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ORGANIZATIONAL BELIEFS AND MANAGERIAL VISION

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Abstract

This paper studies, in a world with differing priors, the role of organizational beliefs and managerial vision in the behavior and performance of corporations.

The paper defines vision operationally as a very strong belief by the manager about the right course of action for the firm. The interaction between employees' beliefs and the manager's vision influences decisions and determines employees' motivation and satisfaction. Through sorting in the labor market, the manager's vision also shapes organizational beliefs. Under weak conditions, a company's board should select a manager with stronger beliefs than its own, although spurious effects may make vision often look better than it really is.

The analysis shows that beliefs play an important role that goes beyond their information content. It also has implications for theories of corporate culture and business strategy.

1 Introduction

Beliefs can shape reality. Organizational beliefs can shape corporate behavior and performance. Donaldson and Lorsch (1983) in their extensive study of top management decisions, stated that 'beliefs and corporate strategy are closely intertwined - at times almost indistinguishably so.' Until 1995, for example, Microsoft and Sun held nearly opposite beliefs regarding the future of computing, which led them to very different strategic choices. Such beliefs are often determined by the vision of the CEO or founder. In fact, practice-oriented studies have concluded that vision is the key to leadership (Korn/Ferry International and Columbia Univ. GSB 1989, The Economist Intelligence Unit and Korn/Ferry International 1996, Robertson and Walt 1999).

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With the exception of Rotemberg and Saloner (2000), discussed in detail below, economics has neglected these topics. This gap might be due to the fact that organizational beliefs and vision are thought to be outside the realm of economics. We will argue, however, that these phenomena do fit the economic paradigm and can be studied formally as long as we allow differing beliefs. Moreover, our analysis suggests that the impact of such belief differences is pervasive, so that an economic theory of organizations will have to take them into account.

The model and results. The focus of this paper is on the interaction between the employees' beliefs and those of the manager. 'Vision' is defined operationally[1] as a very strong belief by the manager about the future and about the right course of action for the firm.

The impact of organizational beliefs and managerial vision is studied in the context of a simple model. In this model, employees can spend effort on developing new initiatives. If an employee comes up with a project, his manager has to decide on implementation. If the project gets implemented and is a success, the employee gets part of the revenue through ex-post bargaining. At the time of the project generation and implementation, however, there is uncertainty about what kind of projects (A vs. B) will be successful. The key to the analysis is that the employee and the manager may openly differ in their beliefs about the right course of action. This means that we do not impose the common prior assumption (CPA), an approach that will be justified in more detail.

A stronger belief of the manager will motivate those employees who agree with him to such a degree that they undertake the project that the manager deems optimal. The reason is simply that they get easier approval for the projects they undertake. But, by the same token, it will demotivate those who disagree too much. Analogous effects will increase resp. decrease employee satisfaction. This gives rise to sorting: a firm attracts employees with beliefs that are similar to those of its manager. Such sorting reduces the demotivating effect of vision. This feedback loop suggests that vision might overall be profitable.

To evaluate the profitability of vision, the paper takes the perspective of an outsider, such as the board, with an 'objective' or reference belief. This gives three conclusions. First, in the presence of sorting, vision is profitable under weak conditions. Second, the effect increases in the importance of motivation and initiative, but decreases as market uncertainty goes away. And, third, even when vision is not optimal ex-ante, ex post the best (and worst) firms in the market will be those with a visionary CEO and strong organizational beliefs. This might make vision look better than it really is. The final sections of the paper contain an informal discussion of extensions and related concepts, such as corporate culture and strategy.

The literature. Bennis and Nanus (1985) and Tichy and Devanna (1986), building on the theories of charismatic or transformational leadership (House 1977, Burns 1978), were the first to really focus on managerial vision. Before them, Donaldson and Lorsch (1983) had already documented the importance of managerial and organizational beliefs.

Rotemberg and Saloner (2000) provided the first formal model of vision. Extending their work on leadership styles and strategy (Rotemberg and Saloner 1993, 1994), they consider a firm with two employees, or product divisions, working on different projects. Vision in their model is a bias of the manager that makes him favor one project over the other. Such vision

[1]The relationship of this definition to those in the managerial and psychology literature will be discussed later.

improves the incentives of one employee at the cost of reducing the incentives of the other. While the setting is quite different, this effect bears similarity to the motivation effect in this paper. We show, however, that this is only the tip of the iceberg. In particular, with all agents holding subjective beliefs, vision also influences decisions, satisfaction, hiring, and the organizational beliefs themselves. This wide range of implications suggests why vision is considered key to leadership. Moreover, the analysis also shows the importance of beliefs beyond their information content.

Goel and Thakor (2000) is complementary to our analysis. They define overconfidence as underestimating project risks and argue that overconfident people have a higher probability to win in tournaments and thus get elected as leader. They argue further that such overconfidence in managers is good for shareholders since it compensates for their risk aversion[2].

Recently, there have also been some empirical contributions on the effects of vision. Baum, Locke, and Kirkpatrick (1998), for example, find evidence of a positive influence of vision on venture growth and discuss other empirical studies. There is also an extensive related literature, such as that on culture, leadership, or delegation. That literature will be discussed later in the paper.

The next section explains the model setup. It also discusses our notion of vision and compares its definition to that in the literature. Section 3 discusses differing priors. Sections 4-6 are the core of this paper. They analyze the impact of organizational beliefs in one-firm and multiple firms contexts, and consider when vision would be profitable. Section 7 discusses the implications for culture and strategy. Section 8 concludes and suggests further topics for research. Appendix A considers some implications for small firms with size restrictions. Appendix B discusses the impact of changes in the assumptions or set-up of the model. All proofs are in Appendix C.

2 The model

A sketch of the model Remember the basic model, as sketched in the introduction. Employees try to develop initiatives. The probability that an employee 'comes up with something' is a function $q(e)$ of his effort e. If an employee comes up with something, the manager decides whether to implement it. In making that decision, he considers not only the project's expected revenue but also its organization-wide implementation cost, which is a random variable I. If the project gets implemented and is a success, the employee gets part of the revenue through ex post bargaining.

The key element of the model is the presence of uncertainty about which projects will be successful and generate revenue. In particular, employees have to choose which projects to spend effort on: A- or B-type projects. These project types are mutually exclusive. The success and revenue of a project depends on its fit with the (unknown) state of the world $x \in \{a, b\}$. In particular, X-type projects are successful if and only if the state is x. Successful projects generate a revenue of 1 while failures generate no revenue. Note that the

[2]For other economic perspectives on leadership see Rotemberg and Saloner (1993) and Hermalin (1998, 1999).

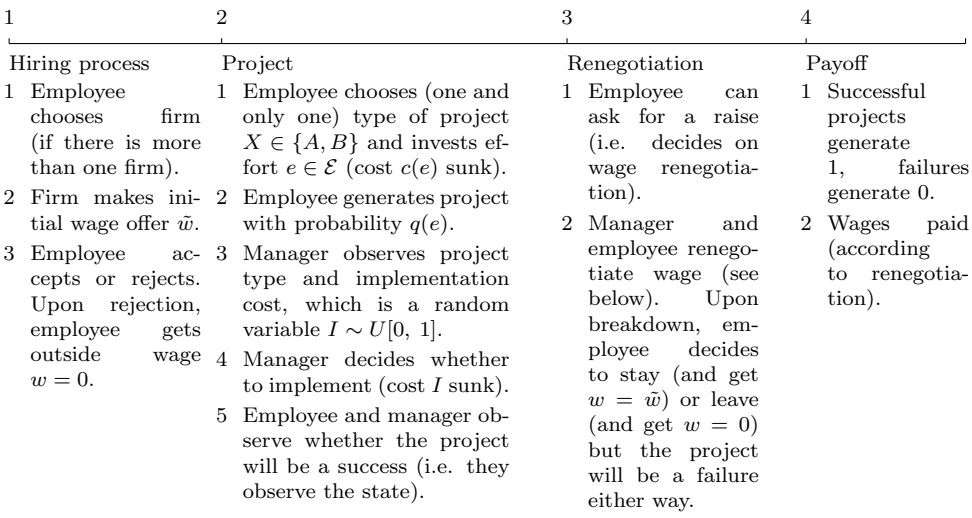

Figure 1: Timeline of game

state may include any factor that has a bearing on what the optimal action is, including evolution of the industry, core competences of the firm, or 'the right way of doing things'.

All agents in the model have their own subjective belief about the likelihood of each state. These beliefs may differ but are common knowledge. This implies, by Aumann (1976), that the agents start from differing priors. It also implies that agents will not update their beliefs merely because they are confronted with a different opinion. This assumption is discussed in more detail in section 3.

We will use the notation $\mu_{i,Y}$ for the probability that agent i assigns to the event that state is Y. Employee E, for example, believes that with probability $\mu_{E,A}$ the state is A. The strength of an agent's beliefs will turn out to play an important role in the analysis. We will denote this by $\nu_i = \max(\mu_{i,A}, \mu_{i,B}) \in [1/2, 1]$, i.e. ν_i is the strength of i's belief in the state he considers most likely. We say that an agent has a 'more precise belief' or 'stronger conviction' if ν_i is larger. Finally, p will denote the reference belief or 'objective' probability (that the true state is a) used to evaluate profitability.

We now proceed to a more detailed description of some elements in the model.

Agents, utilities, and beliefs The model has 3 types of agents: firms, managers, and employees. In the analysis of optimal vision, we imagine the firm to be represented by the board (or the owner) who chooses the manager. The board maximizes expected profits using the reference belief p. Each firm has a manager who hires its employees and decides on implementation. Managers maximize expected firm profit based on their own subjective belief $\mu_{M,Y}$. Employees, finally, choose projects and spend effort on developing them. They maximize their expected revenue net of any cost of effort. In doing so they also use their own beliefs $\mu_{E,Y}$.

Actions and timing The precise timing is indicated in figure 1. Stages 1, 2, and 4 are straightforward. The renegotiation in stage 3 is according to Nash bargaining with relative

bargaining power $\gamma_E, \gamma_M > 0$, with $\gamma_E + \gamma_M = 1$. This means that a dollar extra will be split (γ_E, γ_M). If bargaining breaks down, the project fails and generates 0 revenue while the employee can choose either to stay with wage $w = \tilde{w}$ or to leave the firm and take his outside wage $\underline{w} = 0$. This renegotiation is just a way to assure that the employee cares about the outcome. We would obtain the same results if, for example, the employee cares about the outcome because it affects his outside options or future promotions. Finally, the results would not change if we also allowed the firm to ask for renegotiation. Appendix B considers further modifications to the setup of the model.

