Corporate culture and shared knowledge\textsuperscript{1}

Jacques Crémé\textsuperscript{2}

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\textsuperscript{2}GREMAQ and IDEI, Université des Sciences Sociales de Toulouse, 31042 Toulouse CEDEX. I have benefited from the comments of Daesik Lee, Dan Orr, Jean Tirole, a referee, and participants at seminars at Boston University, Rutgers University, University of Texas at Austin and Yale University. Support from N.S.F. grants SES 8408942 and SES 8722014 is gratefully acknowledged.
1 Introduction

In the last ten to fifteen years, management theorists and sociologists have intensively studied the “cultures” of organizations, and in particular business enterprises. In this paper, I define this concept in economic terms, analyze it with economic tools and study some of its economic consequences.

The concept of corporate culture is attractive because it may provide some language for speaking about the “personalities” of organizations. For economists, the world often seems to spring anew every morning. The weight of the past is disregarded in most of our analyses, and certainly in nearly all our theories (see David (1985), for an interesting discussion of this point). On the other hand, actual organizations seem to have personalities, which are rather stable over time and independent of their actual members. The cultures of I.B.M., G.M. or pre break-up A.T.T. have been widely discussed, and are real phenomena without an economic theory. It is this theory that I try to build.

In this paper I focus on “cognitive” aspects of corporate culture, and ask the following question: why is corporate culture a factor of efficiency in the internal treatment of information within organizations? I do this within a “team-theory” framework, in a pre-Groves (1973) sense: I assume away any questions of incentives. For the purposes of this paper, human beings are perfectly honest and trustworthy, but have limited capacity for processing, receiving and transmitting information. Incentives questions are certainly important, however, I do believe that the nearly exclusive focus of the recent literature on incentive problems, and the nearly complete neglect of bounded rationality questions is unwarranted (see, however, Prescott and Visscher (1980), Crémer (1981), and Geneakoplos and Milgrom (1985), Sah and Stiglitz (1986), Radner (1990), Bolton and Dewatripont (1992)).

In this context, I define culture as the stock of knowledge shared by the members of the organization, but not to the general population from which they are drawn. The acquisition of this knowledge is an investment, and the paper will study the benefit from this investment. The next section presents an informal discussion of the concept of culture and some examples to guide the formal discussion which is presented in section 2. Section 3 presents a formal model that illuminates some aspects of the analysis. Section 4 discusses the stability of corporate culture, and tries to apply the analysis of section 2 to the “limits on the size of firms” problem.

The number of citations do not reflect the extent of my debt to the very nice article of Prescott and Visscher (1980), which gives a very inviting dy-
namic image of firms. Its focus on the importance of time in organizational problems has greatly influenced me. Kreps (1984) has also written on corporate culture. His focus is different as he is interested in the relationship of the firm to its environment. I have used his clever discussion of culture in terms of focal points in developing what follows, although my rephrasing obscures this. Finally, Arrow (1974) has presented a view of the stability of “coding” which is similar to my view of the stability of culture.

2 Efficiency aspects of organizational culture

2.1 Some hints from the literature

For Marris (1964, page 16):

“The organization has special knowledge and ability in managing the assets and the assets have been built up to match the special talents of the organization. This is what is meant by a ‘going concern’. Hence, the value of the team is very much greater than the sum of the salaries the members could earn if disbanded”.

These special talents form “corporate culture”. A well known survey of its development in the sociological literature is provided by Smircick (1983). She points out that there are many possible definitions, depending on the concept of culture used by the writer. Let me quote the definition given by Schein (1984):

“Organizational culture is the pattern of basic assumptions that a given group has invented, discovered or developed in learning to cope with its problems of external adaptation and internal integration, and that have worked well enough to be considered valid, and, therefore, to be taught to new members as the correct way to perceive, think, and feel in relation to these problems.”

Schein’s analyses are couched in terms of the psychological needs which culture fulfills. For instance, it reduces anxiety by providing the members of the organization with a guide to the decisions they must make. He insists on the transmission of the culture (this is the “taught to new members” part of the definition): because it has a stabilizing function new members must adopt it and because individuals believe it is valid, they will want to transmit it. The firm has a continuity which transcends the fate of its individual employees.
This need for a shared pattern of basic assumptions is prevalent in the
literature written for managers. For instance, Peters and Waterman (1982)
stress the importance of a pervasive climate oriented towards “excellence”.
The discussion in Senge (1990) of planning in business organizations stress
the need to build shared insights and ways of seeing the environment among
the senior managers of firms. His discussion of the changes in planning
procedures at Royal Dutch/Shell are very explicit in this regard: their aim
is not to identify policies to be followed, but rather to develop common
ground for discussion of decisions to be taken.

These issues have also been discussed in the economic literature. For
instance, Arrow (1974) tells the following story:

Burton Klein has provided one illustration in an unpublished
manuscript: the primary function of the military is the coordina-
tion of large masses of men and material in circumstances where
coordination is according to a previously planned timetable. Re-
search and development on military weapons is, in the present
era, an important auxiliary service. But, Klein has argued, it
tends to be run by men who think in military terms and there-
fore expect coordination or achievements at predictable time
points in the future. In fact, of course, research and develop-
ment are prime examples of information-gathering with a con-
siderable degree of uncertainty, and achievements are certainly
not predictable. As a result the precisely laid-out timetables
are dramatically unfulfilled, as Summers has shown. The costs
in the end are much higher than they would have been if the
uncertainty had been taken into account initially. Klein’s re-
commended solution, indeed, is to remove military research and
development from military control and put it in the hands of a
separate civilian agency.

Arrow uses this example to show that the “code” that is adapted to the
primary functions of an organization may not be adapted to its secondary
functions. Notice however that it has little to do with coding, but much
with the way of thinking within the organization. It is the theory of this
way of thinking that I begin exploring in the next section. Hopefully, this
everse will also provide some insights of the use of economic concepts to
explore cultural phenomena in other contexts.
2.2 A definition of organizational culture

I define culture as the part of the stock of knowledge that is shared by a substantial portion of the employees of the firm, but not to the general population from which they are drawn. Some of this knowledge will be concerned with the environment of the organization, much with its internal functioning and this paper studies mostly this internal element.

