On the Origin of Shared Beliefs (and Corporate Culture)

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Abstract

This paper studies why members of an organization often share similar beliefs. I argue that there are two mechanisms. First, when performance depends on making correct decisions, people prefer to work with others who share their beliefs and assumptions, since such others 'will do the right thing'. Second, beliefs will converge over time through shared learning.

The theory predicts that homogeneity will be strongest in firms where employees make important decisions, and in successful and older firms. Within a firm, homogeneity will be stronger among more important employees. Homogeneity will also be path-dependent, making managers more selective on early hires. While such homogeneity reduces agency problems, it does so at a cost. I show that, from an outsider's perspective, firms invest on average too much in homogeneity.

Since shared beliefs are an important aspect of corporate culture (Schein 1985, Kotter and Heskett 1992), I finally show that the model matches some observations on corporate culture, such as the influence of a manager on her firm's culture and the persistence of culture in the face of turnover. A fundamental difference from earlier economic theories of corporate culture is that I show that culture, instead of being created for its own good, can be a side-effect of other purposeful actions. As a consequence, there can be too much culture in firms.

1 Introduction

Members of the same organization often share similar beliefs. Apple employees, for example, will think more like other Apple employees than like Microsoft employees. (Or consider the

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notion of a Chicago economist!)[1] Such shared beliefs have important implications. In particular, Van den Steen (2004a) shows that shared beliefs reduce agency problems, thereby increasing delegation, reducing monitoring and influence activities, and facilitating coordination. On the other hand, they also reduce the incentives to collect information and can lead to inertia. Unsurprisingly, shared beliefs have received considerable attention in the management literature (under the heading of 'corporate culture') as I discuss below.

In this paper, I argue that, in a world with differing priors, organizations have an innate tendency to develop homogenous beliefs through two general mechanisms. First, when performance depends on correct decisions (rather than personal effort), people in an organization prefer to work with others who have beliefs that are similar to their own, since such others 'will do the right thing' from their perspective. This gives rise to sorting. Second, employees experience first-hand their firm's behavior and performance, which is an important source of learning. Since all employees of one firm learn from the same source, their beliefs will converge over time. Shared experiences thus also lead to shared beliefs.

In terms of comparative statics, I show that 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. 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 invest on average too much in homogeneity from the perspective of an outsider, such as a social planner or a shareholder. This is because players believe that they are right and thus value similarity in itself, independent of its objective benefits and costs. From the perspective of an outsider, some of the investments in homogeneity thus result in an unproductive reshuffling of people. (Note that this does not mean that homogeneity is inherently bad, but simply that there can be too much of it.) This result illustrates something unique to differing priors: the fact that subjective and objective efficiency can be directly at odds with each other.[2]

Shared beliefs are often considered an important aspect of corporate culture (Donaldson and Lorsch 1983, Schein 1985, Kotter and Heskett 1992, Crémer 1993). The mechanisms in this paper indeed match some 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 both results is forced learning, i.e., 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 forced learning allows one player to shape another player's future actions. I finally show that strong performance creates a strong culture and that the ensuing correlation

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

[2]As discussed in section 3, subjective efficiency uses each player's own beliefs to determine his or her expected utility, while objective efficiency uses one 'reference belief' for all players.

may give the incorrect impression that strong culture improves performance, as has been suggested by studies based on informal observations (Deal and Kennedy 1982, Peters and Waterman 1982).

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 sorting, and how these participants later learn from the firm's actions and outcomes.[3]

Literature The importance of homogeneity has been explicit or implicit in the agency literature (Crawford and Sobel 1982, Crémer 1993, Aghion and Tirole 1997, Dessein 2002). Van den Steen (2004a) summarizes these costs and benefits of homogeneity more systematically, and derives some new elements. This literature, however, has taken homogeneity as exogenously determined and only studied how a given level of homogeneity affects agency problems.

Besley and Ghatak (2005) and Van den Steen (2001, 2005b) independently showed how sorting in the labor market can lead employees to hold beliefs or preferences that are similar to those of the manager. In particular, Besley and Ghatak (2005) study the effect of 'mission', defined as a private benefit from a particular course of action by the firm, while Van den Steen (2001, 2005b) studies the effect of 'vision', defined as (strong) managerial beliefs about the right course of action by the firm. Both show that employees will sort towards 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. Van den Steen (2001, 2005b) shows that it can be optimal to hire a manager who is overconfident and considers the implications for coordination, while Besley and Ghatak (2005) show that incentives will be lower after matching. Neither analysis, however, is focused on homogeneity per se, which is the subject of this paper. As a consequence, neither paper considers comparative statics, the efficient level of homogeneity, other homogeneity-inducing mechanisms, or implications for corporate culture.

As mentioned earlier, homogeneity in beliefs has also been discussed in the management literature under the heading of corporate culture (Burns and Stalker 1961, Baker 1980, Donaldson and Lorsch 1983, Schein 1985, Kotter and Heskett 1992). I will discuss both this and the economic literature on corporate culture (Kreps 1990, Crémer 1993, Lazear 1995, Carrillo and Gromb 1999, Hermalin 2001, Rob and Zemsky 2002) in section 5. As I will discuss there, this paper differs from that literature by its focus on the origin of culture and by the fact that it does not start from the premise that culture is created on purpose for its

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[3]An obvious alternative would be a model where, instead of differing beliefs about the right course of action, people get private benefits from the fact that their organization follows a particular course of action. Besley and Ghatak (2005) consider such model in their study of the missions of non-profit organizations. (Note that this is different, though, from getting private benefits from you yourself undertaking a particular action.) Most of the sorting results would extend to this context, although not the result that there may be too much culture. Moreover, the learning results, which seem important according to informal observation and which suggest some of the more intriguing mechanisms such as forced learning, would obviously also not extend. For these reasons, this paper focuses on differing priors rather than private benefits.

own benefits, but can instead be an unintended consequence of other purposeful action.

The key contribution of this paper is to construct, or better to start constructing, a theory of the origins of organizational homogeneity. Once all elements are put in place, the basic homogeneity results are on themselves not so surprising. But the theory also makes clear empirical predictions on when such homogeneity will be strong, and raises the issue that there may actually be too much homogeneity. It furthermore shows that the results are consistent with informally observed facts on corporate culture. The importance of these results derives from the effects of homogeneity on the agency problem, and from its relationship to corporate culture.