Contractibility Implicit in this timeline are a number of assumptions as to what variables are contractible. In particular, we implicitly assume that the agent's effort e and the project type are economically too complex to contract on. We also assume that employees, without spending any effort, can come up with bad (zero-revenue) projects that are indistinguishable from good ones for an outsider, so that 'coming up with a project' is not contractible. We further let future revenue become (economically) contractible only after the project has been implemented. This can be justified by the difficulty of describing the revenues of a project that does not exist. It then follows that the only possible contract at the start of the game is a fixed-wage contract[3], as described in the timeline. The description of the game also implicitly assumes that the employee's support is needed until the end for the project to become a success, and that he can withdraw that support at will to force a renegotiation. Appendix B discusses how these contractibility and renegotiation assumptions affect the results. That appendix also considers other variations on the basic model.

We also make a number of explicit assumptions:

Assumption 1 *Employees' beliefs are independent draws from a distribution of beliefs F on $[0, 1]$, with continuous density f.*

When indifferent about which firm to apply to, employees randomize between the two firms with equal probability. When indifferent about what action to undertake, employees do as their manager prefers. When indifferent about implementation, managers do as their employee prefers.

Assumption 2

- *The implementation cost I is distributed uniformly on $[0, 1]$.*
- *The probability of success $q(e)$ and the cost of effort $c(e)$ are twice continuously differentiable on $\mathcal{E}$; $0 \in \mathcal{E}$; $\mathcal{E}$ is compact.*
- $1 \geq q(e) \geq 0$, $q'(e) > 0$, $q''(e) \leq 0$;
- $c''(e) > 0$; $c(0) = c'(0) = 0$; $\lim_{e \to \max \mathcal{E}} c'(e) = \infty$;
- $\gamma_E q(\tilde{e}) \leq c(\tilde{e})$ *where* $\tilde{e} = \inf\{e \in \mathcal{E} \mid q(e) = 1\}$

[3]Note that this wage offer $\tilde{w}$ may depend on the employee's belief. Any such dependence, however, gets lost in the later renegotiation.

These are all standard assumptions, except for the last one which assures that the optimal $\hat{e}$ always has room to increase further.

We finally assume that

Assumption 3 *The reference probability* $p \geq 1/2$.

This assumption is without any loss of generality since we can always rename the states and project-types to make sure it holds.

A practical example To fix ideas, think back a few years to the time that the Internet was close to taking off and consider a software product manager who is preparing the next version of his product. His key issue is whether to add and improve traditional features or to focus instead on adding Internet capabilities. The future success of his product may depend crucially on this choice. Complicating matters is the fact that the CEO has the final say on any new release. Consider now the case that the product manager believes the Internet is no more than a fad and developing Internet capabilities a complete waste of resources which might put him fatally behind his competitors. His CEO, however, is a true believer and has made clear to her product managers that they should focus on making their products Internet-ready.

In this case, contracting on direct output is problematic since it is difficult to define what Internet-ready means, what good implementation means, or what the relative importance of different features is. Software development efforts are also difficult to measure objectively. Finally, his product's success is obviously a key factor in the product manager's future wage negotiations (or promotions), but it is difficult to contract on long in advance given the fundamental uncertainties in the industry.

Operational definition of vision As mentioned earlier, we define vision operationally as a strong belief by the manager about the optimal course of action for the firm. A manager who says that 'anything is possible' has no vision, while one who claims that 'in five years handhelds will have completely displaced PC's' conveys a strong sense of vision. In principle, a manager would thus be visionary if he has a stronger belief than the board, i.e. if $\nu_{_M} > \max(p, (1-p))$. Given that we assumed $p \geq 1/2$, however, the interesting case is when the manager has a stronger belief than the reference belief. Our operational definition will thus be that the manager is visionary if $\mu_{_{M,A}} > p$.

This operational definition captures a common element of most descriptions in the literature: vision as a clear idea about (or 'picture' of) the future and the firm's position in that future. Bennis and Nanus (1985), for example, describe it as 'a mental image of a possible and desirable future state of the organization'. Similar definitions are used in most of the literature and dictionaries[4].

[4]Tichy and Devanna (1986) state that '[Transformational leaders] must provide people with an image of what can be ...'. Kouzes and Posner (1987) define it as 'an ideal and unique image of the future'; Kotter (1990) defined it as 'a description of something (...) in the future, often the distant future, in terms of the essence of what it should be.' The Cambridge Dictionaries Online defines vision as 'the ability to imagine how a country, society, industry, etc. will develop in the future and to plan in a suitable way'. As the term

The 'vision' studied in this paper is in fact a case of 'overconfidence' (see e.g. Einhorn and Hogarth (1978), Nisbett and Ross (1980)). This fits rather well with the 'charismatic leadership theory' in psychology (House 1977, Conger and Kanungo 1988), which showed that 'self-confidence' and 'a strong conviction in the own beliefs' are key characteristics of charismatic and transformational leaders.

While a strong belief about the right course of action is a 'necessary' component of vision, it does not seem to be 'sufficient'. The management literature argues, for example, that vision also creates 'meaning' or that vision must be attractive (Bennis and Nanus 1985). By abstracting from these aspects, we do not mean that they are necessarily less important. But we think that doing so is useful on the following grounds. First, the effects seem to be sufficiently independent to allow, at least to the first order, a separate study. Second, such separate analysis is more transparent in terms of cause and effect and allows us to disentangle the implications of specific assumptions. Finally and most importantly, the results we get are very similar to the claims made for managerial vision, which suggests that this very simple definition might well capture the part of the phenomenon that 'does the trick'.

3 A note on 'differing beliefs' in economic modeling

The model in section 2 differs in one respect from most economic models: the agents knowingly entertain differing beliefs[5] (without having private information). The reason for this assumption is pragmatic: differences in beliefs are at the heart of the issues studied here, and assuming common knowledge of differing beliefs is the most transparent and parsimonious way to study this question[6]. Differing beliefs 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 (1967), for example, 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'. The best argument for the traditional use of common priors is Aumann's (1987) argument that they allow us to 'zero in on purely informational issues'. Conversely, differing priors allow us to zero in on the implications of open disagreement and differing beliefs.

became more popular, however, it sometimes got extended to cover a much broader set of concepts (Quigley 1993) or simply as a synonym for 'admired' (Collins and Porras 1994).

[5]Whenever we refer to belief differences, or agents entertaining differing beliefs, we mean that 'agents have differing beliefs about a specific event and their beliefs are common knowledge'. In economics, the term 'disagreement' is often used to denote such belief differences. We avoid this term since it suggests conflict. We are definitely not the first to use such differing priors. See for example Harrison and Kreps (1978) or Yildiz (2000).

[6]While formally most of the analysis can be done under standard assumptions, such analysis would miss the essential point: that, *holding information constant*, the strength of beliefs is an important influence; that it can be optimal to have a CEO who has stronger beliefs than the board *even if he does not have more information*.

Van den Steen (2001) considers this issue in more detail[7]. Among other things, it argues against the idea that differing priors might allow us to explain anything, it discounts the theoretical possibility that agents will make very large or infinite bets[8], and shows that the epistemic foundations for Nash equilibria in the sense of Aumann and Brandenburger (1995) extend to this context with differing priors on the payoff-space.

Working with differing priors also raises the issue how to measure expected profits and thus how to determine the optimality of a vision. To that purpose, this paper uses the perspective of an outsider with a 'reference' belief. This outsider can be interpreted as the board or the financial markets. Or this outsider can be interpreted as a truly objective observer who knows the true probability, in which case the analysis studies which firms will really fare better in expectation.

One further remark to facilitate the interpretation of the model is in order. The distribution of beliefs is implicitly assumed to be generated by the following information process. All agents start with a common prior on the state $x \in \{a, b\}$ that puts equal probability on both states. All agents subsequently get a common signal that, for example, the true state is a. The agents, however, have their own subjective opinion about the correctness of that signal and these beliefs are common knowledge. In particular, it is commonly known that agent i thinks that the signal is correct with probability $\mu_{i,A}$. Note here that differing beliefs about the correctness of the common signal is just a special case of differing priors[9]. Bayesian updating then leads the agent to believe that the probability of state a is $\mu_{i,A}$. The 'reference' belief p is the belief of the board about the signal. Note that a 'visionary' manager, as defined above, is in fact overconfident relative to the reference belief.

4 Decisions, motivation, and satisfaction

The basis of the analysis is an understanding how individual employees react to their manager's beliefs. This is the subject of this section. To that purpose, consider the model of section 2 with the firm having only one employee. Let $\mu_{E,Y}$ and $\mu_{M,Y}$ denote the beliefs of the employee and the manager that the correct course of action is Y. Throughout this and the following sections, hats will indicate optimized choice variables and value functions. So $\hat{e}$ is the employee's optimal choice of effort while $\hat{u}$ is his optimized utility. To make the notation more transparent, the dependence of the maximizers on other variables will be suppressed.

We now reason by backwards induction[10]. The renegotiation process will give the firm

[7]See also Morris (1995) or the discussion between Gul (1998) and Aumann (1998).

[8]Note that such bets are simply not possible in the model under consideration. On the other hand, our model suggests that employees of a 'visionary' company will often have stronger beliefs in its business model than the owners. Stock options are then essentially a (wealth-constrained) bet between these employees and the owners of the firm.

[9]In particular, agents not only have (prior) beliefs about the state $x \in \{a, b\}$, but also about what game they are playing, how correct their information is, etc. In this particular case, agent i puts probability one on the signal being correct with probability $\mu_{i,A}$, but agent j puts probability one on $\mu_{j,A}$, which might be different.

[10]The proof of proposition 1 shows that all SP equilibria have the same outcomes and are equivalent to one in which the firm offers a wage $\tilde{w} = 0$ and the employee accepts.

a gross revenue γ_M if the project is implemented and turns out to be a success, and zero otherwise. Given that the manager can observe the project type, he will thus allow a project Y to be implemented if and only if $\gamma_M \mu_{M,Y} \geq I$. Prior to the revelation of I, the project will thus be implemented with probability $\gamma_M \mu_{M,Y}$, which gives the employee an expected payoff from proposing a project of $\gamma_E \gamma_M \mu_{E,Y} \mu_{M,Y}$. In choosing the type of initiative and e, the employee thus solves:

$$\max_{e \in \mathcal{E}, Y \in \{A,B\}} q(e) \gamma_M \gamma_E \mu_{E,Y} \mu_{M,Y} - c(e)$$

The next proposition now says that whoever has the stronger beliefs or conviction about what should be done, will determine what will be done.

