by the manager's beliefs ($\{Y_1, \ldots, Y_N\} = \{X_1, \ldots, X_N\}$ and $r_{Y_k,M} \geq r_{Y_{k+1},M}$), and let $\mathcal{Y}_n$ denote the set of n best actions according to the manager ($\mathcal{Y}_n = \{Y_1, \ldots, Y_n\}$).

[29] It would actually be more natural to let c be drawn anew for each employee, but although that makes the result more natural it complicates the analysis and does not change the final homogeneity result.

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Proposition B2. The expected homogeneity is higher in the firm than in the population of candidates ($E[H(Z)] \geq E[H(L)]$), with strict inequality unless the manager considers all actions equally likely to succeed ($r_{k,M} = r_{l,M}, \forall k, l$).

Proof. As the effects of the actions are independent, it is sufficient to look at one employee to derive the screening equilibrium. A standard search analysis as in the proof of Proposition 1 then implies that there exists a K such that the manager will hire a potential employee j if and only if j's action $\tilde{a}_j$ is among the K best according to the manager: $\tilde{a}_j \in \mathcal{Y}_K$. The value of K is the one that maximizes

$$V = \frac{\sum_{k=1}^{K} r_{Y_k,M}}{K} - \frac{N-K}{K}c,$$

It then further follows that the two hired employees agree on the best action with probability $\frac{1}{K}$ whereas two potential employees agree with probability $\frac{1}{N}$ so that $E[H(Z)] \geq E[H(L)]$. This holds with equality only if $K = N, \forall c$. But that requires that the manager is totally indifferent among actions that is, $r_{k,M} = r_{l,M}, \forall k, l$. This proves the proposition.

The following proposition extends this homogeneity result to the learning model with N actions.

Proposition B3. $E[H(Z)] > E[H(L)]$.

Proof. Denoting the manager's outcome as ρ, the probability that E_1 and E_2 agree on the optimal course of action is the probability that the two employees agree that the manager's action is best plus the probability that the two employees agree that some other action is best, that is, $(F^{N-1}(\rho))^2 + \frac{1}{N-1}(1 - F^{N-1}(\rho))^2$. Taking the expectation over the manager's action's payoff then gives the expected probability of agreement

$$E[H(Z)] = \int_{\rho} F^{2N-2}(u) + \frac{1}{N-1}[1 - F^{N-1}(u)]^2 \, dG(u) > \frac{1}{N} = E[H(L)],$$

which proves the proposition.

A calculation shows that when $G = F$ in this learning model with N actions, the probability that two employees agree equals $\frac{3N-2}{N(2N-1)}$.

Learning: comparative statics in the basic model. This section considers the comparative statics of two small variations on the basic learning model of Section 3.

The first result is that firms with a longer history will be more homogeneous, because employees will have more shared experiences. To study this formally, assume that the first stage gets split in S different stages. The manager undertakes an action in each of these S stages, each time observing the outcome. All employees observe all actions and outcomes. In stage $S + 1$, the employees each undertake an action. The following proposition then says that homogeneity (measured at the start of stage $S + 1$) will increase with the length of the shared history.

Proposition B4. $E[H(Z)]$ increases as S increases.

Proof. Let A denote the full set of actions, and B^s the set of actions that M has tried by the start of stage s. Condition on $(\rho_a)_{a \in A}$, on B^s, and on $\{r_{a,M}\}_{a \in A}$ (the priors of M). Let the best known action at the start of stage s be $\hat{a}$, with performance $\rho_{\hat{a}}$. Let $k = \#(A \setminus B^s)$ denote the number of unknown actions, and let $\check{a}$ be a randomly selected action from $A \setminus B^s$.

I will prove that the probability of two randomly selected employees agreeing increases when the set of known actions goes from B^s to $B^s \cup \check{a}$, or the number of unknown actions goes down from k to $k - 1$. Because the proposition is trivial when $k = 1$, I will assume $k \geq 2$. With $\hat{a}$ the best known action, the overall probability of agreement is $F(\rho_{\hat{a}})^{2k} + \frac{1}{k}[1 - F(\rho_{\hat{a}})^k]^2$ or $P(k, F) = F^{2k} + \frac{1}{k}[1 - F^k]^2$ where $F = F(\rho_{\hat{a}})$.