The next section considers the sorting model. Section 3 shows that organizations invest too much in homogeneity. Section 4 extends the basic model to consider learning, showing both that most of the sorting results also obtain by pure learning and that some new results obtain. Section 5 discusses implications for corporate culture while section 6 concludes. The appendices contain a general homogeneity result, some examples of shared beliefs, and further sorting and learning results.

2 Sorting

The most obvious source of homogeneity is sorting in the hiring process. Appendix A 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'. It is therefore subjectively efficient for people with similar beliefs to seek each other out when forming organizations. Nearly any process of hiring or matching will then lead to homogenous organizations.

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

2.1 Model

Consider a project with a manager M (denoted as player 0) and two employees E_1 and E_2 (denoted as players 1 and 2). As part of the project, each player 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 is a weighted sum of the individual payoffs, minus some cost d discussed below:

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

where α_i denotes the contribution of player i's payoff.[4] While the 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

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[4]Most results extend with little modification to more general payoff functions, but the interactions among different decisions and the inability to derive explicit analytical expressions complicate the proofs considerably

expected values of ρ_X and ρ_Y according to player i. It is common knowledge that players have differing priors, i.e., $r_{\cdot,i}$ and $r_{\cdot,j}$ may differ even though no player has private information.[5] Each player tries to maximize the project's total payoff R.[6]

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 non-degenerate distribution with support $S \subseteq \mathbb{R}$. For the analysis in this section, only the difference $\Delta_i = |r_{X,i} - r_{Y,i}|$ will matter. Note that Δ_0 measures the strength of the manager's belief, i.e., how strongly she believes that one action is better than the other. 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. This cost c gets drawn from a uniform distribution $U[0, C]$ at the very start of the game. The manager then decides whether to hire this candidate or draw a new one. Once an employee is hired, the process moves either to the next employee position or to period 2 of the 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, i.e., it is as if the manager is drawn from L prior to the game.

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 $\alpha_1, \alpha_2 > 0$.

2.2 Shared Beliefs

Since the manager's payoff depends on her employees' actions, she will want to hire employees who make the 'right' decisions from her perspective, i.e., who share her beliefs.[7] Since the

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without adding much insight. Some more involved results need additional assumptions to allow more general payoff functions.

[5]Differing priors do not contradict the economic paradigm: while rational agents should use Bayes' rule to update their prior with new information, nothing is said about those priors themselves, which are primitives of the model. In particular, absent any relevant information agents have no rational basis to agree on a prior. Harsanyi (1968) observed that 'by the very nature of subjective probabilities, even if two individuals have exactly the same information and are at exactly the same high level of intelligence, they may very well assign different subjective probabilities to the very same events'. For a more extensive discussion, see Morris (1995) or Van den Steen (2005a).

[6]This employees' objective can be endogenized by extending the model to allow for contracting, while limiting what can be contracted upon. One approach is to assume that the project is either a success or failure (with respective payoffs 1 and 0), that $\sum_{i=0}^{2} \alpha_i \rho_{\bar{a}_i}$ is the probability of success, that the only thing that is contractible is whether the project is a success or not, and that a player can (and weakly prefers to) refuse to make a decision, causing a sure failure for the project. Since such extension only complicates the model and the analysis, I simply impose the players' final objective as an assumption.

[7]An obvious issue is whether it wouldn't be more effective to sort on people who like to work hard, than to sort on people who have specific beliefs? While all firms have identical preferences over people who work hard, different firms will typically prefer people with different beliefs. As a consequence, 'working hard' will

1	2	3
Hiring	**Actions**	**Payoff**
a Cost c gets drawn from $U[0, C]$.	Each player i chooses action $\tilde{a}_i$ from $\{X, Y\}$.	Project payoffs are realized.
b Manager hires E_1 (see below).		
c Manager hires E_2 (see below).		

a. Timeline of overall game

i	ii	iii
Candidate selection	**Learning beliefs**	**Hiring decision**
One candidate gets drawn from the set of candidates L.	Manager decides whether to learn the candidate's preferred action, at cost c to the project.	Manager decides whether to hire this candidate (and move to E_{i+1} or period 2) or not (and go back to step i).

b. Timeline of hiring E_i

Figure 1: Timeline

two employees are then each similar to the manager, they will also be similar to each other. Firms will thus be more homogenous 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 (2004a) shows that this is the right measure to characterize, for example, the effect of homogeneity on monitoring and delegation among members of the group G. Van den Steen (2004b) shows that measures of homogeneity based on a distance function give qualitatively the same results.

Using this measure of homogeneity, the following proposition then says that the firm's employees will be on average more homogenous than the population of candidates L. Let $Z = \{E_1, E_2\}$ denote the set of employees, and remember that $\Delta_0 = |r_{X,0} - r_{Y,0}|$ denotes how strongly the manager (player 0) believes one action is better than the other.

Proposition 1 $E[H(Z)] \geq E[H(L)]$ *with strict inequality when* $\Delta_0 > 0$.

Proof : Since 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

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be reflected in the wage, while 'having the right beliefs' typically not. The distinction is similar to that between vertical and horizontal differentiation in product markets.

from employee E_i of $E[R_i] = E[\alpha_i \rho_{\tilde{a}_i}] = \alpha_i m_0$. 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 $E[R_i] = \alpha_i \overline{m}_0 - 2c$, 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 $\hat{a}_i = \hat{a}_0$ when $\alpha_i(\overline{m}_0 - m_0) \geq 2c$ or $\alpha_i \Delta_0 \geq 4c$, and $\hat{a}_i$ equals X and Y with equal probability otherwise.

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

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

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 sorts on her beliefs. Sorting makes both employees choose the same action as M and thus the same action 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).[8] 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).

2.3 Determinants of homogeneity

If firms are more homogenous than society at large, which firms will be most homogenous?

To answer this, let $\Delta_0 = |r_{X,0} - r_{Y,0}|$ denote again the strength of the manager's belief, i.e., 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 sorting is cheap.

Proposition 2a $E[H(Z)]$ *increases in* α_1, α_2, *and* Δ_0, *and decreases in* 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 $\underline{\alpha}$. Since $\underline{\alpha} = \min(\alpha_1, \alpha_2)$, it, and thus $E[H(Z)]$, increases in α_1 and α_2.[9] ∎

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

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[8]There is systematic evidence that firms hire people who fit their firm's 'organizational values' (Meglino, Ravlin, and Adkins 1989, Chatman 1991, Judge and Bretz 1992, Cable and Judge 1997), but since such 'organizational values' are typically very ill-defined in these analyses and cover both beliefs and other things, it is difficult to match this evidence to the model (or to any formal model, for that matter).