Proposition 1 *If the manager has the stronger conviction then the employee undertakes the action that his manager prefers. Otherwise he follows his own opinion. Formally: if* $\nu_M \geq \nu_E$ *with* $\nu_i = \max(\mu_{i,A}, \mu_{i,B})$*, then* $X = \text{argmax}_{Y \in \{A,B\}} \mu_{M,Y}$*, otherwise* $X = \text{argmax}_{Y \in \{A,B\}} \mu_{E,Y}$*.*

The intuition is simple. If the manager and the employee agree on the optimal action, then E chooses of course that action. If they have different opinions, the employee will have to 'disappoint' one of the two. Since the roles of their beliefs are symmetric in the employee's utility function, it is optimal to 'disappoint' the one who holds the weaker belief (i.e belief closer to 1/2).

Given this symmetry, one might wonder what the difference between the employee and the manager really is: why do we say that managers have a vision while employees 'only' have beliefs? The difference is, first, that the manager influences the decision of the employee but not the other way around and, second, that the manager also influences other employees. On the other hand, it should be noted that not only managers have such influence in actual organizations: the sociological literature on 'gatekeepers' describes precisely how persons with little formal authority who control the access to important resources (such as the assistant to the CEO) can wield a lot of influence (Mechanic 1962). Such cases, however, are not intentional and their impact is most probably less pervasive than that of a manager.

A different way to look at proposition 1 is to say that the manager keeps a strong influence over the project type, even though the decision is formally delegated to the employee[11]. In many non-routine jobs, such indirect authority might be a more effective way to influence the course of action than direct authority, since, among other things, the manager has to get involved only after the project has been successfully developed. For this kind of decision processes, the earlier results then imply that

Corollary 1 ('Visionary managers have more influence.') *The prior probability that the project choice is according to the manager's belief increases in* ν_M*, the manager's conviction in his view of the world.*

[11]The model might also complement the theory of delegation (Vickers 1985, Prendergast 1993, Aghion and Tirole 1997, Baker, Gibbons, and Murphy 1999, Zabojnik 2001). The main conjecture would be that, (all else equal) with effort complementary to the probability of success, the project type decision should be taken by the person with the more important non-contractible effort.

While the manager's opinion has an important influence on the *decisions* of the employee, it is also a key determinant for the employee's *motivation and satisfaction* (or effort and utility). The following proposition essentially says that a stronger belief of the manager will motivate the employee and increase his satisfaction *if* the employee acts according to the manager's beliefs. Such stronger beliefs, however, will *de*motivate an employee who goes against the manager's opinion and will reduce his satisfaction. To state this formally, let N be an open neighborhood of μ_{E} and μ_{M} on which the chosen project type X remains identical and let $0 < \mu_{i,A} < 1$ for both agents.

Proposition 2 *Employee effort $\hat{e}$ and satisfaction (or utility) $\hat{u}$ strictly increase in the conviction of the manager $\nu_{M} = \max(\mu_{M,A}, \mu_{M,B})$ (resp. in the employee's own conviction ν_{E}) on N if the employee undertakes the action that the manager strictly prefers $X = \operatorname{argmax}_{Y \in \{A,B\}} \mu_{M,Y}$ (resp. that he himself strictly prefers).*

Analogously, employee effort $\hat{e}$ and satisfaction $\hat{u}$ strictly decrease in his manager's conviction (resp. his own conviction) on N if he undertakes the opposite action of what his manager strictly prefers: $X = \operatorname{argmin}_{Y \in \{A,B\}} \mu_{M,Y}$ (resp. of what he himself strictly prefers).

The intuition is simple. Suppose that the employee undertakes a project that is the right course of action according to his manager. As the manager is more convinced of that action, the probability that he will implement the project increases. This will increase the expected payoff to the employee from trying to develop the project, which indeed motivates him and gives him higher satisfaction.

This result can be loosely interpreted as follows:

- Employees with no specific opinion on the correct action (μ_{E} close to 1/2) get more motivated by managers who know precisely what they want, no matter what they want. The same is true for employees whose utility depends only on implementation or approval, and not on the final success (since this case is formally equivalent to setting $\mu_{E,X} = 1$ for the likelihood of whichever action is chosen).

- Employees with a strong opinion about the correct path of action will be very motivated under managers who agree with them (and more so as the manager is more convinced of that opinion). But they will be very *de*motivated under managers with a different opinion.

These statements fit casual empiricism.

5 The sorting effects of vision

The motivation and satisfaction effects cause sorting in the labor market[12], which then feeds back into motivation and satisfaction. The basic argument runs as follows.

[12]Note that effects similar to the ones described here can occur in other types of markets. In particular, investors (in financial markets) will be willing to pay more for equity in firms whose managers have beliefs that are similar to their own.

- Employees get higher satisfaction working for firms that espouse a vision they agree with. Firms get higher profits from employees who agree with their vision, since the latter are more motivated. An efficient labor market should therefore match employees and firms with similar beliefs. Since sorting determines the type of employees a firm attracts, which then influences its profit, this might on itself constitute a sufficient reason for deviating from the 'objective' (or reference) belief.

- Once sorting has taken place the beliefs of the employees and the manager are more aligned. This will decrease or even eliminate the demotivating effect that vision had on some employees, so that vision becomes more effective.

Partial evidence for such sorting comes from sociological studies (Chatman 1991) that show how employees and firms take into account 'fit' when deciding which firms to join or who to hire. While this evidence relates more to fit in terms of values, it does suggest that such sorting mechanisms operate. We expect the same conclusions to hold for fit in terms of beliefs, especially on the more executive levels of the organization.

To study these effects formally, consider again the model of section 2 but let the employee, with belief $\mu_{E,A}$, have the choice between two firms, F_1 and F_2, with managers M_1 and M_2 who have beliefs $\mu_{M_1,A}$ and $\mu_{M_2,A}$, where we assume wlog $\mu_{M_1,A} \geq \mu_{M_2,A}$.

There is again an essentially unique subgame perfect equilibrium, which gives sorting as indicated in figure 2.

Proposition 3 *Let* $\breve{\mu} = \frac{1-\mu_{M_2,A}}{\mu_{M_1,A}+1-\mu_{M_2,A}}$. *In any subgame perfect equilibrium, all employees with* $\mu_{E,A} > \breve{\mu}$ *end up being hired by* M_1, *while any employee with* $\mu_{E,A} < \breve{\mu}$ *will be hired by* M_2. $\breve{\mu}$ *decreases in both* $\mu_{M_1,A}$ *and* $\mu_{M_2,A}$.

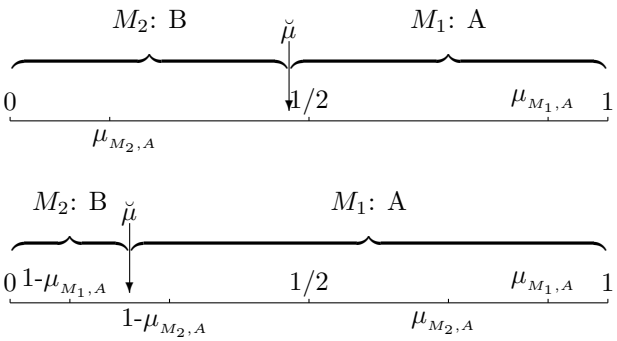

Figure 2: Choice of action in function of beliefs

It can be shown that this allocation of employees is the unique stable matching and the unique element in the core (defined by weak domination) of the corresponding cooperative matching game.

To see intuitively what is happening consider first the upper graph of figure 2. There are two managers who have approximately opposite beliefs. Consider the situation of an employee with belief $\mu_E = 1/2$. Personally this employee doesn't see any difference between

the two alternatives. All he thus cares about is the probability of implementation. So he will go with the manager with the strongest conviction, which is M_1. Given that his preference is strict we know that the cutoff $\breve{\mu}$ must be strictly to the left of 1/2.

Note two things :

1. The employee with $\mu_{_E} = 1/2$ is closer to M_2 in terms of beliefs, but goes to firm F_1, since M_1 'knows better what he wants'.

2. As M_1 gets more convinced, he becomes more attractive to work for. In particular, an employee that before was indifferent will now go to work for M_1. So $\breve{\mu}$ shift to the left as $\mu_{_{M_1}}$ shifts to the right. The same is true for M_2. This gives the lower graph.

The result is also striking in the sense that the firm with the stronger vision attracts precisely these employees who take action according to its manager's beliefs[13].

Corollary 2 *If manager M_1 has the stronger belief, then any employee hired by F_1 will choose the action preferred by its manager, while any employee hired by F_2 will choose the other action (which then might or might not be preferred by M_2). Formally: if $\nu_{_{M_1}} > \nu_{_{M_2}}$ then $X = \text{argmax}_{Y\in\{A,B\}}\, \mu_{F_1,Y}$ for F_1.*

The intuition is simply that an agent who goes to F_2 and undertakes action A would have been better off going to F_1 while still undertaking A, and vice versa.

The result also says that firm 2 gets 'pushed' into taking the other action, even if its manager thinks it should take the same action as firm 1. It thus follows that firm 2 might be better off hiring a manager with the opposite vision of firm 1, or one whose vision is still stronger. This raises the broader issue how firms will compete with and on vision, a topic of further research[14].

Note, finally, that there is an implicit assumption in this model that firms are not limited in size: they hire any employee that comes their way. In the presence of many candidate-employees, this leads to the rather surprising result that the more visionary firm tends to be larger and have employees with more diverse beliefs. In reality, however, firms are not flexible in terms of their size. Taking into account such limitations would largely eliminate these results. They also tend to disappear as the number of project types increases.

Corollary 2 above combines nicely with the results of section 4. There we concluded that an increase in vision could *de*motivate and reduce employees' utility, that is, if they favored the other action so strongly as to go against the manager's opinion. The corollary, however, implies that this negative effect does not apply to the more visionary of the two firms. Since all its employees choose according to the manager's vision, they also get motivated by stronger vision.

Corollary 3 *If M_1 has the stronger belief ($\nu_{_{M_1}} > \nu_{_{M_2}}$) then the effort and utility of F_1's employees increase in $\mu_{_{M_1,A}}$ and thus in $\nu_{_{M_1}}$.*

[13]It should be noted that this extreme outcome is partially due to the limited state-space. Nevertheless, even with richer state-spaces, we conjecture that the essence of the result will carry over.