In this definition, culture is slightly different from specific human capital. The specific human capital of an individual is the part of his knowledge that has use only within the firm. Corporate culture is the portion of specific human capital that is shared by many employees of the firm. For instance, a janitor’s knowledge of the place where cleaning material is stored is part of his specific human capital, but not of corporate culture. On the other hand the rule “janitors must know the storage place of cleaning material” could be part of corporate culture. This definition is very one sided: Culture is seen as knowledge, not at all as values. This is partly due to the use of economic discourse, as standard economic methodology precludes us from assuming that the utility functions of the individuals are dependent on their environment. It is also partly due to the focus of this paper on cognitive aspects. One could approach the description of “values” by an analysis of the strategies used by individuals. This analysis will have to wait for the integration of incentives in the discussion.

In most cases, the stock of knowledge of an individual is function of the multiple groups to which he belongs. For instance, an engineer in a firm will be at the intersection of an engineering culture and a corporate culture. Furthermore, different subgroups in the firm can have different cultures. Indeed, according to some authors, many conglomerates run into difficulties linked to the heterogeneity of cultures within the organization (see section 4). I will for the most part neglect these considerations.

The culture of an organization enables it to respond better to the information it receives. To back up this statement, I first discuss the precise meaning of a “better response”. I then discuss the channels of communications and decisions which are the instruments used to provide this response. The choices between these instruments are dictated in great part by the bounded rationality of employees, which is analyzed in 2.5. I turn to corporate culture proper in 2.6 and present a classification of its different aspects. This enables me to discuss its efficiency properties in 2.7.
Note: In all that follows, I speak about the “firm”. The theory would be the same for any organization, whether public or private, although a more complete theory should discuss the effects of the mode of control on the behavior of the organization.

2.3 The firm’s response to outside messages

The description of the firm as an information processing apparatus is now commonplace among economists. It receives messages from its environment, processes them and responds by a message, or/and puts some of its physical resources into play. By analogy with standard definitions of technical efficiency, this response is cost-efficient when a set of decisions of a given quality is taken at the lowest possible cost. I will distinguish two main aspects of the quality of a response: its appropriateness and its speed.

A good response is *appropriate*, that is close to the response that would have been forthcoming in the absence of bounded rationality. In other terms, appropriateness measures how well the response serves the interests of the firm. As with all second best concepts, it can only be defined with respect to a specific environment. Response A to a given message can be more appropriate than some other response B for a given set of responses to other messages, whereas B would be more appropriate than A for another set. This will most obviously be the case when consistency of responses is important. For instance, a firm whose marketing strategy requires stable prices will react differently to an increase of the price of an input than a firm whose strategy allows it to disregard the stability of its clientele.

An important aspect of appropriateness is *specificity*, which is the way responses are modified according to the incoming message. The archetypical bureaucratic response “it is so because this is the rule” is a good example of a non specific response. More formally, a firm will build a partition of the set of incoming messages, and will respond in a similar manner to two messages in the same element of this partition. Responses are more specific when the partition is finer. Many losses are due to the failure to provide specific enough responses. For instance, not recognizing specific characteristics of would be borrowers may lead either to bad loans or to the neglect of potentially profitable clients.

Appropriateness also requires responses from different parts of the organization to be coordinated. An outside message is often processed in parallel through different channels and the response is composed of several decisions. Their coherence determines in large part the appropriateness of the response.
of the organization as a whole.

Speed, the other component of quality, is not necessary to every response. But it is an indispensable component in some cases, and important in many others. Hence, it is the possibility to respond fast which is important. Furthermore, there must be some mechanism by which the firm can judge whether speed is of the essence.

Often, speed and appropriateness must be traded against each other. An officer or a soldier on a battlefield, for instance, must recognize cases where fast action is warranted from cases where referral to higher authority is necessary to ensure coordination with other units. Similarly, while negotiating an executive must recognize demands to which he can answer rapidly of his own initiative from those which require discussions with other parties in the firm.

Speed and appropriateness do not describe completely the response of an organization to messages, and my neglect of other aspects needs to be mentioned. First, I take incoming messages as a datum, whereas the decision to search for new information is of course important. Second, I mostly neglect the interplay between strategic positioning and the types of messages that reach the organization. I will study the messages to which a firm can efficiently respond, and discuss briefly how this affects its strategy. However, I will not discuss in any detail the feedback effect, but it may be important given the number of firms who claim that they will change their culture to fit some new strategy.

2.4 Channels of communication within the firm

Simon (1973) has pointed out that the decisions that have deadlines attached to them determine the optimal organization, and I focus on short run decisions. I consider relatively rapid responses to messages from the environment, and more precisely decisions that do not affect the decision making process itself. The request by a client for some modification to a machine tool fits in this discussion. Decisions of the type “should we change from a functional to a multidivisional structure?”, “should we diversify in a new industry?” are outside the scope of this paper. The internal treatment of a message is conducted by the proper arrangement of elementary operations: decisions, unilateral communications, and discussions. In response to a telephone call from a client, the receptionist tells his superior (unilateral communications) the nature of the problem. The superior discusses with the staff the work schedule, decides to send a repairman the next day, and
gives orders (unilateral communications) to inform the client and to prepare the material. I now turn to a discussion of these techniques.

In my model, individuals take decisions, and commit the firm to some action. The response of the organization to a message can be the result of one individual decision. A sales representative screens out some of the requests of clients. Alternately, the response can be the result of several serial decisions. Often, the superior places bounds on possible responses (first decision) and the subordinate uses his judgment within these bounds (second decision). Finally, a response can be the result of concurrent decisions, for instance when members of a committee must all sign a document that commits the firm (see Sah and Stiglitz (1986)). Of course, these different modes of decision making can be mixed. For instance, each of a series of sequential decisions can be either an individual decision or a set of concurrent decisions.

A unilateral communication transfers information from an employee to another, who may use it to take a decision, and/or retransmit it to other agents, either in its original or modified. Some unilateral communications are sent as the result of decisions (should I speak to Judy about this problem?) or automatically (by following a rule of transmittal of all information in a certain category). For my purposes, the transmission of orders and information will not be distinguished.