[9]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.

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 sorting, and thus making the manager more selective. Since 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 homogenous (on relevant dimensions) than an assembly plant where employees just execute pre-specified 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.

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 2 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 homogenous.

Proposition 2b *For any subset $z \subset Z$ with 2 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 homogenous than rank-and-file employees, and that employees in the 'core' activities of the firm will be more homogenous 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.

2.4   Self-sorting

While the above analysis focuses exclusively on sorting of potential employees by the manager, self-sorting by the potential employees themselves is an equally important phenomenon. In particular, since employees' utility depends on the actions and beliefs of their manager and colleagues, some people may *prefer* not to work for a specific firm.[10] Especially in firms with a strong set of beliefs, such self-sorting seems to be quite prevalent (Collins and Porras 1994).

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[10]Note that even when an employee's utility depends only on the outcome of his own actions, he may still care about the beliefs of his manager and colleagues. This is because the manager or colleagues can often influence the employee's actions through social norms, a need for coordination, or implicit authority.

Self-sorting has a number of interesting implications. In this section, I will show the following two things. 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, each potential candidate k has an outside options in which he gets, with respective probabilities β and $1 - \beta$, the payoffs of his most and least preferred actions, $\overline{m}_k$ and $\underline{m}_k$. The probability β is a random variable, $\beta \sim U[0, 1]$, that gets drawn publicly at the start of the game simultaneously with c. The candidates can exercise their outside option at any point in time (i.e., at the start of any stage or sub-stage), but have a lexicographic preference to exercise the option earlier. Moreover, all potential candidates can observe the preferred actions of already hired employees. To simplify the analysis, I assume that $\alpha_0 = 0$, $\Delta_0 < C$, and that employees observe β but not 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 and β, 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 sort when hiring E_1 than when hiring E_2 (even when $\alpha_1 = \alpha_2$). Finally, $P[\hat{a}_2 = \hat{a}_0 \mid \hat{a}_1 = \hat{a}_0] > P[\hat{a}_2 = \hat{a}_0 \mid \hat{a}_1 \neq \hat{a}_0]$.*

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 $\hat{a}_0$ is best. M will sort 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 $\alpha_2 \theta(1 - \theta)\Delta_0 \geq c$.

Consider now the decision of potential candidates to apply for E_2. Since $\alpha_0 = 0$, this depends only on $\hat{a}_1$. A candidate k with $\hat{a}_k = \hat{a}_1$ gets payoff $\overline{m}_k \geq \beta \overline{m}_k + (1 - \beta)\underline{m}_k$ upon getting hired, and will thus always apply (since he might get hired independent of his beliefs if c, which is unknown to him, is very high). A candidate with $\hat{a}_k \neq \hat{a}_1$ gets payoff $\alpha_1 \underline{m}_k + \alpha_2 \overline{m}_k$ upon getting hired, which is larger than his outside option when $\alpha_2 \geq \beta$. It follows that

1. for $\alpha_2 < \beta$, there is perfect self-sorting by E_2, but no sorting by M (since θ is either 0 or 1).

2. for $\alpha_2 \geq \beta$ and $\alpha_2 \geq \frac{4c}{\Delta_0}$, there is no self-sorting (so that $\theta = .5$), but perfect sorting.

3. for $\beta \leq \alpha_2 \leq \frac{4c}{\Delta_0}$, there is neither self-sorting nor sorting.

Consider next the hiring of E_1. Since 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 1 (for E_2), the manager will sort on E_1 if $\overline{m}_0 - 2c \geq m_0$ or if $\Delta_0 \geq 4c$. In case 2, the manager will sort on E_1 if $\alpha_1 \overline{m}_0 - 2c \geq \alpha_1 m_0$ or $\alpha_1 \Delta_0 \geq 4c$. In case 3, the manager will again sort if $\alpha_1 \Delta_0 \geq 4c$.

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Note now that the sequence of E_1 and E_2 only matters for whether or not the project ends up in case 1. Since case 1 is (weakly) better than either 2 or 3, M prefers $\alpha_1 > \alpha_2$, and will thus choose to hire first for the position with the larger α. This proves the first part of the proposition. This, together with the sorting rules above, implies the second part and, together with the fact that there is perfect self-sorting by E_2 when $\alpha_2 < \beta$, also the last part. ∎

Intuitively, once the firm hired E_1, it becomes more attractive to potential candidates who agree with E_1. Such self-sorting can be very attractive to the manager, since it allows her to get the 'right' employees without spending time and money on sorting. Since 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 sorting and self-sorting is ambiguous, however. On the one hand, self-sorting makes sorting more effective, since the likelihood of getting a good type upon rejecting a bad type is high. On the other hand, self-sorting makes sorting less necessary (or useful), since self-sorting itself improves the base rate of candidates. The second effect dominates in the current setup, so that sorting and self-sorting are mutually exclusive, but other settings may give different results. While the exact results of this proposition may thus not always obtain, the facts that self-sorting increases homogeneity, that it introduces path-dependence, 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 sorting by the manager. It seems, in particular, 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, since much of the match-specific investments get made in exactly that period.

3 Overinvestment in Homogeneity

Given that both sorting and self-sorting can be very expensive, do organizations end up with the right level of homogeneity? I will argue here that organizations actually invest on average too much in homogeneity from an outsider's perspective. The reason is that the manager cares about homogeneity for its own good, since she fundamentally believes that she is right and thus that people who think like her will make better decisions. The manager will therefore spend resources on sorting that from the perspective of an outsider, who may disagree with the manager, deliver on average little more than an unproductive rearrangement of people. Note that this does not mean that homogeneity (or culture) on itself is bad, but simply that there may be too much of it.

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 what the right prior belief is to determine the efficiency of an allocation. There are

fundamentally two approaches, that each have their own use. The first approach, which I call '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 and of the Coase Theorem.[11]

The second approach, which I call '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 since it captures how shareholders and academic researchers will evaluate organizational behavior.

This objective efficiency, however, can be sensitive to the belief that is chosen as 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 would 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 sort. In particular, assume that the social planner can subsidize or tax the managers' cost of sorting, 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?

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 $\gamma > 1$ since he thinks that the manager invests on average too much in sorting. As I mentioned earlier, I will assume here, for simplicity and symmetry, that the empirical distribution of the manager's beliefs is as if the manager were also drawn from L, i.e., $r_{X,0}, r_{Y,0} \overset{\text{i.i.d.}}{\sim} F$. 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 sort.