[14]We conjecture that such competition leads to more extreme visions since firms have an incentive to outbid each other. Some of that might have been going in the early history of e-commerce, with firms competing on business models.

Overall the analysis suggests the following characteristics of a 'visionary organization':

- Employees choose their initiatives without intervention from the top, but nevertheless they choose what management would want them to choose. This strengthens the case for delegation.
- Visionary firms also attract employees that do not really agree with the vision, but who are attracted by its conviction.
- Vision motivates all employees, including those who actually think the other project would be better.

6 Profitability of vision

The analysis thus far has uncovered both beneficial and harmful effects of vision. Can we say anything about when a company gains from hiring a CEO with vision? In line with our discussion in section 3 on the outsider's perspective, we consider here the question *'Given some reference p, where we assume $1 > p > 1/2$, is the optimal belief of the firm $\mu_{M,A} > p$?'*.

According to the analysis up to this point, the optimal CEO-belief depends on the following forces:

- The motivation/demotivation effect.
- The sorting effect and the influence on the project choice.
- The cost of wrong implementation decisions.

The following subsections consider how these effects combine in specific cases. The conclusions are as follows:

- Absent sorting, no conclusions can be drawn in full generality, though we do obtain clear results for a more restricted but important class of belief distributions.
- When sorting occurs, we show that at least some degree of vision is optimal under very weak conditions.
- Even when vision is not optimal ex-ante, it might seem optimal ex-post. This spurious optimality result suggests some caveats for 'In Search of Excellence'-type of analyses.
- The impact of vision increases in the importance of motivation and initiative, but decreases as the uncertainty goes to zero.

6.1 Profitability of vision absent sorting

Consider first the case without sorting. With employees' beliefs drawn from a distribution F, the firm's reference expected profits can be written[15]:

$$\begin{aligned} E[\pi] &= \int_0^{\mu_{M,B}} q(\hat{e})\gamma_M^2 \mu_{M,B} \left((1-p) - \frac{\mu_{M,B}}{2}\right) f(u)du \\ &+ \int_{\mu_{M,B}}^1 q(\hat{e})\gamma_M^2 \mu_{M,A} \left(p - \frac{\mu_{M,A}}{2}\right) f(u)du \end{aligned}$$

Since the balance of forces depends on the distribution of beliefs, we cannot say anything in full generality. There exists, however, an important class of distributions that does allow clear conclusions. Consider in particular the following restriction:

Assumption 4 *All agents think A is the optimal project, i.e.* $\operatorname{supp} F \subset (1/2, 1]$.

This assumption will, for example, be satisfied when all employees approximately hold the reference belief. It eliminates all employees who get demotivated or switch actions as the manager gets more convinced. The remaining trade-off is then between the motivation effect and the cost of wrong implementation.

Proposition 4 *Let A4 hold. If* $q(e) \equiv 1$*, then the unique optimal belief is the reference (or 'objective') belief. If* $q(e)$ *is strictly increasing, then vision is strictly optimal.*

The intuition is simple. As long as there is some effect of effort, the motivation effect dominates, since the effect of wrong implementations is second order at $\mu_{M,A} = p$. When the motivation effect is completely absent, then the cost of making wrong decisions will make it optimal to hold the reference belief. Note that this proposition is a partial exception on the general assumption that $q(e)$ is strictly increasing in e.

6.2 Profitability of vision with sorting

When sorting occurs, an important cost of vision gets eliminated for the most visionary firm: no employee will get demotivated by the manager's vision. Moreover, at small levels of overconfidence the cost of wrong implementations is second order since it concerns only projects that go marginally the other way. This suggests that 'vision is always good in moderate amounts'. There is still one caveat, however: it is theoretically possible that all potential employees hold beliefs opposite to the reference belief p. A visionary firm ($\mu_M > p$) could then end up with nearly no employees and thus nearly no profits.

To formalize this argument, let the focal firm face one competitor whose manager holds the reference belief p. Consider any of the following two conditions.

Condition 1 *The support of* F *is contained in* $[(1-p), 1]$.

[15] Remember that hats indicate optimal choice variables and value functions, and that the dependence of maximizers on parameters has been suppressed. In particular, $\hat{e}$ is function of the type of action taken, γ_E, γ_M, $\mu_{M,A}$ and u.

or

Condition 2 *The distribution of beliefs F First Order Stochastically Dominates some symmetric distribution*[16] *and* $1/2 < p < 1$.

This second condition says that the distribution of beliefs weakly favors the side of the reference belief, in the sense that it can be generated from some symmetric distribution by moving some probability mass up. This holds for example when $F(x) \leq 1 - F(1-x)$ or when F is the Beta-distribution $F(x; a, b) = \frac{\int_0^x u^{a-1}(1-u)^{b-1}du}{\int_0^1 u^{a-1}(1-u)^{b-1}du}$ with $0 < b \leq a < \infty$.

The following results confirm that vision is optimal under fairly weak conditions.

Proposition 5 *Under C2 or C1 vision is optimal (against a firm whose manager holds the reference belief).*

Note, however, that this answer is incomplete since we constrained the other firm to hold the reference belief.

6.3 Spurious (ex-post) optimality of vision

The fact that many successful firms have visionary CEO's or strong organizational beliefs might be taken as casual evidence for the optimality of vision. Looks may deceive, however. In particular, vision and strong beliefs induce an important selection bias. If you act as if you knew the future and you turn out to be right, then your actions will be ex-post optimal, even if they were ex-ante suboptimal given the objective odds. So we would expect that even when vision is *not* optimal, ex-post the best (but also worst) firms in the market will be those with visionary managers.

To confirm this argument formally, consider an economy with N firms with K employees each. Each employee of firm n faces a choice of action $X_n \in \{A_n, B_n\}$. The state of the world relevant to firm n is an independent draw x_n from $\{a_n, b_n\}$ with probabilities p and $(1-p)$ respectively, where we assume $1 > p > 1/2$. All employees hold the reference belief $\mu_{_E} = p$, which implies A4. Let $q(e) \equiv 1$, so that the reference belief ('no vision') is optimal by proposition 4. The managers' beliefs are independent draws from a distribution of beliefs F with support $[p, 1]$ and with an atom of size $0 < P[p] < 1$ at the endpoint p. Any such draw thus results with probability $P[p]$ in an 'objective' manager. With probability $1 - P[p]$, the draw will be a 'visionary' manager with a belief $\mu_{_v} > p$[17]. Assume that the firms face equivalent opportunities: the implementation cost I_k of the k$^{\text{th}}$ employee's project is identical for all firms. The following proposition confirms that visionary firms will have extreme results:

Proposition 6 *As the number of firms N and employees per firm K increases, the probability that the best (and worst) firms have visionary managers (as indicated in figure 3) and*

[16] A distribution F first-order stochastically dominates a distribution G when F is generated from G by adding to every outcome some non-negative random variable. An alternative definition is that $F \leq G$, i.e. some probability mass of G is shifted upwards to obtain F.

[17] Note that, for the sake of getting a simple argument, we implicitly assume that no sorting takes place.

that the profit difference with any firm with an objective manager is strict, converges to one. The probability of being ex-post the best (or worst) performing firm increases in the firm's rank[18] *in terms of strength of its manager's belief.*

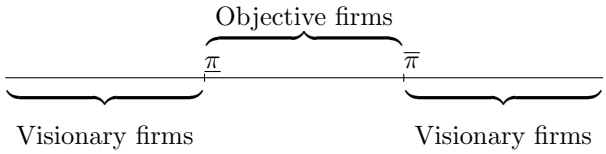

Figure 3: The extreme performance of visionary companies

The intuition is exactly the one set forth at the start of this section, and the result confirms essentially the initial conjecture.

Corollary 4 (In Search of Excellence) [19] *For a large enough number of firms and employees per firm, the very best firms in the market have (nearly always) visionary managers.*

This might also explain the observation that many famous 'visionary' managers were actually founders or co-founders of their firm (e.g. Steve Jobs, Sam Walton, Bill Gates, Larry Ellison, Scott McNealy). In particular, the theory here suggests that these people might actually have had too strong beliefs (from an ex ante expected profitability perspective) but turned out to be right. Note also that such extreme believers are willing to spend extreme effort on developing their ideas.

This spurious effect will be stronger as there is more underlying uncertainty (which might explain why 4 out of the 5 names above come from the software sector):

Proposition 7 *The difference in ex-post profitability between the firm of the most visionary manager ($\mu_v = 1$) and that of the closest objective manager increases in the 'objective' uncertainty*[20] *$p(1-p)$.*

The intuition is simply that objective managers are very cautious in markets with high uncertainty. There is thus much more room for overconfidence to make a difference.

6.4 Comparative statics

Which technological and market conditions make vision more or less important? While we can try to answer this question, the results should be treated with great caution. The

[18] We define rank here as '#firms that have strictly stronger belief+1'. So the firm with the strongest belief has rank 1, and a firm with rank m has $m-1$ firms that have strictly stronger beliefs. Other definitions are just a matter of changing notation.

[19] Although 'In Search of Excellence' (Peters and Waterman 1982) does not refer to it as 'vision', it does conclude that excellent companies are characterized by strong beliefs and values (e.g. 'a belief that most members of the organization should be innovators...') and argues that these values and beliefs are often created by a leader. This is not to say that their results were all spurious. But the effect may have played an important role.

[20] Note that $p(1-p)$ is the variance of a binomial distribution with probability p.

assumption that only one of the firms can choose its vision seriously affects any comparative statics. A more complete analysis awaits further research.

Consider first how the impact of vision depends on the underlying uncertainty. The most natural measure for 'uncertainty' is $p(1-p)$, the variance of the binomial distribution generated by the reference probability. The basic conjecture is that the impact of vision should decrease as the uncertainty about the true state goes to zero. The argument is simply that there is less room for a manager to be overconfident, and thus for vision to make a difference.

While this intuition is complete in the absence of sorting, things are a bit more complex with sorting. In this case, the overall gain has two components. The first is the gain from inducing sorting with a minimum (limit) deviation from the reference belief, which we call the pure sorting effect. The second is the extra gain from holding a belief that is strictly greater than p. We call this the gain beyond the pure sorting effect. The suggested intuition applies only to the latter.