Consider now what happens when a new action $\check{a}$ gets tried. If $\rho_{\check{a}} < \rho_{\hat{a}}$, then it is just as though one action got removed from $A \setminus B^s$. The probability of agreement is then $P((k-1), F) = F^{2(k-1)} + \frac{1}{(k-1)}[1 - F^{(k-1)}]^2$. If, however, $\rho_{\check{a}} > \rho_{\hat{a}}$, then $\check{a}$ becomes the new best known action. Denote $\check{F} = F(\rho_{\check{a}})$, then the probability of agreement becomes $P((k-1), \check{F}) = \check{F}^{2(k-1)} + \frac{1}{(k-1)}[1 - \check{F}^{(k-1)}]^2$ with $\check{F} \geq F$.

Combining these equations implies that we need to show that $\Delta P = \check{F}^{2(k-1)} + \frac{1}{(k-1)}[1 - \check{F}^{(k-1)}]^2 - (F^{2k} + \frac{1}{k}[1 - F^k]^2) \geq 0$ for $k \geq 2$, $F, \check{F} \in [0, 1]$, and $\check{F} \geq F$. A long algebraic analysis, available from the author, shows that this indeed holds.

The second result is that, in the original model (with $S = 1$), homogeneity increases when employees are more likely to observe the manager's actions and payoffs. Assume, in particular, that employees only observe the manager's action and payoff with (exogenously given) probability q.

Proposition B5. $E[H(Z)]$ increases in q.

Proof. This follows from the fact that $E[H(Z)] = \frac{1}{N} + \frac{N}{N-1} q \int_{\rho} (F(\rho)^{N-1} - \frac{1}{N})^2 \, dG(\rho)$ and the fact that $(F(\rho)^{N-1} - \frac{1}{N})^2 \geq 0$.

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This result predicts, for example, that shared beliefs will be especially prevalent in small organizations where communication flows easily, in organizations that involve their employees in decision making, and in firms that invest a lot in socialization and training.

A model with private effort. To study the effect of private effort on the screening result, consider the model of Section 2 but with the following payoff function

$$R = \sum_{i=0}^{2} \alpha_i e_i \rho_{\hat{a}_i} - d,$$

where e_i is the private effort exerted by employee i. For this private effort e_i, employee i incurs a private cost $b\frac{e_i^2}{2}$ where b, among other things, normalizes the cost of effort so that we can take $\sum_{i=0}^{2} \alpha_i e_i \rho_{\hat{a}_i} - d - b\frac{e_i^2}{2}$ as the employee's objective (or $\alpha_i e_i \rho_{\hat{a}_i} - b\frac{e_i^2}{2}$ if the employee cares only about his own payoff, as mentioned in footnote 10).

As private effort now matters, the manager has incentives to select employees not only on what action they would choose but also on how much their beliefs provide incentives for effort. In particular, the manager will want to choose employees who are optimistic (i.e., have high $r_{a,i}$) about the action that they will implement. But because the manager makes a tradeoff between such optimism and (subjectively) correct actions, the overall result is still that firms will be more homogeneous than society.

Proposition B6. The expected level of homogeneity is higher among employees than among the population ($E[H(Z)] \geq E[H(L)]$) with strict inequality as long as the manager is not indifferent ($\Delta_0 > 0$).

Proof. Given the earlier proofs, it suffices to show that the manager is more likely to choose a potential employee who agrees with her than one who does not agree with her (and strictly so if $\Delta_0 > 0$). Assume wlog. that the manager prefers X: $r_{X,M} \geq r_{Y,M}$ and $\hat{a}_M = X$. Note that an employee i who chooses action a will exert effort $e_i = \frac{\alpha_i r_{a,i}}{b}$ so that the manager's expected payoff from employee i is

$$\alpha_i \frac{\alpha_i r_{a,i}}{b} r_{a,M} = \frac{\alpha_i^2}{b} r_{a,i} r_{a,M}.$$