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

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

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

---

[11]For example, in a pure exchange economy where differences in utilities are, in part, due to differing priors, the first and second welfare theorem only hold if Pareto-efficiency is meant as 'subjective efficiency' in the sense above. The welfare theorems typically do not hold for 'objective efficiency', defined below, as long as there are differing priors along relevant dimensions.

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. ∎

The intuition here is that from an outsider's perspective, managers are as likely to be right as to be wrong. The gain from sorting in the first case exactly cancels out the loss from sorting in the second. The net result are resources spent on sorting, which are lost.

Appendix C.1 shows that this result holds even when the manager has other ways to control employees' behavior, such as oversight. In particular, it considers an extension where the manager can centralize decisions at some cost. Homogenous organizations will then be more decentralized, so that homogeneity saves on centralization costs. Despite these benefits of homogeneity, a social planner would still want to impose a tax on sorting in order to reduce the manager's incentives to sort. An earlier working paper (Van den Steen 2004b) shows that similar results and intuition hold when there is some exogenous benefit from homogeneity, i.e, some benefit that is proportional to H. In that case, however, there is also a second mechanism that works in the opposite direction and that can cause the opposite effect. This requires further investigation.

4   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.[12] Since 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.

Since employees of different firms will have different experiences, however, and since first-hand experiences are difficult to communicate,[13] 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 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 sorting also extend if the manager can affect the employees' learning. Under that condition, I also derive an important new comparative static: successful firms will be more homogenous.

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

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[12]Recall that the assumption of differing priors by no means rules out the employees' use of Bayes' rule to update their beliefs as they accumulate experience. To the contrary, employees are Bayes-rational in exactly the usual way.

[13]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).

4.1 Model

The model in this section makes a few small modifications to the model of section 2 to allow agents to learn from the firm's experience. Assume, in particular, that the manager chooses her action first, before the employees do, and that the employees observe the manager's action and payoff. Since the employees will now learn from the performance of M's action, the empirical distribution of the ρ_a will play a role. For simplicity and symmetry, assume that the true returns are empirically distributed like the prior beliefs: $\rho_a \overset{\text{i.i.d.}}{\sim} F$. Note that the latter is *not* a prior distribution but an empirical distribution of the agents' differing priors, which is introduced for the sole purpose of the analysis.[14] To consider the pure learning case, assume finally that $c = \infty$, so that there is no sorting.

4.2 Shared Beliefs

I 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 homogenous than society at large. There is a small complication since there are two possible reference points: the original labor pool L (who have not learned from anyone) or the employees of other firms (who have learned, but from other managers). In what follows, I will consider both.

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

Proposition 1′a $E[H(Z)] > E[H(L)]$

Proof : Denoting the manager's outcome as x, the probability that E_1 and E_2 agree on the optimal course of action is $F(x)^2 + [1 - F(x)]^2$ so that

$$E[H(Z)] = \int_x F(u)^2 + [1 - F(u)]^2 \, dF(u) = \int_0^1 v^2 + [1 - 2v + v^2] \, dv = \frac{2}{3} > \frac{1}{2} = E[H(L)]$$

∎

Note that shared experience creates homogeneity in two ways, which are more or less opposites. On the one hand, if the experience was good, then each employee is more likely to undertake that particular action, 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 is less likely to undertake that particular action, which increases the likelihood that they will agree on the other action.

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

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[14]There is also an implicit assumption, to make sure the model is consistent, that either i's prior belief about ρ_a has the same support as F, or that a zero-probability belief can be revised upon an observation that contradicts it.

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 $Z_d = (E_{i,f}, E_{j,g})$, 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 $E[H(Z_s)] = 2/3$. Consider then two employees of different firms. If their managers undertake the same action, it is as if they were in the same firm. If their managers undertake different actions, then (since $\rho_a \overset{\text{i.i.d.}}{\sim} F$) they agree with probability $\frac{1}{2}$. It follows that $E[H(Z_d)] = \frac{\frac{2}{3}+\frac{1}{2}}{2} < E[H(Z_s)] = \frac{2}{3}$. ∎

4.3 Determinants of Homogeneity

Consider now again the question what determines homogeneity, i.e., under which conditions firms are more likely to have shared beliefs. The basic learning model of section 4.1 delivers relatively few comparative statics: appendix C.1 shows, using two small variations on the model, that homogeneity will be stronger in older firms and when the manager's experience is easier to communicate or observe.

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 sorting extend, and that, moreover, successful organizations will be more likely to develop shared beliefs. In other words, success breeds homogeneity.

To that purpose, 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, for each employee whether to communicate the first-period outcome to that employee, at a cost k to the firm. This cost is a random variable $k \sim U[0, K]$, 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, its expected payoff according to i is distributed according to $r_{a,i} \overset{\text{i.i.d.}}{\sim} F$ for $i \in L$, as is its empirical distribution $\rho_a \overset{\text{i.i.d.}}{\sim} F$.

The following proposition says that nearly all comparative statics of proposition 2 extend to this case.[15] 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′ $E[H(Z)]$ *increases in* α_1 *and* α_2, *and decreases in* K. *For any subset* $z \subset Z$ *with 2 or more employees,* $E[H(z)]$ *increases in* α_i *for* $i \in z$.

---

[15] A result similar to the part of proposition 2a concerning Δ_0, the manager's conviction, seems to hold (at least in expectation), but requires a reformulation and a lot more machinery in this context.