Proposition 8
- *Absent sorting, the profit gain from vision, if any, converges to zero as* $p \to 1$. *Formally* $\left[\max_{\mu_{M,A} \geq p} E[\pi] - E[\pi \mid \mu_{M,A} = p]\right] \to 0$ *as* $p \to 1$.
- *Under C1 or C2 and sorting, the profit gain from vision beyond pure sorting converges to zero as* $p \to 1$. *Formally* $\left[\max_{\mu_{M,A} \geq p} E[\pi] - \lim_{\mu_{M,A} \downarrow p} E[\pi]\right] \to 0$ *as* $p \to 1$.

In contrast to proposition 7, the effect here is a real decrease in ex-ante expected profit, instead of a spurious ex-post effect.

The role of 'motivation' in the model also suggests that vision will be more important in sectors where individual non-contractible effort is more important. The problem is to capture the notion of 'effort being more important' without any side effects. We would want to parameterize $q(e)$ and $c(e)$ by η such that $\frac{\partial^2 q(e)}{\partial \eta \partial e} \geq 0$ while at the same time $\hat{e}$ is independent of η and $\left[\frac{\partial q(e)}{\partial \eta}\right]_{e=\hat{e}} = 0$ so as to eliminate indirect effects. In that case, we indeed get

Proposition 9 *Under C1 or C2 and sorting, or under A4 absent sorting, the optimal vision increases as* η *increases.*

While this confirms the conjecture in principle, it is not clear which practical parameterization would have these properties. On the other hand, the result itself does hold for some common parameterizations with only slightly stronger conditions.

7 Implications for theories of organizational culture and business strategy

We now consider some implications for corporate culture and strategy, which are both closely related to organizational beliefs and vision.

Culture After some modification, the model allows an interpretation in terms of differing utility functions instead of differing beliefs. For example, someone who cares about the environment likes to work for a manager with similar preferences since he will then more likely get approval for environmentally friendly projects. As such, it suggests a theory of 'organizational values': why they matter and how they get formed. The sociological and management literature has often defined corporate culture as 'shared beliefs' or as 'shared values' (Schein 1984, Schein 1985, Kotter and Heskett 1992). These thus correspond directly to the original model and the above modification respectively. The 'behavioral norms' that are often considered an important aspect of corporate culture, are then interpreted as a reflection of underlying beliefs or values. For example, a strong belief that 'there is one best way to do things' leads some firms to value uniform practices throughout its worldwide offices, which leads to many implicit and explicit rules about 'how things are done here'. Our theory thus provides a model of corporate culture, which is complementary to existing economic theories of corporate culture (Kreps 1990, Cremer 1993, Lazear 1995, Hermalin 1999a). Lazear (1995) is also complementary to the sorting effect in this model, in that he considers how culture evolves in an organization. Cremer's (1993) definition of corporate culture as shared knowledge is closely related to the definition of culture as shared beliefs.

Strategy Rotemberg and Saloner (2000)[21] argue that business strategy is a substitute for vision since it can provide similar incentives by restricting which businesses the firm can be in. They further argue that vision is more effective since it allows a finer trade-off[22]. But strategy can also be a means to communicate the vision (Saloner, Shepard, and Podolny 2001) and thus complement it.

With respect to this second interpretation, however, our theory predicts that a CEO would often like to communicate a stronger belief than he really has. Formulating a strategy that follows the stronger belief would be the answer, but this poses the issue how to commit to such a strategy. Except for hard-wiring the strategy in promotions, incentive schemes and such, the natural approach would be to build a reputation for following strategic plans. This, on its turn, supports the categorical nature of strategic plans implicitly assumed by the interpretation of Rotemberg and Saloner: While in principle there is no reason that strategic plans wouldn't be able to mimic the nuance of a vision, it is difficult to build a reputation for following a plan when it is very nuanced.

8 Conclusion

This paper argued that managerial vision and organizational beliefs are to a large extent amenable to economic analysis, and that they are an essential part of organization theory.

[21] See also Zemsky (1994) on the value of intertemporal commitment provided by strategy.

[22] This assumes that strategy is a simple rule that excludes certain types of activities or projects (as it was used operationally by Rotemberg and Saloner (1994)). There is in principle no reason, however, why strategy should be so categorical. On the other hand, part of the argument we are about to make is precisely why more nuanced strategies might be very difficult to implement.

The paper then considered some basic effects of beliefs and vision on decision making, motivation, and satisfaction and showed how vision can shape organizational beliefs. It finally concluded that vision is profitable under weak conditions, but also identified an important spurious effect that may make vision look better than it really is.

There are many interesting extensions to this work:

- The coordinating role of vision has been left unexplored, although the analysis suggests some possible mechanisms. Since all employees of a visionary firm have similar ideas about the future, they will tend to act in mutually consistent ways. Employees also tend to shade their decisions towards the belief of their manager, making the latter an implicit coordination point. The motivation effect, finally, means that more effort is spent on projects that align with the CEO's vision.

- The current analysis is essentially static. How vision interacts with learning or how a CEO will choose his successor are interesting dynamic issues that are left to explore. The issues of communication, influence, and conviction are also completely absent from this model. Lazear (1995) presented some results in this sense.

- The firms in this model focus all their energy single-mindedly on one course of action[23]. This raises the question under which circumstances the firm would do better to hedge its bets by spending part of its resources on the other option. This is obviously related to the issues of diversity (Athey, Avery, and Zemsky 2000) and autonomous strategic action by middle management (Burgelman 1983, 1991, 1994, Rotemberg and Saloner 2000).

While we cited already some empirical and 'casual' evidence that supports the theory, real testing remains to be done. The most effective method would probably be experimental. This is facilitated by the fact that only the employees' perceptions matter, so that individual experiments suffice. A different approach consists of testing how employee motivation and satisfaction, and firm hiring and firing are affected by the fit in beliefs between the employee and the organization or manager. A direct empirical test of the vision-performance relationship is complicated by its non-monotone form. Testing the second moment prediction (that more visionary firms have more variation in their results) might be more powerful.

From a broader perspective, we think that economic theory has much to gain from studying the consequences of belief differences.

[23]This is not necessarily the same as 'exploitation' in the sense of March (1991) or the absence of innovation. In particular, the manager's vision can focus the firm's actions on innovation and exploration, at the cost of exploitation. It is plausible, however, that vision often leads to exploitation at the cost of exploration.

A Vision, selective hiring, and size

Sorting can also occur because the firm hires selectively. Consider for example a firm that is alone in a market with N potential employees. Let the employees' beliefs be independent draws from some distribution F. Let the firm have a limited number of $K < N$ positions to fill. Assume in particular that if $n > K$ potential employees accept a wage offer from the firm, then the firm can choose which K employees out of that group it really hires. The following result essentially says that smaller firms tend to have stronger beliefs, higher motivation and satisfaction, and higher expected profits per employee (after correcting for other size related effects).

Proposition 1 *For a given firm-belief $\mu_{M} > 1/2$, fix any $\epsilon > 0$ and consider for each number of employees N the class of firms with size $K < \left[1 - F\left(\frac{1-\mu_M}{\mu_M}\right) - \epsilon\right] N$. Let, for each N, P_N denote the minimal ex ante probability that for any two firms with sizes $0 < K_1 < K_2 \leq K$, the smaller firm has stronger average employee beliefs, higher average effort and satisfaction, and higher expected profits per employee than the larger one. Then $P_N \to 1$ as $N \to \infty$.*

Moreover, for very small firms, the manager's optimal vision can be weak compared to the beliefs of his employees. In any firm with $K < \left[1 - F(\hat{\mu}_{M,A})\right] N$, all employees will have strictly stronger beliefs than the (optimal) manager. The manager thus plays a bit the 'voice of reason', although he is still overconfident.

It should be noted, though, that these results are very sensitive to the particular assumptions made about the presence of other firms and the ensuing sorting process in the market.

Proof of Proposition 1: We first of all claim that, as $N \to \infty$, there are almost surely at least K employees with belief $\mu_{E} \geq \frac{1-\mu_{M,A}}{\mu_{M,A}}$. With F_N denoting the empirical distribution of a draw of N employees, we need to show that almost surely $\frac{K}{N} < 1 - F_N\left(\frac{1-\mu_{M,A}}{\mu_{M,A}}\right)$. Since we know that $\frac{K}{N} < 1 - F\left(\frac{1-\mu_{M,A}}{\mu_{M,A}}\right) - \epsilon$ it suffices that, as $N \to \infty$, $\left|F\left(\frac{1-\mu_{M,A}}{\mu_{M,A}}\right) - F_N\left(\frac{1-\mu_{M,A}}{\mu_{M,A}}\right)\right| \leq \frac{\epsilon}{2}$ which follows from the Glivenko-Cantelli theorem. This allows us to condition the rest of the argument on the event that there are at least K employees with belief $\mu_{E} \geq \frac{1-\mu_{M,A}}{\mu_{M,A}}$.

We now claim that, conditional on that fact, the firm hires the K employees with the strongest beliefs in A. Let, in abuse of notation, K denote the set of employees hired by the firm and K_L and K_H respectively the subsets of K with beliefs $\mu_{E} < 1 - \mu_{M,A}$ and $\mu_{E} \geq 1 - \mu_{M,A}$, i.e. $K_L = K \cap [0, 1 - \mu_{M,A})$ and $K_H = K \cap [1 - \mu_{M,A}, 1]$. The firm's profit (from its own subjective perspective) can be written

$$\sum_{K_L} q(\hat{e})\gamma_{F}^{2} \frac{(1-\mu_{M,A})^2}{2} + \sum_{K_H} q(\hat{e})\gamma_{F}^{2} \frac{\mu_{M,A}^2}{2}$$

We now claim that this is maximized when K_L is empty and all employees in K_H have belief $\mu_{E} \geq F_N^{-1}(N - K)$. In this case, all hired employees undertake A-projects. They also all have beliefs $\mu_{E} \geq \frac{1-\mu_{M,A}}{\mu_{M,A}}$, so that $\mu_{E}\mu_{M,A} \geq 1 - \mu_{M,A}$ which implies that each hired employee will put in more effort than any non-hired potential employee. Combined with the fact that $\frac{(1-\mu_{M,A})^2}{2} < \frac{\mu_{M,A}^2}{2}$ this implies that we can never be better off by hiring an employee that would undertake B. And for all employees undertaking A, the firm prefers to hire those with the strongest beliefs in A.

Take now any firm with size $K < \left(1 - F(\frac{1-\mu_{M,A}}{\mu_{M,A}}) - \epsilon\right) N - 1$ (and condition on the fact that there are at least $K+1$ employees with belief $\mu_E \geq \frac{1-\mu_{M,A}}{\mu_{M,A}}$)). Consider what happens when this firm hires one more employee. That extra employee will have a weakly weaker belief (in A) than any other employee of the firm, so that the median and average belief weakly decrease. The other results follow analogously. ■

B Modifications of model and assumptions

This appendix considers how the results are affected by changes in assumptions or in setup.