I will call discussions any sequential exchange of information between agents. Discussions fall in two types. Some lead to decisions by only one of the participants. Their main purpose can be to transmit information to the agent who will take the decision. In this case discussions help focus the information that is transmitted better than unilateral communications. Their aim can also be to make use of the power of reasoning of the agent who is not ultimately responsible. High level executives and their closest collaborators often engage dialog in this manner. The literature on planning procedures (Lange (1938), Malinvaud (1967), and many others) attempts to model some aspects of discussions which lead to unilateral decisions. Discussions of the second type lead to linked decisions by the participants. They can have the aim outlined above, but they may also serve to coordinate the different decisions, and to make sure that the response of the organization as a whole is appropriate.

Employees' time forms the main component of the cost of processing information. As a first approximation, one can neglect the cost of machines, telephone calls and all physical support of the communication. For a given quantity and quality of responses to outside messages, an efficient
organization will minimize this processing cost. The number of internal communications will be minimized; the ratio of their cost to the quantity of information transmitted, will be minimized; the time which employees spend processing information, received from internal or external sources, will be minimized. My aim is to explore the link between these objectives and the presence of a strong corporate culture. Generally, discussions are more expensive than unilateral communications. They require more time, because formulating questions and converging to a common understanding takes time. They should be used when the benefits from more precise understanding outweigh the additional cost.

The concepts discussed above take life when they are integrated in a communication/decision system. The description of this system distinguishes this paper from the rest of the literature. Typically, economists consider the firm as a network of rigid communications channels. This is clear, for instance, of principal-agent models where a “superior” deals with a “subs-ordinate”. In other formal models, each agent deals with a superior and a fixed group of subordinates. The communications channels are clearly defined, all hierarchical, and each employee communicates directly with only a few, well specified, other employees (see, for instance, Crémer and Riordan (1987)). The same assumption is made, implicitly or explicitly, in much of at least the economic non-formal literature.

For certain analytical purposes, this assumption of restricted channels of communications causes little harm. However, it may lead us to forget that actual organizations make extensive use of non-hierarchical, or lateral, channels. By this, I mean not only communications between two agents who share the same superior, but also communications between agents who are distant cousins in the family tree defined by the organization chart of the firm. Rough evidence can be gathered by discussions with executives of any well managed firm. Furthermore, the logic of the situation shows that this must be the case for some services in many firms. For instance, the purchasing division must have many contacts across the firm and, obviously, these contacts cannot all be conducted through hierarchical channels, up to the chief executive officer, and down. Burns (1954, quoted by Gutzkow (1965)) presented some evidence that “lateral communications are essential to the proper functioning of the vertical system”. After a study of four departmental executives in a British factory, he concluded that “the vertical system would be virtually unworkable without the considerable flow of information laterally”. There is also experimental evidence that “more centralized structures are generally characterized by “vulnerability” which leads to negative
performance results as long as centralized decision structures have not developed" (Mulder (1960) again quoted by Gutzkow (1965)). Furthermore, there exist many examples of firms which encourage lateral communications. Open office plans and the use of task forces come readily to mind.

The greater the flexibility of internal communications, the better the potential quality of responses to non repetitive outside messages. First, decisions can be reached faster when middle level executives in different areas of the firm can communicate directly rather than through the chain of command. By the same token, the cost of reaching decisions of equal quality will decrease because the manpower involved in message transmission declines. Finally, because gathering information is less expensive, employees will be more ready to gather relevant internal information before taking decisions, and they should therefore take more appropriate, and especially more specific, decisions.

Without going through a detailed analysis, one can expect lateral communications to be more important when:

- The types of messages to which the firm must answer are more varied and uncertain. In these cases, the limits of the hierarchical channels will be met fast, and a greater flexibility is in order.

- Speed become more crucial.

- Employees are more specialized. The number of employees involved in the response to any simple message becomes larger.

- Internal messages that must be transmitted between employees not in a hierarchical line become more complex.

The first two conditions refer to properties of the environment, the last two to the way in which the firm is managed. Ford’s famous “they can have it any color they want if they want it black” pushes inflexibility to its extreme. The responses to outside messages meet none of the two first criteria listed above, and a very hierarchical mode of communication seems appropriate. At the other extreme, firms who develop new products to meet demands of their clients (3M is often given as an example) will have to rely heavily on non hierarchical communications. The universality of the theory that developed here is not guaranteed, but as routine production tasks become more and more machine intensive its relevance may increase.

I stress the importance of non hierarchical communications because they have been neglected in the economic literature. Although they are impor-
tant, they must still be managed within a framework where hierarchical communications have precedence. Chandler’s discussion of Du Pont after World War I provides a clear example of circumstances where lateral communications cannot compensate the shortcomings of the formal organization (Chandler (1962) pages 52–113, Crémer (1981)). Organized in a departmental structure, Du Pont was unable to manage the introduction of new products which required intense communications between employees in different departments. In this case, it was necessary to reorganize the formal system.

With flexible patterns of communications, employees must be able to communicate efficiently with a vast array of interlocutors. Changes of assignment and promotions will require the same ability. When an employee changes jobs, he must be able to quickly reestablish methods of communicating with his new superior, subordinates, and coworkers. Even when he stays in the same position, the identity of his direct co-workers change regularly. Armies, with relatively short tours of duty, are notoriously in this case. This influences their culture. Both the existence of lateral communications, and the presence of turnover require employees to be able to communicate and work effectively with a large variety of their colleagues.

2.5 Bounded rationality

Humans are not perfect processors, acquirers, or transmitters of information. At a given level of knowledge, the human brain cannot compute the best solution to all problems, even when objectives are perfectly well defined. Furthermore, humans are limited by the amount of knowledge they can acquire. Relevant, accessible information will not be used. For instance, an executive will decide to launch a new product with imperfect knowledge of the engineering aspects. The information is available from many sources: books, journals, consultants, subordinates, but it is too costly to assimilate. All this is by now well understood, although consequences have certainly not been explored in sufficient detail. For my purposes, the role of time in the discussion of bounded rationality needs to be stressed. It is important, as many academics who “did not have the time to write this paper” (rather than being “unable to do it”) will testify.