Proof : Consider first the manager's decision to invest in communication. Let A denote the set of actions, $\bar{r}_0 = \frac{\sum_{a \in A} r_{a,0}}{N}$ the average payoff according to M, and $\check{r}_0 = \frac{\sum_{a \in A \setminus \{\tilde{a}_0\}} r_{a,0}}{N-1}$ the average payoff according to M of all but her chosen action. If the agent does not get any information about the payoff, he takes (from M's perspective) a random action, with expected payoff $\bar{r}_0$.[16] If the first-period payoff is x and the agent does observe that payoff, then he chooses that action with probability $F(x)^{N-1}$ and some other action, with expected payoff $\check{r}_0$, with complementary probability. It follows that M's expected continuation payoff for E_i is then $\alpha_i \left(xF(x)^{N-1} + \check{r}_0(1 - F(x)^{N-1}) \right)$. So M's gain from having E_i observe M's action and outcome is

$$S_i = \alpha_i \left(xF(x)^{N-1} + \check{r}_0(1 - F(x)^{N-1}) - \frac{x}{N} - \frac{(N-1)\check{r}_0}{N} \right) = \alpha_i(x - \check{r}_0) \left(F(x)^{N-1} - \frac{1}{N} \right).$$

Since M communicates to E_i iff $S_i \geq k$, E_i will learn with probability $q_i(x) = P[S_i \geq k]$. Let $\check{x}$ be defined as $F(\check{x})^{N-1} = \frac{1}{N}$ and let $x_0 = \min(\check{x}, \check{r}_0)$ and $x_1 = \max(\check{x}, \check{r}_0)$. Then $q_i(x)$ is (semi-strictly) quasiconvex in x with $q_i(x) = 0$ for $x \in [x_0, x_1]$, and $q_i(x)$ increases in α_i and decreases in K. Note that the probability that 2 employees agree is $\frac{1}{N}$ unless *both* observe the manager's action and performance. Let $q(x) = \min_i q_i(x)$, then

$$
\begin{aligned}
E[H(Z)] &= \int_x \left(q(x) \left[F(x)^{2(N-1)} + \frac{1}{N-1} \left[1 - F(x)^{N-1} \right]^2 \right] + (1 - q(x)) \frac{1}{N} \right) f(x)\, dx \\
&= \frac{1}{N} + \frac{N}{N-1} \int_x q(x) \left(F(x)^{(N-1)} - \frac{1}{N} \right)^2 dF(x).
\end{aligned}
$$

This proves the first half of the proposition since $q(x)$ increases in α_1 and α_2 and decreases in K. The second half is analogous. ∎

As with sorting, 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.

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.

Consider now the prediction that success breeds homogeneity. Let x denote the payoff of the manager's action and assume for simplicity that F has full support. The following proposition then says that only the most successful firms will attain a certain level of homogeneity.[17]

Proposition 5 *For any $N > 2$, there exist $\hat{H}$ and $\hat{x}$ such that $E[H(Z)] > \hat{H}$ if and only if $x > \hat{x}$.*

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[16]When the employee does not observe the first period action and payoff, that fact on itself allows him to make inferences about x (since it says that it is likely that the manager did not find it worthwhile to invest). However, since employees' beliefs are symmetric ex-ante and since the employee doesn't know what action the manager took, the employee's action will still be random from M's perspective.

[17]Proposition 8 shows that a similar result also holds for the relationship between homogeneity and employee performance.

Proof : From the proof of proposition $2'$, it follows that for any N, there exist $x_0 \le x_1$ such that $E[H(Z)]_{x=\tilde{x}}$ is strictly decreasing in $\tilde{x}$ for $\tilde{x} < x_0$ and strictly increasing for $\tilde{x} > x_1$ with

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

where $q(x) = P[\alpha_i(x - \breve{r}_0)\left(F(x)^{N-1} - \frac{1}{N}\right) \ge k]$, so that $\lim_{\tilde{x} \to \infty} E[H(Z)]_{x=\tilde{x}} = \frac{1}{N} + \frac{N}{N-1}(1 - \frac{1}{N})^2 = 1$ and $\lim_{x \to -\infty} E[H(Z)]_{x=\tilde{x}} = \frac{1}{N} + \frac{N}{N-1}(\frac{1}{N})^2 = \frac{1}{N-1}$. For any N, let $\hat{H} = \frac{1}{N-1}$ and let $\hat{x}$ be defined by $\frac{1}{N} + \frac{N}{N-1} q(\hat{x})(F(\hat{x})^{(N-1)} - \frac{1}{N})^2 = \hat{H}$ for $\hat{x} > x_1$. This concludes the proposition. ∎

The intuition is that, for reasons that I'll 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, while 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, and more interesting, 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 extremely high payoffs than for extremely low payoffs. In particular, agreement on what action is best leads directly to similar actions, while 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, since the latter leaves $N - 1$ actions to choose from. As a consequence, extreme successes create more homogeneity than extreme failures.[18]

I discuss an important implication of this result in section 5. In any case, the result predicts that organizations with very strong past performance will invest more in communication (or training or socialization).

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[18] To some, this result may seem counter-intuitive. Suppose, for example, that the outcome is drawn from a 2-point distribution: with probability .9999 the outcome is 100 while with probability .0001 the outcome is zero. It may then seem that remembering a bad outcome is worth more than remembering a good one. This is incorrect, however: once you know an outcome that produces 100, you can take that action forever, and there is never any chance that you hit a 0 outcome. (This result would actually hold weakly even if we knew that $N = 1000$ and that there is exactly one outcome that produces 0 while all others produce 100. In this case, however, the draws are negatively correlated, and it is difficult to imagine what could cause such negative correlation.)

5 Corporate culture

Since shared beliefs are an important part of corporate culture, I consider here how this theory relates to the literature on corporate culture, and what it can contribute.

5.1 Corporate Culture as Shared Beliefs

The idea that shared beliefs are a core component of corporate culture goes back at least to Burns and Stalker (1961) who define corporate culture as 'a dependable constant system of shared beliefs.' Other early contributors, such as Baker (1980), Schwartz and Davis (1981), Peters and Waterman (1982), or Donaldson and Lorsch (1983), also defined shared beliefs and assumptions either as an important component or as the core element of corporate culture. Probably the most influential and most cited perspective on corporate culture is that of Schein (1984, 1985). He defines culture as having three levels. 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 reflect a second, deeper, level of culture, which are the firm's shared values. Shared values are on their turn driven by the third and most fundamental level of culture: shared assumptions or shared beliefs about the world.[19]

There is also a small but growing economic literature on corporate culture. Within that literature, Crémer (1993) and Lazear (1995) both focus explicitly on this notion of corporate culture as shared beliefs. Crémer (1993) models corporate culture as shared information in a team-theory model and shows how such shared beliefs improve the alignment of actions. Lazear (1995) does not model the beliefs or values explicitly, but assumes that they diffuse like genetic traits and shows that this leads to dynamic and equilibrium properties that fit many aspects of corporate culture as discussed in the management literature.