B.1 Contractibility and renegotiation assumptions

Consider first what happens when effort e would become contractible. Assume in particular that, after the employee has accepted the wage offer $\tilde{w}$, the firm can offer an extra effort-based compensation $b(e)$. If the employee rejects, the game just proceeds as before. If the employee accepts, this effort compensation becomes non-renegotiable (while the wage $\tilde{w}$ remains renegotiable)[24]. The following informal argument suggests that all qualitative results are preserved in this case. Let $\hat{e}$ denote the effort that the employee would choose absent any extra compensation scheme. Any compensation scheme $b(e)$ can be replicated by one that induces the same effort as that compensation scheme, say $\tilde{e}$, and that simply consists of a bonus $\tilde{b} = b(\tilde{e})$ if and only if the employee chooses $e = \tilde{e}$. This bonus must be non-negative (since the employee can always reject $b(e)$ and choose $\tilde{e}$ anyways). It is also straightforward that we must have $\tilde{e} \geq \hat{e}$ (since the firm will never pay anything extra for a lower effort) and $\tilde{b} = [q(\hat{e}) - q(\tilde{e})]\mu_{M,X}\mu_{E,X}\gamma_M\gamma_E - [c(\hat{e}) - c(\tilde{e})]$ (since this is the minimum that the firm has to offer to make the employee willing to choose $\tilde{e}$). It now follows already that the employee's project choice and utility are the same as in the original game. The satisfaction and sorting effects are thus preserved. Moreover, the effort will be larger than before and moves with the manager's ν_i as in the original game.

If instead of effort, we made the project type contractible in the way we just described, then the qualitative effects would again be preserved. The choice of project type will still be influenced by both beliefs although the manager's belief will get more weight. The employee's motivation and satisfaction will still depend on his own and his manager's belief in the action undertaken. So we also get sorting. The case where both project type and effort are contractible in the way described is essentially a combination of both cases, so that we would expect the qualitative results to be again preserved.

A second issue is the non-contractibility of the agent's participation, which leads to the ex-post renegotiation. We noted already that the results extend to the case where the employee gets instead some exogenously determined benefit, such as improved outside options or satisfaction from a successful project. A very different case, however, is that where the firm can make an up-front offer of wage plus bonus, which are then non-renegotiable. The choice of the optimal bonus introduces a second optimization problem in the game, which complicates the analysis. While the original

[24]This corresponds to a situation where $b(e)$ is paid immediately after the effort is spent, while the wage w is paid only at the end of the game.

Note that there are numerous alternatives for modifying the game and that our only goal is to clarify the role of the contractibility assumptions. Therefore, we limit ourselves to some direct modifications and are not too concerned about the realism of the resulting game.

results seem to hold under appropriate restrictions on the third derivatives, a full analysis of this case awaits further research. Alternatively, this game could be simplified by assuming that the size of the bonus is exogenously given, but this brings us back to the above model with exogenously determined benefits.

B.2 Other modifications

Consider now some more structural changes to the model. A first important modification is the timing of the renegotiation. We could for example imagine that the firm and the employee renegotiate at the time of implementation (i.e. that the employee's support is critical for implementation). It can be shown that the employee will then undertake the project that the manager considers best, that he spends more effort as the manager has stronger belief, and that he gets the higher expected utility from working for the manager with the stronger beliefs. It thus also follows that vision is optimal. The key change, however, is that the sorting is not based any more on the employee's beliefs (since his wage gets fixed before the project gets realized).

A different set of modifications pertains to the role of employee effort e. In particular, in the model employee utility was strictly increasing and supermodular in e, $\mu_{M,Y}$ and $\mu_{E,Y}$. While this appears to be the more natural case, these properties do not necessarily always hold in modified games[25]. The property that the employees' utility is increasing in the manager's belief in the project he undertakes, tends to hold in most situations. In that case, vision still causes sorting and an increase in satisfaction. The complementarity between e and $\mu_{M,Y}$ however, is more fragile. In some situations, the motivation effect may get lost or even reversed. If so, the optimality of vision depends on the exact strength and interaction of the different effects.

Finally, one might wonder about the impact of the allocation of authority. We consider two cases of interest. First, if the manager were to choose the type of project (while the employee still chooses his own effort level), his criterion would put strictly more weight on his own beliefs. Second, the case in which the employee makes the implementation decision is identical to a situation where the manager happens to have the same belief as the employee. In particular, the analysis implies that the firm would want to hire overconfident employees.

[25]Consider, for example, the following modification. Let the cost of implementation be distributed according to some general distribution function G. Let $q(e)$ denote the probability that the employee's project will be a success conditional on being of the right type (i.e. conditional on fitting the state), instead of the probability that the employee comes up with a proposal. In this case, the employee's overall utility function becomes $\gamma_E \mu_{E,Y} q(e) G(\gamma_M \mu_{M,Y} q(e))$. Complementarity between $\mu_{M,Y}$ and e now depends on the behavior of g'. Another possible modification is that where the effort e is expended after the project is approved (with $q(e)$ then being the probability of success conditional on being of the right type). In this case, there will be no interaction between e and $\mu_{M,Y}$.

C Proofs of the propositions

C.1 Basic results for one firm

Lemma 1 *All subgame perfect equilibria of this game have the same project types, effort levels and payoffs, and are equivalent to one in which the firm offers $\tilde{w} = 0$ and the employee accepts.*

Proof : Let us first determine the full equilibrium by backwards induction. Assume that the firm has made a wage-offer $\tilde{w}$ and the employee has accepted. Let $\check{w} = \max(\tilde{w}, 0)$. The outside options in the bargaining are $\check{w}$ for the employee and $-\check{w}$ for the firm. These are also the final payoffs in case there is no successful project at the start of the renegotiation stage. Furthermore, Nash bargaining when there *is* a successful project will give the employee $w = \gamma_E + \check{w}$. The employee will thus always ask for renegotiation and end up with this wage while the firm gets $\gamma_M - \check{w}$.

Consider now the firm's decision when it gets a proposal for a project of type X. The firm implements iff $\mu_{M,X}(\gamma_M - \check{w}) + (1 - \mu_{M,X})(-\check{w}) - I (= \mu_{M,X}\gamma_M - \check{w} - I) \geq -\check{w}$ or iff $\mu_{M,X}\gamma_M \geq I$ i.e. with probability $\mu_{M,X}\gamma_M$.

The employee's payoff upon generating a project is $\mu_{E,X}\gamma_M\mu_{M,X}(\gamma_E + \check{w}) + (1 - (\mu_{E,X}\gamma_M\mu_{M,X}))\check{w} = \check{w} + \gamma_E\gamma_M\mu_{M,X}\mu_{E,X}$ while it is just $\check{w}$ without any project. So the employee solves $\max_{e\in\mathcal{E}, Y\in\{A,B\}} \check{w} + q(e)\gamma_E\gamma_M\mu_{M,Y}\mu_{E,Y} - c(e)$. It follows that the employee chooses the project, say X, with the highest $\mu_{E,Y}\mu_{M,Y}$, and then chooses e to solve: $\max_{e\in\mathcal{E}} q(e)\gamma_E\gamma_M\mu_{M,X}\mu_{E,X} - c(e) + \check{w}$. This is non-negative by A2 and the fact that the employee can set $e = 0$. Since $\underline{w} = 0$, the employee accepts any $\tilde{w}$.

The firm's payoff from offering a wage $\tilde{w}$ is

$$q(\hat{e}) \int_0^{\gamma_M \mu_{M,X}} (\gamma_M \mu_{M,X} - I) dI - \max(\tilde{w}, 0) = q(\hat{e}) \frac{\gamma_M^2 \mu_{M,X}^2}{2} - \max(\tilde{w}, 0)$$

so the firm offers $\tilde{w} \leq 0$, so that $\check{w} = 0$. Any such wage gives the same payoff. ■

Proof of Proposition 1: Lemma 1 says that the employee will choose the action $Y \in \{A, B\}$ with the highest $\mu_{E,Y}\mu_{M,Y}$. Let $\nu_i > \nu_j$ and let wlog. $A = \text{argmax}_{Y\in\{A,B\}} \mu_{i,Y}$. If also $\text{argmax}_{Y\in\{A,B\}} \mu_{j,Y} = A$ then $\mu_{E,A}\mu_{M,A} = \nu_i\nu_j > 1/4 > (1 - \nu_i)(1 - \nu_j) = \mu_{E,B}\mu_{M,B}$, else $\mu_{E,A}\mu_{M,A} = \nu_i(1 - \nu_j) > (1 - \nu_i)\nu_j = \mu_{E,B}\mu_{M,B}$. In any case, the employee chooses indeed the action preferred by i. If $\nu_M = \nu_E$ and $\mu_M \neq \mu_E$, then, by A1, the employee does as his manager prefers. ■

Proof of Corollary 1: Let, essentially wlog, $\mu_{M,A} > 1/2$, so that $\nu_M = \mu_{M,A}$. The probability that the decision follows the manager's belief is $\int_{1-\mu_{M,A}}^1 dF$ which increases in $\mu_{M,A}$ and thus in ν_M. ■

Proof of Proposition 2: We first show that, with X denoting the project undertaken by the employee, '$\hat{e}$ and $\hat{u}$ strictly increase in $\mu_{i,X}$ on N'. With $l(e) = \frac{c'(e)}{q'(e)}$, we have that $\hat{e} = l^{-1}(\gamma_E\gamma_M\mu_{E,X}\mu_{M,X})$ so that $\frac{d\hat{e}}{d\mu_{i,X}} = [l^{-1}(\cdot)]'\gamma_E\gamma_M\mu_{-i,X}$ which is strictly positive. This implies the first part of the statement. The second part follows from applying an envelope theorem on the employee's problem $\max_{e\in\mathcal{E}} q(e)\gamma_E\gamma_M\mu_{E,X}\mu_{M,X} - c(e)$.

Assume now that the manager strictly prefers project A, i.e. $\mu_{M,A} > 1/2$, so that $\nu_M = \mu_{M,A}$. If now $X = A$ then $\frac{d\hat{e}}{d\nu_M} = \frac{d\hat{e}}{d\mu_{M,A}} = \frac{d\hat{e}}{d\mu_{M,X}} > 0$. If $X = B$, then $\mu_{M,X} = \mu_{M,B} = 1 - \mu_{M,A} = 1 - \nu_M$, so that $\frac{d\hat{e}}{d\nu_M} = \frac{d\hat{e}}{d\mu_{M,A}} = -\frac{d\hat{e}}{d\mu_{M,X}} < 0$.