The cost of a communication is determined by the time spent by the parties which are transmitting and receiving it. Furthermore, the storing of information which reaches the eye or the ear also takes time. On the other hand, the brain can hold a large amount of information. This is the reason why students who, in the first term of graduate studies, have
difficulty mastering the definition of a vector and the notion of equilibrium read the *Theory of Value* during their second year. For the purposes of this paper, I assume that the quantity of information which can be accumulated is unbounded, and that there is perfect retention.¹

The quality of the decision taken by an individual will depend, among many factors, on the stock of information he has stored. This stock of information is the total knowledge of the decision maker. My model of the process is sequential. From a state of previous knowledge, individuals accumulate information to reach a state of final knowledge which, after processing, leads to a decision. This should not change the conclusions, and greatly simplifies the exposition.

Because the stock of previous knowledge is combined with new information to reach a decision, there are economies of scope in decision making. At the most obvious level, a foreman uses the same knowledge for his decisions on Mondays and Tuesdays. More sophisticated examples easily come to mind.

Time also forms the basic cost of processing information. Chess provides an interesting example. The time allowed for moves plays an important role in the game. During this processing, information is stored. In a game of chess, while planning my next move, I analyze the positions, and think about possible new combinations. This generates information which is added to my stock of knowledge. Some of it will be useful in the next move. The important point here is that reflection generates new knowledge. In many circumstances, this information is then transmitted to other parties, for instance when preliminary work or a decision is decentralized to someone else.

Of course the stock of knowledge is the main component of human capital (strong muscles also enter athletes' human capital). My discussion emphasizes the acquisition of this capital and its link to bounded rationality. Without bounded rationality, there would be no need for human capital, as an individual could relearn very fast all he needs whenever it is useful.

¹Such assumptions cannot be defended *a priori*. To test them, one would need to rebuild the theory without them, and check whether the results are substantially closer to reality. Note that because these assumptions are certainly "not true" in the real world, lifting them would improve the model; the problem is to know whether this improvement is substantial. I have done this informally, and believe that this is not the case. A complete discussion would take us very far afield in an already very long paper.
2.6 An analysis of corporate culture

I will analyze corporate culture by decomposing it in three elements:

- a common language or coding;
- a shared knowledge of certain facts;
- a knowledge of certain established rules of behavior which I will also call “rules of action”, or again “simple rules”.

One of the most interesting conclusions will be that the knowledge of, and adhesion to, rules plays the same role as the knowledge of facts.

Coding has been extensively discussed by economists (see, for instance, Arrow (1974), pages 55–59, Williamson (1975), page 25, Gutzkow (1965), page 551). The argument goes as follows. A natural language, such as English, French or Occitan, is a general code. It must be flexible to adapt to many different uses. If some type of information is to be transmitted repeatedly, then it is efficient to generate a specialized code to transmit ideas or facts that recur repeatedly. For instance, sailors find it convenient to speak of a “sheet” rather than a “rope that is used to flatten the sail”. Similarly, in organizations, buildings, jobs, and types of clients will be designated by their own code word. Very often this word will not be new, but rather an existing word used to refer to a very specific object or phenomenon. In many organizations, actions can also serve as coding mechanisms. Well known examples include the allocation of offices or telephone lines. The story has it that I.B.M. signals “punishments” to some of its managers by allocating them to jobs which in the organization are understood to show disfavor.²

In an organization, a certain number of facts are known by most members of the organization. In many firms, this is fostered by newsletters, and other forms of systematic diffusion of information. For instance, Sumimoto, a Japanese firm took control on July 1, 1984 of the Montluçon, France, factory of Dunlop. Le Monde of January 21, 1986 reports:

“Every employee went through a training period. They learned about the firm, its objectives and more concretely how the product is conceived and sold (everyone spent at least eight days in a sales agency).”

²See also the discussion of the speed of job turnover as a signal in Schein (1986).
Not only is there this general background, but more directly functional aspects are known throughout the firm, among them the location of factories, telephone codes, and some summary of the responsibilities of different executives. The presence of a common set of known facts will, like coding, increase the effectiveness of communications. But it will do so by allowing certain things to be left unsaid rather than by allowing them to be said faster.

The third element of corporate culture is the knowledge of rules of behavior, which, or course, employees must also accept to follow. I do not study how they are maintained, but the role that they play in the efficiency of decision making. These rules can be divided in three categories:

- there are rules of social behavior, rites of politeness, choice of clothing which play a crucial role in some institutions. For instance, soldiers are generally expected to adhere strictly to military etiquette;³

- some rules of internal behavior are generally respected throughout the firm. I have in mind knowledge of the patterns of communication that are allowed (obtain from your superior the permission to speak to his boss, phone quickly another employee if you come across information that he might find useful) or knowledge of rules for intercourse between employees of the firm (if the chief of another division ask you for work, provide it if it takes less than a day; otherwise refer to your hierarchical superior);

- some rules of actions for the firm as a whole in its dealings with other agents are usually accepted (we only provide high quality products, there is priority to meeting customers’ demands for new products, or to smooth functioning of internal operations—Peters and Waterman (1982) discuss these types of rules at length).

A priori these rules may seem to be either vacuous self serving statements, or irrational bounds on the actions of employees. I will show that they can be conducive to greater efficiency if they are at the same time simple and of broad enough applicability. They must serve as guides to decision making under uncertainty. For instance, a rule of the type “Take action which maximizes shareholders’ returns” will not help a salesman presented with a complex problem by a potential client.

³One could be tempted to argue that this has no efficiency objective, but is only a tradition perpetuated without much justification. But then an interesting problem is raised: how did this tradition persist in so many countries and over such long periods?
The imperatives of academic writing have forced me to decompose the elements of knowledge, and to present them as if they could be neatly exposed in a handbook. If part of knowledge is indeed transmitted under this form, much is transmitted in other forms. Some authors have studied the transmission of culture through stories, which either speak of the general history of the firm or tell some anecdote. The information is transmitted both through the stories and through the interpretations which are attached. They serve to emphasize rules and to give examples of the relative weight that they should have when they come in conflict.