Other economic work on corporate culture has focused more on what Schein called the 'visible artifacts', such as symbols, convention, myths, and norms. Kreps (1990), as interpreted by Hermalin (2001), suggests two ways to think about corporate culture: the selected equilibrium in a game with multiple equilibria and a reputation for dealing in a specific way with unforseen contingencies. Both can, in part, be interpreted as implications of underlying shared beliefs. For example, Van den Steen (2004a) shows how shared beliefs about the world make coordination on a particular equilibrium faster, more likely, and more predictable. Furthermore, a common view of the world should also make reactions to unforseen contingencies more predictable. Hermalin (2001) gives an in-depth perspective on the existing economic research on corporate culture, including his interpretation of Kreps (1990), and adds to it by linking culture to insights from other fields, such as IO. Along such lines, Carrillo and Gromb (1999) model corporate culture as production technologies for which employees can make specific investments. The fact that employees choose their investments

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[19]Note that there are other views on corporate culture in the management literature. Some authors have focused exclusively on the visible aspects of culture, such as myths, conventions, norms, and symbols. Others have taken a more post-modernist approach, focusing on 'ambiguity as the essence of organizational culture' (Martin 1992). Nevertheless, even Martin (1992) recognizes that the vast majority of the literature interprets corporate cultures as shared beliefs and values.

simultaneously, combined with the possibility for the firm to change technology, can lead to the coexistence of a strong culture (high investment) equilibrium and a weak culture (low investment) equilibrium. Rob and Zemsky (2002) present a theory in which firms differ in the stationary levels of cooperation among their employees. They equate this with corporate culture in the sense of a 'stable, [. . .], pattern of behavior'.[20]

The current paper differs in two key respects from this existing economic literature. First, I focus completely on the micro-mechanisms that generate 'culture as shared beliefs' and make predictions based on those mechanisms. The existing literature, on the contrary, has either focused on identifying potential benefits of culture or has, starting from different notions of culture, tried to match specific observations. Second, and less obvious, much of the existing economic literature on culture, starting with Kreps (1990), implicitly assumes that management creates a firm's culture on purpose and for its own good. Based on that assumption, that literature then identifies the benefits of culture that make it worth investing in and shows how even optimally chosen culture can have a downside. This paper, in contrast, shows that homogeneity and culture can be unintended consequence of other purposeful action: trying to make sure that employees hold the right beliefs or the right values. This raises the issue whether the level of homogeneity of organizations is actually appropriate. This approach is consistent with the wider academic debate on corporate culture. In particular, while early work made claims that culture in itself would improve performance (Deal and Kennedy 1982, Peters and Waterman 1982), thereby pushing the early literature towards explaining the benefits of culture, the lack of systematic evidence on this claim (Martin 1992) has brought about a more balanced cost-benefit view and a greater focus on when or what culture is beneficial (Kotter and Heskett 1992).

The remainder of this section considers this paper's implications for an economic theory of corporate culture. I first show that the mechanisms in this paper match some observations on corporate culture. I show, in particular, that the manager has an important influence on 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. In an earlier working paper (Van den Steen 2004b), I also showed why different firms may develop different cultures and why cultures may be suboptimal even when firms have indefinite opportunity to learn from experience.

I then consider this paper's implications for the link between culture and performance. I argue, in particular, that strong performance will create a strong culture. The ensuing correlation between culture and performance may be interpreted incorrectly as culture causing high performance.

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[20]A bit further afield, my model is also related to the work of Prescott and Visscher (1980) and could be extended to overlap with organization capital in their sense. Weber and Camerer (2003) focus on 'communication codes' as an expression of corporate culture and show experimentally that 'merging' groups with different communication codes reduces the joint group's performance. Finally, the result that culture may persist in the face of turnover is reminiscent of Tirole (1996), although the two results are about different things and are also driven by different mechanisms.

5.2 The Manager's Influence on Culture

To capture the notion of corporate culture as a firm's 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 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 then is that a firm's culture is influenced by its manager's beliefs. I will show, in particular, that the manager's action $\tilde{a}_0$ is more likely than any other action to become the firm's culture (i.e., belief most likely to be shared). In the sorting model, this is trivial since the manager sorts according to her prior beliefs. The interesting result here is that it also holds in the pure learning model, despite the fact that the manager's prior, which determines $\tilde{a}_0$, is completely unrelated to the underlying performance or to the beliefs of her employees. To see this result formally, consider the basic learning model of section 4.1 with $N \geq 2$. The following proposition says that $\tilde{a}_0$ is more likely than any other action to become the firm's most shared belief .

Proposition 6 *For any $a \neq \tilde{a}_0$, $P[a_c = \tilde{a}_0] \geq P[a_c = a]$ with strict inequality for $N > 2$.*

Proof : Let x be the payoff of $\tilde{a}_0$. The likelihood that two employees agree on $\tilde{a}_0$ as the best action is $\int_x F(x)^{2(N-1)} \, dF(x) = \frac{1}{2N-1}$ while the likelihood that two employees agree on any particular other action is $\int_x \left[\frac{1-F(x)^{N-1}}{N-1} \right]^2 \, dF(x) = \frac{2}{N(2N-1)}$. This proves the proposition. ∎

This 'forced learning' result is important since most 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).

5.3 Persistence over time

Closely related to this managerial influence is the phenomenon that culture persists over time, even when all original members of the organization are gone. This observation makes organizational culture intriguing: it is as if culture exists independent from the people in the organization, as if the organization itself has some personality or identity. I will show that culture is indeed persistent in the models of this paper.

Persistence is straightforward in an overlapping-generations extension of the sorting model: managers hire employees in their own image, who on their turn hire the next generation in the same image, etc. More interesting is again the result that persistence also obtains in the pure learning model. To that purpose, consider two generations of the learning model of section 4.1 with $N \geq 2$, where an employee of the first generation becomes the manager in the second generation (and the employees of the second generation are new draws from L). Denote by $\tilde{a}_{0(1)}$ the action of the first-generation manager. I will show that, under reasonable

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conditions, the second-generation manager is more likely to undertake $\tilde{a}_{0(1)}$ than any other action, and second-generation employees are more likely to agree on $\tilde{a}_{0(1)}$ as the best action than on any other action. In fact, both these results also hold 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 die.

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, i.e., by exposing the player to experiments chosen by someone else (rather than by himself).

To analyze this effect formally, consider the model of section 4.1 with $N \geq 2$ but repeated twice. The first of these two stages is exactly the same as specified in section 4.1. 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 4.1, 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, with $\epsilon \to 0$, player i's belief about ρ_a puts probability $1 - \epsilon$ on $r_{a,i}$ and probability ϵ on the rest of the support. As a consequence, each player will in each period simply choose the action with the highest expected payoff.[21] Let $a_{c(2)}$ then denote the firm's culture in period 2, i.e., the action on which the second-generation employees are most likely to agree (at the time they have to choose their actions), $\tilde{a}_{0(1)}$ the action of the first-generation manager, and $\tilde{a}_{0(2)}$ the action of the second-generation manager.