Following a standard search argument, the manager will either not screen at all (when c is too high) or screen (when c is low enough) until she draws an employee for whom the expected payoff exceeds a certain cutoff level, that is, until $\frac{\alpha_i^2}{b} r_{a,i} r_{a,M} \geq \hat{V}$ for some cutoff level $\hat{V}$. In other words, if the current employee draw would choose action a, then the manager will hire this employee iff

$$r_{a,i} \geq \hat{r}_a = \frac{b\hat{V}}{\alpha_i^2 r_{a,M}}.$$

As $r_{X,M} \geq r_{Y,M}$, $\hat{r}_X \leq \hat{r}_Y$ and the manager will thus hire a wider range of employees who choose the manager's action X than employees who choose the alternative action Y, and strictly so when the manager is not indifferent. Because a manager is equally likely to draw a potential employee with $\hat{a}_i = X$ as with $\hat{a}_i = Y$ and because the conditional distribution of $r_{a,i}$ is identical, she is overall more likely to hire an employee who agrees with her. That implies the proposition.

Implicit in this proposition is the differential effect of $r_{a,i}$ versus Δ_i: from the perspective of providing incentives for effort, the manager wants to hire employees who are confident about the action that they will implement (i.e., with high $r_{\hat{a}_i,i}$) whereas from the perspective of action choice the manager wants to hire employees who share her relative beliefs over actions (i.e., her Δ_i). For the effect of bias on effort in a common priors setting, see, among others, Dewatripont and Tirole (1999), Zábojník (2002), and Dur and Swank (2005).

A note on outside options. The screening model in this article assumes that employees' outside options are constant and independent of their beliefs. This is a natural assumption in many settings for example when workers are in excess supply. But there are also settings where this assumption will not hold, for example when workers are in short supply so that firms need to compete for workers and all firms care about the same set of employee beliefs. In that case, an employee's outside value will depend on her beliefs because these beliefs determine what other firms are willing to pay. What would happen in such a context? Obviously, the outcome will depend on (the details of) the job search and wage-setting mechanisms. Any (subjectively) efficient mechanism, such as a variation on Nash bargaining or an auction, will still align the beliefs of employees and managers so that the main screening results would go through. The interesting question is whether one could say anything about the structure of wages. In particular, an employee's outside option in the wage bargaining is now typically whatever the next best firm would pay (although this may depend on the mechanism). It turns out, however, that what the next best firm would pay depends strongly on the specific details of both the setting and the mechanism.

Whereas a formal analysis goes beyond this article, let me indicate informally some of the issues that affect the results here. For this purpose, it is useful to think of a slightly different model. In the model of Section 2, an employee's belief deterministically determines her action choice. The "strength" of an employee's belief (i.e., how much he or she believes in one action over the other) does not matter. Because that belief strength is exactly one of the parameters of interest in the context of wage setting, assume that there is some random cost attached to each action that is publicly drawn

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just before the action choice. In that case, the action choice has a random element and the likelihood that an employee chooses X over Y increases in the strength of her belief. Consider now a setting with two firms, denoted 1 and 2, where the two managers prefer different actions and both have very strong beliefs: 1 very strongly prefers X and 2 very strongly prefers Y. Assume that the employee's utility depends only on the (fixed) wage. In that case, the wage is completely driven by the employee's (subjective) effect on firm profits. (If the employee's utility also depends on incentives or on intrinsic motivation, then the alignment between the employee's and the manager's beliefs may enter the wage negotiation through other channels.) Relative to an employee with weak beliefs about either action, an employee with a strong belief in X is worth more to firm 1 but less to firm 2. If all the bargaining power is on the side of the *employee*, then this employee with a strong belief in X will be paid *more* than an employee with weak beliefs because she can extract all the value from firm 1. If all the bargaining power is on the side of the *firm*, then this employee with a strong belief in X will actually be paid *less* than an employee with weak beliefs because her outside option is low. Things get more complicated when the two firms have similar beliefs. The wage can depend on the potential employee's belief in complex ways depending on the firms' relative beliefs, the subjective sensitivity of each firm's payoffs to the beliefs, and the bargaining power. Furthermore, if the employee's utility depends on other factors than the wage, then that would add yet another complication to the analysis. Overall, this discussion suggests that the results may depend heavily on the specific assumptions, and that any conclusion must be carefully weighed in terms of robustness.

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