For purposes of comparison, it is convenient to have a concept of the "strength" of a culture. Then, one can make statements of the type "as the culture becomes stronger,...". The definition that comes naturally to mind is that the culture is stronger the greater the stock of knowledge shared by the employees. Of course, some strengths might not be comparable as the relative stocks of knowledge are greater in some dimensions and smaller in others, but this is only a minor problem. A more fundamental difficulty arises when a firm has much of its behavior rigidly determined by a few rules. The very bureaucratic agencies studied by Crozier (1963) provide good examples. Their organizations are very rigid, and all employees obey rules which control all work. Because this work is very simple, there are few rules. I shall neglect these types of institutions and stick to the definition of stronger culture outlined above, which should be modified to study incentives. A culture can be strong because there is much shared knowledge within the organization. It can also be strong because recruitment is focused on special subgroups of the population. There is some informal evidence that firms for which a strong culture is important pay attention both to training and to recruitment (Pascale (1984)).

If my analysis is correct, firms will be different and history will matter. This was already pointed out by Arrow (1974, pages 56–77) in his discussion of coding. History will matter, because investments in culture are irreversible. It would be inefficient to try to adjust it to every change in the environment, and therefore different firms of the same industry are managed differently. In this case, of course, feedback effects would imply that their strategies would also be different. In the next subsection, I will argue that the existence of a corporate culture can be source of efficiency. Hence, these differences among firms cannot be shrugged off as minor incidents due to the weight of history, or as reflecting managerial preferences which can be satisfied only because of lack of competition.
A useful comparison is to see corporate culture as the bounded rationality of the corporation. Individuals, faced with time constraints, use simplified rules for decision making. Often, these rules prescribe not to explore some branches in a decision tree. In other cases, they replace the search for an optimal decision by a “satisfying” decision. The same phenomenon obtains for organizations. They choose not to explore some branches of their decision trees: for instance, they do not systematically investigate every single industry to examine for possible diversification and they also use some administrative rules, which are not perfectly optimal, but which save on decision costs.

2.7 Corporate culture and efficiency

In this subsection, I answer the following question: *Given the presence of bounded rationality (2.5), how does the presence of a corporate culture (2.6) improve the efficiency of internal communications and of decisions, which are the tools used by the firm to respond to messages from its environment (2.4)?* My main task will be to explain the way in which corporate culture affects the efficiency of the techniques discussed in 2.4. For a given pattern of communications and decision making, it will reduce the cost of making a given decision. Furthermore, it will allow substitution of more efficient for less efficient techniques, and enable the firm to reach better decisions.

The discussion will be clearer if it is focussed on the following type of decisions. There is a well defined, rather small, finite set of alternatives to choose from. Mixing these alternatives is costly. The simplest case would be a “yes or no” decision in response to a request of a client, where “maybe” is not feasible. But it could also be a choice of a type of machinery among the limited number on the market. The coordination problem within the firm arises because of one of the following two phenomena. First, the decision is separable into components. For instance, at the same time that a salesman is discussing with a client, a purchasing manager is choosing inputs which will make it more or less difficult to adapt production to the wishes of that client. Or, different salesmen are negotiating with different clients when economies of scope exist in production. Second, the choice of an alternative can impose costs which are directly borne by other divisions or departments in the firm, and of which he has imperfect knowledge. For instance, a design engineer chooses a production method which will influence maintenance costs. A strong corporate culture is a technique which enables the firm to choose
efficiently among alternatives.\footnote{I focus on finite sets of alternatives for two reasons. First, it makes life much simpler. Carrying in parallel the analysis of different types of decisions creates difficulties both for analysis and exposition. Second, an analysis parallel to the one I am about to follow shows that when coordination is essential for choices involving continuous variable, there will be benefits to choosing a priori a finite set of values that are admissible. For instance, if the choice variable must be in the interval $[0,1]$, one would limit choices to be 0, .5, or 1. This is the rule played by the notion of focal points in the coordination of decisions (see Schelling (1960) and Kreps (1984) for an application to corporate culture).}

### 2.7.1 Corporate culture and efficiency of decisions

Corporate culture improves the efficiency of decisions. Consider an employee who must take a decision and has already collected all the information he will choose to use. In some cases, this decision is the whole response of the firm to the outside message, which simplifies the analysis. It is important to remember that although the decision is made by one individual, usually, and this is the interesting case, this individual commits the organization as a whole. Hence, the problem of coordination still exists. In other cases, the decision will bear on only one component of the response and other components are decided by other employees. Then, the coordination problem is obvious.

First, knowledge of facts about the organization enables agents to take more appropriate decisions. This is clear of shared knowledge. It enables agents to compute more accurately the benefits and costs of different alternatives, because they can predict better the reactions of the rest of the organization, and also better evaluate its capacities. In particular, it allows them more specific reactions to outside messages as they have a more subtle understanding of the range of actions that can be taken.

Simple rules play here the same role than knowledge of facts. They enable the agent to predict the actions of others. This is crucial, of course, when the decision is but a component of the total response. For instance, the famous “Ma Bell” culture stressed the fact that service was paramount. In case of breakdown an employee could commit his own effort to reestablish a portion of the line, in full knowledge that work on the rest of the connections was not interrupted because overtime was too costly or the weekend was approaching. It is clear that some incentives considerations were present, but note that there is also an important cognitive aspect. Without some understanding of what the rest of the firm is up to, resources would be wasted, even in the absence of any moral hazard or adverse selection. The
trade off is clear. Rules prevent agents from taking some specific actions which may be more appropriate in some cases. But, they make the actions of the different employees of the firm more predictable, which has a positive value. The best rules will be those that provide the best coordination at lowest cost in foregone opportunities. An extreme case of the role of simple rules to ease decentralized decisions can be found in the military. Military culture stresses obedience. During combat, officers have to make many rapid decisions. For coordination purposes, they need to know precisely what their subordinates are doing. Hence, it is better that the latter obey orders even when they have information that shows them to be sub-optimal. In this example, simple rules help predict the behavior of the other agents.