Proposition 7 *For any $a \neq \tilde{a}_{0(1)}$, $P[a_{c(2)} = \tilde{a}_{0(1)}] \geq P[a_{c(2)} = a]$ and $P[\tilde{a}_{0(2)} = \tilde{a}_{0(1)}] \geq P[\tilde{a}_{0(2)} = a]$, both with strict inequality when $N > 2$.*

Proof : Given the proof of proposition 6, it suffices to show $P[\tilde{a}_{0(2)} = \tilde{a}_{0(1)}] \geq P[\tilde{a}_{0(2)} = a]$, with strict inequality when $N > 2$. With A the set of actions, M_2 the second manager, and $r_{a,0(2)}$ M_2's prior belief about action a at the start of the game (prior to him having taken action as employee), condition on the returns $\{\rho_a\}_{a \in A}$, and assume wlog. that $\tilde{a}_{0(1)} = a_N$ with $\rho_{\tilde{a}_{0(1)}} = x$. To determine the probability that $\tilde{a}_{0(2)} = a_N$, note that this can happen in two different ways. The first possibility is that x is larger than all M_2's remaining prior beliefs, i.e., $x \geq r_{a_n,0(2)}$ 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 x 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 x. 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 $F(x)^{N-1} + (N-1)(1-F(x))F(x)^{N-2}F(x)$. The unconditional probability is then

$$P[\tilde{a}_{0(2)} = \tilde{a}_{0(1)}] = \int F(x)^{N-1} + (N-1)(1-F(x))F(x)^{N-1} \, dx = \frac{2}{N+1}$$

while $P[\tilde{a}_{0(2)} = a] = \frac{1 - P[\tilde{a}_{0(2)} = \tilde{a}_{0(1)}]}{N-1}$ so that $P[\tilde{a}_{0(2)} = a] < P[\tilde{a}_{0(2)} = \tilde{a}_{0(1)}]$ iff $P[\tilde{a}_{0(2)} = \tilde{a}_{0(1)}] > \frac{1}{N}$. The proposition follows. ∎

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

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, and the manager in any period is more likely to undertake $\tilde{a}_{0(1)}$ than 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.

5.4 Culture and Performance

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), or Collins and Porras (1994) have popularized the notion that strong culture is a driver of good performance.

The point of this section is to show that the issue of inverse causality looms large when assessing the relationship between culture and performance. In particular, section 4.3 showed that high performance will lead to shared beliefs and thus to a strong culture. The ensuing correlation between culture and performance can easily be mistaken as 'culture improves performance'.

Using the same model as in section 4.3, I now show that something similar holds for employee performance: only employees of homogenous firms will have a high average performance, even though homogeneity has itself no performance benefits.

Proposition 8 *For any $N > 2$ and for $i \in \{1,2\}$, there exists a $\hat{R}$ and $\hat{H}$, such that $E[\rho_{\tilde{a}_i}] \geq \hat{R}$ if and only if $E[H(Z)] \geq \hat{H}$.*

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

$$E[\rho_{\tilde{a}_i}] = q_i(x)[xF^{N-1}(x) + (1 - F^{N-1}(x))\mu_F] + (1 - q_i(x))\frac{x + (N-1)\mu_F}{N}$$

where μ_F denotes the expected value of F. This function strictly increases in x when $x > \max(\mu_F, \check{x})$, where $\check{x}$ is defined, as before, $F^{N-1}(\check{x}) = \frac{1}{N}$. Given the $\hat{x}$ of proposition 5, let $\hat{\hat{x}} = \max(\hat{x}, \check{x}, \mu_F)$, and let $\hat{H}$ now be defined such that

$$\hat{H} = \frac{1}{N} + \frac{N}{N-1}q(\hat{\hat{x}})(F(\hat{\hat{x}})^{(N-1)} - \frac{1}{N})^2$$

and let

$$\hat{R} = q_i(\hat{\hat{x}})[\hat{\hat{x}}F^{N-1}(\hat{\hat{x}}) + (1 - F^{N-1}(\hat{\hat{x}}))\mu_F] + (1 - q_i(\hat{\hat{x}}))\frac{\hat{\hat{x}} + (N-1)\mu_F}{N}$$

Combining this with the proof of proposition 5 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.
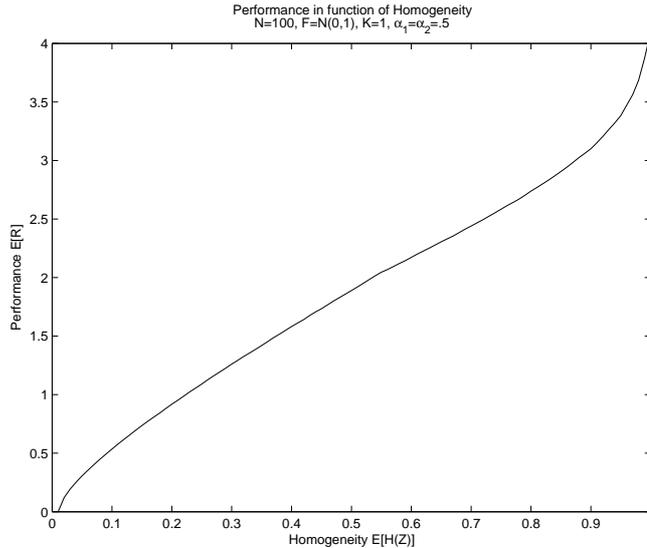
Figure 2: Performance in function of homogeneity.

Note that, in the 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 that people get struck by the strong cultures of extreme performers. It is then tempting to conclude that culture must be a key to high performance. This inverse causality issue questions the inferences that can be drawn from simple correlation or regression analyses, such as these 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).

6   Conclusion

This paper shows that organizations have an innate tendency to develop homogeneity, in the sense of shared beliefs, through two mechanisms. On the one hand, people prefer to work with others who have similar beliefs, since such others will make the right decisions. This leads to sorting. On the other hand, people of the same organization share experiences, which also leads to shared beliefs. I show that, from an outsider's perspective, organizations invest on average too much in homogeneity. I also derive comparative statics on when homogeneity will be particularly pronounced.