The arguments for increases and decreases in utility, and for the analogous relationships with respect to the employee's conviction and project preference, are completely analogous. ■

C.2 Sorting

Proof of Proposition 3: Remember that an employee of firm F_i who undertakes Y gets a payoff $q(\hat{e})\gamma_{E}\gamma_{M}\mu_{E,Y}\mu_{M_i,Y} - c(\hat{e})$.
We claim first of all that in any SPE, all employees (with $\mu_{E} \neq \breve{\mu}$) hired by F_1 choose A and all those hired by F_2 choose B. This follows by contradiction: Consider any employee who applies to F_1 but chooses action B. He would be strictly better off applying to F_2 and still undertaking B .
Next, given that F_1 (resp. F_2)-employees choose A (resp. B), an employee strictly prefers F_1 if $\max_{e\in\mathcal{E}} q(e)\gamma_{E}\gamma_{M}\mu_{E,A}\mu_{M_1,A} - c(e) > \max_{e\in\mathcal{E}} q(e)\gamma_{E}\gamma_{M}\mu_{E,B}\mu_{M_2,B} - c(e)$ or if (by an envelope theorem argument) $\mu_{E,A}\mu_{M_1,A} > \mu_{E,B}\mu_{M_2,B}$ or if $\mu_{E,A} > \breve{\mu}$.
An analogous argument shows that if $\mu_{E} < \breve{\mu}$ then the employee will definitely choose firm F_2.
The fact that $\breve{\mu}$ decreases in $\mu_{M_1,A}$ and $\mu_{M_2,A}$ follows from its definition. ■
Proof of Corollary 2: This follows directly from the proof of proposition 3. ■
Proof of Corollary 3: By the earlier results and assumptions, all employees of F_1 choose A. The corollary then follows from monotone comparative statics and an envelope theorem on the employee's problem.

■

C.3 Profitability of vision

Lemma 2 *Absent sorting, the optimal $\mu_{M,A}$ increases in p.*

Proof : It is sufficient to show that $E[\hat{\pi}_O]$ is supermodular in p and $\mu_{M,A}$. The profit equation is:

$$\begin{aligned} E[\hat{\pi}_O] &= \int_0^{\mu_{M,B}} q(\hat{e})\gamma_M^2 \left((1-p)\mu_{M,B} - \frac{\mu_{M,B}^2}{2}\right) f(u)du \\ &+ \int_{\mu_{M,B}}^1 q(\hat{e})\gamma_M^2 \left(p\mu_{M,A} - \frac{\mu_{M,A}^2}{2}\right) f(u)du \end{aligned}$$

where we suppressed notation that indicates that $\hat{e}$ depends on both agents' beliefs and on the action taken. The cross partial of this function in $(p, \mu_{M,A})$ is positive. ■

C.3.1 Restricted belief-support

Proof of Proposition 4: We first want to show that $\hat{\mu}_{M,A} \geq 1/2$. By lemma 2 above, it is sufficient to show this for $p = 1/2$. By contradiction, assume that $\mu_{M,A} < 1/2$ while $p = 1/2$, then firm profits are:

$$E[\hat{\pi}_O] = \int_{1/2}^{\mu_{M,B}} q(\hat{e})\gamma_M^2\mu_{M,B}\frac{\mu_{M,A}}{2}f(u)du + \int_{\mu_{M,B}}^1 q(\hat{e})\gamma_M^2\mu_{M,A}\left(\frac{\mu_{M,B}}{2}\right)f(u)du$$

Consider now what happens if we select instead a manager with belief $\breve{\mu}_{M,A} = 1 - \mu_{M,A} > 1/2$.

- Employees who before chose A will still choose A, but their effort strictly increases. This implies that the second term strictly increases.
- Employees who before chose B will now choose A. By the relation between $\mu_{M,A}$ and $\breve{\mu}_{M,A}$, the $\mu_{M,X}$ (the manager's belief in the action chosen by the employee) remains the same. $\mu_{E,X}$ on the contrary increases (since by A4 all employees believe more in A than in B), so that again employee effort increases. This implies that the first term increases.

This implies that overall the firm profits increase, so that $\mu_{M,A} < 1/2$ is not optimal.
Consider now the case that $q(e) \equiv 1$. The employee sets $\hat{e} = 0$ and undertakes the action that maximizes $\mu_{E,Y}\mu_{M,Y}$. Since $\hat{\mu}_{M,A} \geq 1/2$, profit equals $E[\hat{\pi}_O] = \int_{1/2}^{1} \gamma_M^2 \mu_{M,A} \left(p - \frac{\mu_{M,A}}{2}\right) f(u)du$ which is maximized at $\hat{\mu}_{M,A} = p$. This proves the first part of the proposition. For the second part, the firm profit when $\mu_{M,A} \geq 1/2$ is $E[\hat{\pi}_O] = \max_{\mu_{M,A}} \int_{1/2}^{1} q(\hat{e})\gamma_M^2 \mu_{M,A} \left(p - \frac{\mu_{M,A}}{2}\right) f(u)du$ where the maximum is well defined since the profit function is continuous in $\mu_{M,A}$ on $[1/2, 1]$. The derivative of the integrand (for $\mu_{M,A}$) is strictly positive for $1/2 \leq \mu_{M,A} \leq p$ and continuous in $\mu_{M,A}$. It thus follows that the optimal $\mu_{M,A}$ is strictly larger than p and thus that vision is optimal. ■

C.4 Profitability with sorting

Remember that we assume that $1 > p > 1/2$ and that the focal firm F faces one competitor with belief $\mu = p$. We first introduce some notation. Let $\hat{\pi}_H = \max_{\mu_{F,A} \geq p} E[\pi]$ when F attracts all employees with $\mu_{E,A} \geq \breve{\mu}$, and let $\hat{\mu}_{F_H}$ be the corresponding maximizer. Let analogously $\hat{\pi}_L = \max_{\mu_{F,A} \leq p} E[\pi]$ when F attracts all employees with $\mu_{E,A} \leq \breve{\mu}$, and let $\hat{\mu}_{F_L}$ be the maximizer. Note that this implies that $0 \leq \hat{\mu}_{F_L} \leq p \leq \hat{\mu}_{F_H} \leq 1$.

Let $\tilde{\pi}_L$ be the profit of F when $\mu_{F,A} = p$ but F attracts all employees with $\mu_{E,A} < (1-p)$; $\tilde{\pi}_H$ be the profit of F when $\mu_{F,A} = p$ but F attracts all employees with $\mu_{E,A} \geq (1-p)$; $\tilde{\pi}_M$ be the profit of F when $\mu_{F,A} = p$ and employees are allocated randomly between the two firms with equal probability. Note that we always have that $\hat{\pi}_H \geq \tilde{\pi}_H$ and $\hat{\pi}_L \geq \tilde{\pi}_L$.

Finally, let $F^-(x) = \lim_{u \uparrow x} F(u)$ and $F^+(x) = \lim_{u \downarrow x} F(u)$.

Lemma 3 *If $F^-(1-p) < 1$ then $\hat{\mu}_{F_H} > p$. If $F^+(1-p) > 0$ then $\hat{\mu}_{F_L} < p$. Finally, if $F^-(1-p) < 1$ or $F^+(1-p) > 0$ then either $\hat{\pi}_L > \tilde{\pi}_M$ or $\hat{\pi}_H > \tilde{\pi}_M$ or both. If both conditions are satisfied (which is the case when F has full support), then the optimal belief is strictly different from the reference belief.*

Proof : Consider the first part of the lemma, so assume $1 - F^-(1-p) > 0$. Conditional on $\mu_{F,A} \geq p$ and F attracting all the employees with $\mu_{E,A} \geq \breve{\mu}$, its optimal profits are: $\hat{\pi}_H = \max_{\mu_{F,A}} \int_{\breve{\mu}}^{1} q(\hat{e})\gamma_F^2 \left(p\mu_{F,A} - \frac{\mu_{F,A}^2}{2}\right) f(u)du$ with $\breve{\mu} = \frac{1-p}{\mu_{F,A}+1-p}$. This profit function is (right-) continuously differentiable in $\mu_{F,A}$ on $[p, 1)$. Its right derivative in $\mu_{F,A}$ at $\mu_{F,A} = p$ is:

$$\left[\frac{d\hat{\pi}_H}{d\mu_{F,A}}\right]^+_{\mu_{F,A}=p} = \int_{1-p}^{1} q'(\hat{e})\gamma_F^2 \frac{p^2}{2} \frac{d\hat{e}}{d\mu_{F,A}} f(u)du - q(\hat{e})\gamma_F^2 \frac{p^2}{2} \frac{d\breve{\mu}}{d\mu_{F,A}} f(1-p)$$

The second term is non-negative since $\frac{d\breve{\mu}}{d\mu_{F,A}} \leq 0$. The first term is strictly positive since $F(1-p)^- < 1$ and $\frac{d\hat{e}}{d\mu_{F,A}} > 0$. This implies that the optimal $\hat{\mu}_F > p$. Note that this also implies that $\hat{\pi}_H > \tilde{\pi}_H$.

The argument for the second part is analogous and implies $\hat{\pi}_L > \tilde{\pi}_L$.

We now show that if $F^-(1-p) < 1$ or $F^+(1-p) > 0$ then either $\hat{\pi}_L > \tilde{\pi}_M$ or $\hat{\pi}_H > \tilde{\pi}_M$ or both. Just checking definitions of $\tilde{\pi}_L$, $\tilde{\pi}_H$, and $\tilde{\pi}_M$ shows that $\tilde{\pi}_L + \tilde{\pi}_H = 2\tilde{\pi}_M$. But, we always have that $\hat{\pi}_H \geq \tilde{\pi}_H$ and $\hat{\pi}_L \geq \tilde{\pi}_L$ with one of these strict when $F^-(1-p) < 1$ or $F^+(1-p) > 0$. This implies that under that condition $\hat{\pi}_L + \hat{\pi}_H > \tilde{\pi}_L + \tilde{\pi}_H = 2\tilde{\pi}_M$ which implies that $\max(\hat{\pi}_L, \hat{\pi}_H) > \tilde{\pi}_M$.