Increasing the speed of decision making has two advantages. First, it increases the speed of the response to outside messages. Second, it decreases its cost as the decision maker spends less time processing information. Corporate culture helps speed decisions. As I have shown in the preceding paragraphs, it provides for easy access to information through the shared knowledge of facts and the existence of simple rules. In particular, because these simple rules restrict the actions of other members of the firm, they ease predictions of the effects of a decision on the rest of the organization. Rules also ease computations because they cut off some branches of the decision tree. For instance, if the culture emphasizes the smooth running of the production process, a salesman will not need to explore the branches of his decision tree that involve modifying a product extensively in order to please a client. Some discussions of bounded rationality emphasize that it allows an agent to shortcut some computations in this way. Corporate culture coordinates the bounded rationality of the members of the organization.

### 2.7.2 Corporate culture and the efficiency of unilateral communications

A strong corporate culture improves the efficiency of non hierarchical unilateral communications (see 2.4). What test should be used to determine if communications are more effective? The aim is to bring recipients to certain levels of knowledge on which they can base decisions or which they can synthesize and retransmit. Hence, to show that corporate culture increases the efficiency of the communications, I will show that it allows the recipient to reach the same level of final knowledge, with less time spent on communications.

First, coding improves the efficiency of communications. Williamson

"Communication systems become effective when they employ a language which carry large amounts of meaning with relatively fewer symbols. Organizations find such things as blueprints, product number systems, and occupational jargons helpful in increasing the efficiency of their communications."

Arrow (1974) makes very much the same point. As noticed earlier, some non verbal means of communications play the same role. Furthermore, the form of communications can also help. For instance, I suspect that long term Procter and Gamble employees become very adept at understanding one page memos and at deciphering their meanings. The rather standardized form of academic writing plays the same role. If information is transmitted only along very rigid lines, a common coding for the whole organization would have limited value. It gains in importance when there are many potential recipients to the messages sent by any employee.

My definition makes part of the discussion of the way in which shared knowledge of facts improves the efficiency of communications almost tautological. If many facts are known by every potential recipient, to bring them to a given level of final knowledge requires less communication. One can go further: agents should not only know facts but they should also know what others know. The "shared knowledge" aspect is important, so that only relevant information is transmitted. On the other hand, if the recipient has some relevant knowledge that the sender does not know that he knows, it will still be included in the message, and this will be a waste of resource, although this knowledge by the recipient still has some positive value as he will spend less time assimilating it (he will, for instance, read fast the pages that discuss topics that he already knows).

Shared knowledge of facts has two other, perhaps less obvious, advantages. First, the sender has better knowledge of what the receiver needs to know. Because there is a cost to transmitting information, a choice must be made by the sender. This choice will be better focused when he is aware of the problems faced by the receiver. Similarly, the knowledge of the firm will help the sender find the relevant receiver for his message. For instance, if during a visit to a client an engineer notices some sales opportunities, he should be able to locate fast the relevant marketing manager.

Rules of action improve unilateral communications in a manner very similar to shared knowledge. As already discussed, they provide knowledge of the functioning of the firm. One aspect, though, deserves to be emphasized.
Rules that enable the sender to know what the receiver needs to know are particularly useful. Consider the case where the receiver will take a decision based on this communication. The rules enable the sender to have a better idea of the scope of decisions that are serious candidates, and hence to only transmit decisions relevant to the choice among them.

Many unilateral communications are actually sent by one person to many. All that I have already said about unilateral communications apply to this case, if we consider these communications as a group of simultaneous unilateral communications. However, the commonness of coding, knowledge and rules takes a special importance, as the sender can take advantage of economies of scope in the language and content of his message. For instance, the need for retranslations is eliminated if there is a common code within the organization. A special, and interesting, case of communications with many receivers arise in communications "down the hierarchy". Top level management sends instructions to the second level which decomposes them and retransmits to the third level, and so on, down the hierarchy. There is a flow of communications, which are processed and/or retranslated at each stage. The actions taken as consequences of these directives must be coherent, hence, these different operations of translations and reprocessing must also be conducted coherently. This will be easier if the top level of the hierarchy communicates a) in a language which needs little retranslating, i.e., in a language which has meaning at low levels of the hierarchy, and b) in a way which ensures that the interpretation done by lower levels when they retranslate and retransmit objectives is coherent. This shows that financial ratios have limits as communications instruments. They may have appeal at the top of the hierarchy, but they are subject to potentially costly misinterpretations in terms of actual actions. For instance, if two subsidiaries which trade products are told to maximize some measure of profits, it is not clear that the decision that they will take on this basis will enable a good management of the flow of products between the two of them. The instructions from the hierarchy should explicitly state, for instance, that fast responses to changes in the environment are essential and that the supplier subsidiary should give priority to the downstream subsidiary over its other clients.

2.7.3 Corporate culture and efficiency of discussions

Finally, let me turn to discussions. Because they are sequences of utterances by the parties in presence, much of what I have said about unilateral discussions also applies here. I only consider the new aspects. First, if we think of
discussions as gradient processes where successive iterations help the parties find the optimal set of information to transfer, the closer the starting point from the final outcome the better. Hence, the shared knowledge aspect, of facts or derived from the rules, enables the discussants to converge faster on the essentials. The restraints imposed by the rules of actions also simplify the discussion. Some alternatives need not be explored.

2.7.4 Concluding remarks on the efficiency inducing role of corporate culture

Up to this point, I have shown that culture makes every technique of treatment of information more efficient. This will imply that firms will change techniques according to their new relative costs, and to take advantage of new possibilities that are open. In the relatively obvious case, what used to be a sequence “discussion followed by a decision” will be replaced by a “unilateral transfer of information followed by a decision”. But as more expensive techniques (in terms of time) become more efficient they may be used more and replace less efficient techniques, so that a decentralized decision might be replaced by a sequence “discussion-decision”, as the cost-benefit ratio of the discussion has decreased enough to make more explicit coordination worthwhile.

Before turning to a simple model that throws light on some aspects of the theory, let us look at two examples.