Since shared beliefs is an important component of corporate culture, I consider what the implications of this paper are for an economic theory of corporate culture. 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. I also show that the sometimes

suggested, although never empirically confirmed, correlation between a strong culture and strong performance may actually be due to the fact that strong performance leads to shared beliefs, rather than the other way around.

More generally, the paper argues that homogeneity matters, and that economics may gain from studying such more global characteristics of organizations.

A A General Homogeneity Result

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

Assumption A1 *For any belief by agent i about x, there exists a set of actions that maximize $E_i[R]$. For any set of beliefs (by the set of agents) about x, 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 quasi-concave (in the own action). Except for the conditions to satisfy this assumption, I impose no assumptions on R.

Proposition A1 *Under assumption A1, each agent is (subjectively) better off when all other agents have beliefs identical to his own, than when some or all other agents hold different beliefs.*

Proof : Consider wlog agent 1. Fix any belief for agent 1. Let $\hat{\mathbf{a}} = (\hat{a}_1, ... \hat{a}_J)$ be a set of actions that maximize $E_1[R]$ under that belief. Consider now first the case that all agents have beliefs that are identical to that of agent 1. I claim that $\hat{\mathbf{a}} = (\hat{a}_1, ... \hat{a}_J)$ 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 A1, whenever all agents have the same beliefs as agent 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 agents. Let $\breve{\mathbf{a}}$ be the actions of any Nash equilibrium that corresponds to this set of beliefs. If $E_1[R(\breve{\mathbf{a}})] > E_1[R(\hat{\mathbf{a}})]$, then that contradicts the definition of $\hat{\mathbf{a}}$ above. This proves the proposition. ∎

On the one hand, this result is very strong since 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.[22] On the other hand, the result does not imply (local) monotonicity, which requires some more specific assumptions.

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.

B Shared Beliefs and Culture

While 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 personal experience and from case studies in the management literature.

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[22]Note that the result will 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.

The first example is based on my personal experience in the Brussels offices of both McKinsey and Arthur D. Little. These two consulting firms competed directly in the Belgian market and were very similar in terms of clients, in terms of the schools from which they hired, and in terms of the type of studies they conducted. Despite these structural similarities, they were also a study in contrasts. McKinsey consultants generally share 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 Arthur D. Little, 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 since '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, McKinsey consultants also tend 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. Arthur D. Little, 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. Arthur D. Little 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 McKinsey 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 an official 'one Firm policy' that states 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. Arthur D. Little consultants, on the contrary, believed in a 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 studied 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, while 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, while debate was avoided since 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, while 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 management of different companies hold very different beliefs about things such as the desirability of debt, the necessity and optimal level of growth, or the desirability of corporate diversification. Some companies believe that the way to get good people is to offer high pay, while others believe that, instead, growth opportunities are key and that good pay follows good performance. Indeed, beliefs as to what 'drives' people is often a distinguishing characteristic of many firms. While 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 phenomenon under study. The fundamental belief is that human actions are a bit like physical phenomena, and can be studied as such. 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 'all else is never equal'.

C Extensions and Further Results

C.1 Sorting

I extend here the result of section 3. In particular, I will show that organizations invest on average too much in homogeneity from an outsider's perspective even when the manager has other ways to control employees' behavior.

To that purpose, assume that in stage 2, the manager can centralize decisions at some cost. In particular, at cost I, the manager can actually choose (i.e., 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. In this case, homogeneity will reduce the need for centralization. Nevertheless, the following proposition says that the firm will still invest on average too much in homogeneity.

Proposition C1 *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 sorting and centralization will be mutually exclusive (since both are costly and attain the same result). M will sort 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 $\frac{\alpha\Delta_0}{4\gamma} < 1$,

$$E[R] = \int_0^{\alpha\Delta_0} \left[\int_{\frac{I}{4\gamma}}^1 (\hat{m} - I)\, dc \right] dI + \int_0^{\frac{\alpha\Delta_0}{4\gamma}} \left[\int_{4\gamma c}^1 (\hat{m} - 4c)\, dI \right] dc + \int_{\alpha\Delta_0}^1 \int_{\frac{\alpha\Delta_0}{4\gamma}}^1 \hat{m}\, dc\, dI$$

where the first term is for when M centralizes, the second term when M sorts and the third for when M does neither. The second term includes immediately the lump-sum payment to compensate for the tax or subsidy (so that the cost if $4c$ 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.
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 $4\gamma > 1$,

$$E[R] = \int_0^1 \left[\int_0^{\frac{I}{4\gamma}} (\hat{m} - 4c)\, dc + \int_{\frac{I}{4\gamma}}^1 (\hat{m} - I)\, dc \right] dI$$

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. ∎

A fairly straightforward argument also shows that in this model homogenous organizations are more decentralized, i.e., with Cent denoting the event that M centralizes the decisions, $P[\text{Cent} \mid H(Z)]$ decreases in $H(Z)$.

C.2 Learning

C.2.1 Comparative Statics in the Basic Model

This section considers the comparative statics of two small variations on the learning model of section 4.1.

The first result is that firms with a longer history will be more homogenous, since 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 C2 $E[H(Z)]$ *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 $\{r_{a,0}\}_{a \in A}$ (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 agents 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 $k - 1$. Since 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 $F(\rho_{\hat{a}})^{2k} + \frac{1}{k} \left[1 - F(\rho_{\hat{a}})^k \right]^2$ or $P(k, F) = F^{2k} + \frac{1}{k} \left[1 - F^k \right]^2$ 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 just is as if one action got removed from $A \setminus B^s$. The probability of agreement is then $P((k-1), F) = F^{2(k-1)} + \frac{1}{(k-1)} \left[1 - F^{(k-1)} \right]^2$. 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 $P((k-1), \check{F}) = \check{F}^{2(k-1)} + \frac{1}{(k-1)} \left[1 - \check{F}^{(k-1)} \right]^2$ with $\check{F} \geq F$.

Combining these equations implies that we need to show that $\Delta P = \check{F}^{2(k-1)} + \frac{1}{(k-1)} \left[1 - \check{F}^{(k-1)} \right]^2 - \left(F^{2k} + \frac{1}{k} \left[1 - F^k \right]^2 \right) \geq 0$ 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 C3 $E[H(Z)]$ *increases in q.*

Proof : This follows from the fact that $E[H(Z)] = \frac{1}{N} + q \frac{N-1}{N(2N-1)}$. ∎

While the result is nearly trivial, it does suggest some useful empirical implications. It suggests, 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.

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