The very last part follows from the fact that when $F^-(1-p) < 1$ *and* $F^+(1-p) > 0$ then $\hat{\mu}_{F_H} > p$ and $\hat{\mu}_{F_L} < p$. ■

Proof of Proposition 5: For C2, this follows immediately from the lemmas that follow. For C1, it is immediate that the optimal belief must be $\mu \geq p$ since a firm with $\mu < p$ has no employees. Next, there exist some $\mu > p$ that gives the focal firm higher profits than $\mu = p$ (since with $\mu > p$ all the employees prefer the focal firm, while they randomize between the two when $\mu = p$). Finally, the right-derivative (in the manager's belief) of firm profit at $\mu = p$ is strictly positive, so that the optimal belief subject to $\mu \in (p, 1]$ is well-defined. ■

Lemma 4 *Vision is optimal (against a firm with reference beliefs) for any symmetric distribution of beliefs.*

Proof : Fix a symmetric distribution of beliefs F. Note that we always have that $F^-(1-p) < 1$, so that $\hat{\mu}_{F_H} > p$.

Consider first the case that $p = 1-p = 1/2$. By symmetry we have $\hat{\pi}_H = \hat{\pi}_L$ so that vision ($\hat{\mu}_F > p$) is (weakly) optimal.

As p increases, $\hat{\pi}_H$ strictly increases since $\frac{d\hat{\pi}_H}{dp} = \frac{\partial \hat{\pi}_H}{\partial p} = \int_{\breve{\mu}}^1 q(e)\gamma_{F_H}^2 \mu_{F_H,A} f(u)du > 0$, while $\hat{\pi}_L$ (weakly) decreases since $\frac{d\hat{\pi}_L}{dp} = \frac{\partial \hat{\pi}_L}{\partial p} = -\int_0^{\breve{\mu}} q(e)\gamma_{F_L}^2 \mu_{F_L,B} f(u)du \leq 0$. This implies that for all $p > 1/2$, $\hat{\pi}_H > \hat{\pi}_L$. ■

Lemma 5 *Let G and H be distribution functions on $[a, b]$, with H FOSD G. Let $k(\theta, x) = E_{u\sim\theta H+(1-\theta)G}[f_3(x, u) \mid f_1(x) \leq u \leq f_2(x)]$ with $\theta \in [0,\ 1]$, $a \leq f_1 \leq f_2 \leq b$ and f_3 u-measurable. Let finally $K(\theta) = \max_{x\in X} k(\theta, x)$ be well-defined for $\theta \in \{0,\ 1\}$.*

If $f_3(x, u)$ increases in u (for fixed x), then $K(1) \geq K(0)$.

Proof : Let $f_3(x, u)$ increase in u. Since H FOSD G, the basic theorem on FOSD says that for any fixed $x \in X$, $k(1, x) = E_{u\sim H}[f_3(x, u) \mid f_1(x) \leq u \leq f_2(x)] \geq E_{u\sim G}[f_3(x, u) \mid f_1(x) \leq u \leq f_2(x)] = k(0, x)$. Let $\hat{x}_H \in \text{argmax}_{x\in X} k(1, x)$ and $\hat{x}_G \in \text{argmax}_{x\in X} k(0, x)$ which exist by assumption. We then have: $K(1) = k(1, \hat{x}_H) \geq k(1, \hat{x}_G) \geq k(0, \hat{x}_G) = K(0)$ which proves the lemma. ■

Lemma 6 *If vision is optimal for some belief-distribution G, then it is optimal for any belief-distribution H that FOSD G.*

Proof : The fact that vision is optimal for some belief-distribution G implies that $\hat{\pi}_{H,G} \geq \hat{\pi}_{L,G}$ where $\hat{\pi}_{H,G} = \max_{\mu_{F_H}\geq p} \int_{\breve{\mu}_H}^1 q(\hat{e})\gamma_F^2 \left(p\mu_{F_H} - \frac{\mu_{F_H}^2}{2}\right) g(u)du$ with $\breve{\mu}_H = \frac{1-p}{\mu_{F_H}+1-p}$ and $\hat{\pi}_{L,G} = \max_{\mu_{F_L,B}\geq 1-p} \int_0^{\breve{\mu}_L} q(\hat{e})\gamma_F^2 \left((1-p)\mu_{F_L,B} - \frac{\mu_{F_L,B}^2}{2}\right) g(u)du$ with $\breve{\mu}_L = \frac{1-\mu_{F_L}}{p+1-\mu_{F_L}}$.

Define now $\tau_H(\mu_{F_H}, p, \breve{\mu}_H, u) = q(\hat{e})\gamma_F^2 \left(p\mu_{F_H} - \frac{\mu_{F_H}^2}{2}\right)$ if $u \geq \breve{\mu}_H$ and zero otherwise. Define analogously $\tau_L(\mu_{F_L}, p, \breve{\mu}_L, u) = q(\hat{e})\gamma_F^2 \left((1-p)\mu_{F_L,B} - \frac{\mu_{F_L,B}^2}{2}\right)$ if $u \leq \breve{\mu}_L$ and zero otherwise. Then we

can write $\hat{\pi}_{H,G} = \max_{\mu_{F_H}} \int_0^1 \tau_H(\mu_{F_H}, p, \breve{\mu}_H, u)g(u)du$ and $\hat{\pi}_{L,G} = \max_{\mu_{F_L}} \int_0^1 \tau_L(\mu_{F_L}, p, \breve{\mu}_L, u)g(u)du$. By lemma 5 it suffices to show that τ_H increases and τ_L decreases in u, to conclude that $\hat{\pi}_{H,H} \geq \hat{\pi}_{H,G} \geq \hat{\pi}_{L,G} \geq \hat{\pi}_{L,H}$ which would imply the proposition. The rest of this proof shows that that is indeed the case.

Note, first, that the optimal μ_{F_H} and $\mu_{F_{L,B}}$ must be such that both $\left(p\mu_{F_H} - \frac{\mu_{F_H}^2}{2}\right) > 0$ and $\left((1-p)\mu_{F_{L,B}} - \frac{\mu_{F_{L,B}}^2}{2}\right) > 0$ since otherwise profits are non-positive while, in each case, it is always possible to set $\mu_F = p$, which gives strictly positive profits. But then the inequalities follow immediately: For τ_H (using the fact that $\breve{\mu}_H$ is no function of u): the derivative is zero for $u < \breve{\mu}_H$, the function makes a jump upwards at $\breve{\mu}_H$, and the derivative for $u > \breve{\mu}_H$ is $q'(\hat{e})\gamma_F^2\left(p\mu_{F_H} - \frac{\mu_{F_H}^2}{2}\right)\frac{d\hat{e}}{du}$ which is positive (since $\frac{d\hat{e}}{du}$ is positive for employees who undertake A). An analogous argument for τ_L shows that it is decreasing. ■

C.4.1 The spurious (ex-post) optimality of vision

Proof of Proposition 6:

The probability that the manager of a randomly selected firm has belief $\mu \geq x$ for some x such that $1 > x > p$, is $1 - F(x) > 0$. That fact combined with the fact that $1 > p > 0$ implies that both the event that 'there exists some firm with belief $\mu \geq x$ which turns out to be correct about the true state of the world' and the event that 'there exists some firm with belief $\mu \geq x$ which turns out to be wrong about the true state of the world' are almost surely true in the limit as $N \to \infty$.

The difference in profit between a visionary firm with belief $\mu \geq x > p$ and an 'objective' firm with belief p that turn out to be correct equals $\sum_{k=1}^{K} I_{\{\gamma_M p < I_k \leq \gamma_M \mu\}}(\gamma_M - I_k)$ which is almost surely strictly positive for $K \to \infty$. Analogous arguments show that there are strict differences in profitability between an objective firm that is right and one that is wrong and between an objective firm that is wrong and a (strictly) visionary firm that is wrong. Combined with the earlier conclusion, this proves the first part of the proposition.

For the last part of the proposition, consider a firm that has the m'th rank in terms of strength of belief. The probability that the firm turns out to be the weakly best performing firm equals the probability that this focal firm is correct while the $m-1$ firms with stronger beliefs turn out to be wrong, and is thus $(1-p)^{m-1}p$. The probability that it turns out to be the worst performing is analogously $p^{m-1}(1-p)$. Both decrease in m, so that they increase as the firm is ranked higher in terms of belief strength. ■

Proof of Corollary 4: This follows from the proof of proposition 6. ■

Proof of Proposition 7: Note that, given that we assumed $p > 1/2$, it is sufficient to prove that that difference increases as p decreases to $\frac{1}{2}$.

Consider first a visionary $\mu_v = 1$ firm that turns out to be right. The objective firm that is closest in terms of profit is just one that is right. The difference in profitability is $\sum_{k=1}^{K} I_{\{\gamma_M p < I_k \leq \gamma_M\}}(\gamma_M - I_k)$ which increases as p decreases since each $\gamma_M - I_k$ term is positive and the number of terms increases as p decreases. The proof for a maximally visionary firm that turns out to be wrong is analogous. ■

C.5 Comparative statics

Proof of Proposition 8: For the first part, note that with $\hat{\mu}_{M} = \text{argmax}_{\mu_{M,A} \geq p}(E[\pi])$, we have $p \leq \hat{\mu}_{M} \leq 1$. Clearly, as $p \uparrow 1$, $\hat{\mu}_{M} \uparrow 1$. This combined with the continuity of the expected profit $E[\hat{\pi}_{O}]$, implies the proposition.

For the second part of the proposition, note that vision is optimal so that $p < \hat{\mu}_{M} \leq 1$. Clearly, as $p \uparrow 1$, $\hat{\mu}_{M} \to 1$. But this, combined with continuity of the profit function $E[\hat{\pi}_{O}]$, implies the proposition. ■

Proof of Proposition 9: Consider first the case under C1 or C2 and sorting. By the earlier proposition, vision is optimal. So the profit must be: $E[\hat{\pi}_{O}] = \int_{\breve{\mu}}^{1} q(\hat{e})\gamma_{M}^{2}\mu_{M,A}\left(p - \frac{\mu_{M,A}}{2}\right) f(u)du$ so that the cross partial

$$\frac{\partial^2 E[\hat{\pi}_{O}]}{\partial \mu_{M,A} \partial \eta} = \int_{\breve{\mu}}^{1} \frac{\partial^2 q(e)}{\partial e \partial \eta} \gamma_{M}^{2} \mu_{M,A} \left(p - \frac{\mu_{M,A}}{2}\right) \frac{d\hat{e}}{d\mu_{M,A}} f(u)du$$

is positive. The proof for the case under A4 without sorting is analogous. ■

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