Academec culture  Universities provide many interesting examples of corporate culture at work. Take the selection of deans in American universities. Their job is fundamentally different from that of professors. They are not expected to conduct either research or teaching, and if they do the quality of their performance in these activities is nearly irrelevant to the judgment by the institution on their performance as a whole. They are primarily expected to be good administrators, and sometimes fund raisers. Why are they nearly always recruited among professors? Deans spend most of their time managing professors (sometimes indirectly). They must therefore know the language of academia, as well as the manner in which it functions, the rules of actions in the terminology of this paper, or in other words that they be part of the culture.\(^5\)

\(^5\)It is clearly a knowledge of academic culture that is required in this case, not of specific facts, as can be seen by the reluctance of universities to hire deans outside of academia, where most good managers can be found, but their willingness to hire outside their own

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**Facts and rules** The referee — to whom I am very grateful — asks the following puzzle: is the location of corporate headquarters part of corporate culture? My definition would say that in general it is; communication costs are substantially lower when this location is shared knowledge. On the other hand, many experts would argue that there is no general answer. In some companies a particular location might be deeply ingrained in the culture. If a new hire asks why headquarters cannot be moved; everybody laughs: “they stay here, as long as the company survives”. In other companies, headquarters may move once a decade: “we move headquarters occasionally as the business requires”.

In these two companies, knowledge of the location of headquarters is shared, and is part of corporate culture, but this knowledge has a very different status. This is easy to interpret in terms of the definitions of this paper. In both cases, there is shared knowledge of a fact — the location of headquarters — and of a rule. The rule is very different in these two companies, in one of them it is “headquarters do not move”, in the other “they move regularly”. Shared knowledge of these rules has an efficiency inducing function, it will influence investment specific to the location of headquarters, which will be encouraged in the first case but not in the second.\(^6\)

### 3 A model of shared knowledge

In this section, which the reader can skip without loss of continuity, I present a simple team theoretical model that allows a formal exploration of the following question: “how much common knowledge is optimal?” The model generalizes the work I presented in Crémer (1990) where the fact that the information was totally shared or completely diversified was taken as an hypothesis. Its aim is not to summarize the discussion that precedes, but to demonstrate that the concepts that have been developped can form the basis of formal theory.

The framework of this model has much in common with the extensive literature that studies information sharing in oligopolies (see, among others, Novshek and Sonnenschein (1982), Vives (1984), Gal-Or (1985), Li (1985), Shapiro (1986)).

\(^6\)These different rules also have a coding function. The signal ‘headquarters move’ has very different meanings in these two companies.
In 3.1, the problem is approached through a symmetrical two agents model, while in 3.2 the results are generalized to the case where the payoff function is asymmetrical, and there is some brief discussion of the problems arising from the introduction of more than 2 agents.

3.1 A Symmetrical Model

A team is composed of two agents, \( i = 1, 2 \). Each of them must take one decision, which is to fix the value of a real variable \( x_i, i = 1, 2 \). The payoff to the team is\(^7\)

\[
\Pi(x_1, x_2; A) = A(x_1 + x_2) - \frac{B}{2}(x_1 + x_2)^2 - \frac{C}{2}(x_1 - x_2)^2.
\] (1)

Both members of the team act in good faith to maximize common welfare.

One could think of the two members of the team as two divisions bureaus in charge of preparing the servicing of clients. They receive information about the demand, and in order not to waste time we cannot make one division wait for the result of the investigation by the other. The firm’s profit depends both on the total amount of spending allowed for the client, represented by the terms in \( x_1 + x_2 \). It also decreases when \( (x_1 - x_2)^2 \) increases, because the divisions are in charge of producing goods that are complementary from the viewpoint of the client. When \( B = C \) the payoff function is separable in \( x_1 \) and \( x_2 \). In order for the payoff function to be concave, we assume that both \( B \) and \( C \) are positive.

The parameters \( B \) and \( C \) are perfectly known to the two agents, whereas \( A \) is uncertain. The agents accumulate some information about \( A \), and on the basis of this information take independently the decisions for which they are responsible. This model studies the benefit of shared knowledge, and I assume away any communication between the agents except at the outset when the information structure and the decision rules are chosen. In particular agent \( i \) does not know the \( x_j \) chosen by the other agent. For a discussion of this assumption see Crémer (1990a).

\(^7\)This payoff function can be defined as an approximation through a Taylor expansion to a payoff function \( p: \mathbb{R}^2 \to \mathbb{R} \) such that \( p(x_1, x_2) = p(x_2, x_1) \) for all \( (x_1, x_2) \). If the expansion is around \( \bar{x} = (\bar{x}_1, \bar{x}_2) \), we set \( B = -(p''_{12}(\bar{x}) + p''_{11}(\bar{x}))/2 \) and \( C = (p''_{12}(\bar{x}) + p''_{11}(\bar{x}))/2 \). Malcomson (1978) and Weitzman (1978) discuss the difficulties created by such approximations.

Marshak and Radner (1972) use payoff functions where the linear term is of the form \( A_1 x_1 + A_2 x_2 \).
The results exposed below are not modified if we replace the payoff function (1) by

\[ A(x_1 + x_2) - \frac{B}{2}(x_1 + x_2)^2 - \frac{C}{2}(x_1 - x_2)^2 + r_1 x_1 + r_2 x_2 \]  

where \( r_i \) is a random variable, perfectly well observed by agent \( i \) but not at all by agent \( j \neq i \). This functional form might provide a better description of an environment where it is natural to have two different agents take the decisions \( x_1 \) and \( x_2 \). I keep the specification of equation (1) because it makes computations and exposition simpler.

The random variable \( A \) is normally distributed (see Li (1985) for techniques that make it possible to relax this hypothesis). There is no loss of generality in assuming that its mean is zero.

Each of the two agents can observe \( n \) of a large number of random variables of the form \( \eta_h = A + \zeta_h, h \in H \), where all the \( \zeta_h \)'s are identically normally distributed, of mean 0, and independent from each other. Each \( \zeta_h \) represents an observation error. Before making its observations, the team will identify three subsets of \( H \). The first, \( H_c \) identifies the variables \( \eta_h \) that both agents will observe. The second \( H_1 \) and the third \( H_2 \) identify the variables that only one of the agents, 1 and 2 respectively, will observe. Thus for some \( \alpha \in [0,1] \), there are \((1-\alpha) n \) variables — the elements of \( H_c \) — that are observed by both agents. Agent \( i \) also observes individually \( \alpha n \) variables — the elements of \( H_i \) — which are not observed by the other agent.

The team will also choose decision rules \( x_1(\bar{\eta}_c, \bar{\eta}_1) \) and \( x_2(\bar{\eta}_c, \bar{\eta}_2) \), where \( \bar{\eta}_c = \{\eta_h\}_{h \in H_c} \) and \( \bar{\eta}_i = \{\eta_h\}_{h \in H_i} \). The expected payoff associated with these decision rules will be:

\[
E_{A,\bar{\eta}_c,\bar{\eta}_1,\bar{\eta}_2} \left[ A[x_1(\bar{\eta}_c, \bar{\eta}_1) + x_2(\bar{\eta}_c, \bar{\eta}_2)] - \frac{B}{2}[x_1(\bar{\eta}_c, \bar{\eta}_1) + x_2(\bar{\eta}_c, \bar{\eta}_1)]^2 
- \frac{C}{2}[x_1(\bar{\eta}_c, \bar{\eta}_1) - x_2(\bar{\eta}_c, \bar{\eta}_1)]^2 \right].
\]  

(3)

The expectation is taken with respect to \( A \), and all the relevant \( \eta_h \)'s. If the sets \( H_i \) are empty information is totally shared, there is common knowledge. On the other hand, if the set \( H_c \) is empty, information is differentiated.

For a given information structure, that is a given choice of the sets \( H_c \), \( H_1 \), and \( H_2 \), the problem of the team is to choose functions \( x_1(\cdot) \) and \( x_2(\cdot) \) that maximize the expression (3). It is relatively simple to show that at the optimum such functions must be linear in the observations (see Marschak

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and Radner (1972), and therefore that, for \( i = 1, 2 \), there must exist coefficients \( \lambda^i_h \) such that:

\[
x_i(\tilde{\eta}_e, \tilde{\eta}_h) = \sum_{h \in H_c \cup H_i} \lambda^i_h \eta_h
\]

Using this expression the payoff becomes:

\[
E_{A, \tilde{\eta}_e, \tilde{\eta}_1, \tilde{\eta}_2} \left[ A \left( \sum_{h \in H_e \cup H_1} \lambda^1_h \eta_h + \sum_{h \in H_e \cup H_2} \lambda^2_h \eta_h \right) \right.
\]

\[
- \frac{B}{2} \left( \sum_{h \in H_e \cup H_1} \lambda^1_h \eta_h + \sum_{h \in H_e \cup H_2} \lambda^2_h \eta_h \right)^2 - \frac{C}{2} \left( \sum_{h \in H_e \cup H_1} \lambda^1_h \eta_h - \sum_{h \in H_e \cup H_2} \lambda^2_h \eta_h \right)^2 \right].
\]

Remembering that \( \eta_h = A + \zeta_h \) and keeping in mind the independence of the relevant random variables we transform this expression into:

\[
\sigma^A \left( \sum_{h \in H_e} (\lambda^1_h + \lambda^2_h) + \sum_{i=1,2} \sum_{h \in H_i} \lambda^i_h \right)
\]

\[
- \frac{B}{2} \left( \sigma^A \left( \sum_{h \in H_e \cup H_1} \lambda^1_h + \sum_{h \in H_e \cup H_2} \lambda^2_h \right)^2 + \sigma^A \left( \sum_{h \in H_e} (\lambda^1_h + \lambda^2_h)^2 + \sum_{i=1,2} \sum_{h \in H_i} \lambda^i_h^2 \right) \right)
\]

\[
- \frac{C}{2} \left( \sigma^A \left( \sum_{h \in H_e \cup H_1} \lambda^1_h - \sum_{h \in H_e \cup H_2} \lambda^2_h \right)^2 + \sigma^A \left( \sum_{h \in H_e} (\lambda^1_h - \lambda^2_h)^2 + \sum_{i=1,2} \sum_{h \in H_i} \lambda^i_h^2 \right) \right)
\]

Let

\[
\bar{\lambda} = \sum_{h \in H_e} (\lambda^1_h + \lambda^2_h)
\]

and

\[
\bar{\mu} = \sum_{h \in H_1} \lambda^1_h + \sum_{h \in H_2} \lambda^2_h.
\]

As noticed earlier, there exists \( \alpha \in [0, 1] \) such that the sets \( H_1 \) and \( H_2 \) have the same cardinality, \( \alpha n \), and that the cardinality of \( H_c \) is \((1 - \alpha)n\). It is easy to verify that, because the function \( f(x) = x^2 \) is convex, any optimal family of \( \lambda^i_h \)'s must satisfy:

\[
\lambda^1_h = \lambda^2_h = \frac{\bar{\lambda}}{(1 - \alpha)n} \quad \text{for all } h \in H_c
\]

\[
\lambda^1_h = \lambda^2_h = \frac{\bar{\mu}}{\alpha n} \quad \text{for all } h \in H_1 \cup H_2.
\]

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Let \( \sigma_{\xi}^2 = \frac{\sigma_{\xi}^2}{\alpha n} \) and \( \sigma_{\delta}^2 = \frac{\sigma_{\delta}^2}{(1-\alpha)n} \) (the rationale for this notation will become clear soon). The payoff is equal to:

\[
\sigma_{\lambda}^2 \bar{\lambda} + \sigma_{\lambda}^2 \bar{\mu} - B \bar{\lambda} \bar{\mu} \sigma_{\lambda}^2 - \bar{\lambda}^2 B \frac{1}{2} \left( \sigma_{\lambda}^2 + \sigma_{\delta}^2 \right) - \bar{\mu}^2 \left( \frac{B}{2} \sigma_{\lambda}^2 + \frac{B^2}{4} \sigma_{\delta}^2 \right) + \frac{C}{4} \sigma_{\delta}^2. \tag{4}
\]

This is convex in \( \bar{\lambda} \) and \( \bar{\mu} \). Differentiation with respect to these variables gives the solution:

\[
\bar{\lambda} = \sigma_{\lambda}^2 \frac{(B + C) \sigma_{\delta}^2}{2B(\sigma_{\lambda}^2 + \sigma_{\delta}^2) \left( B \sigma_{\lambda}^2 + (B + C) \frac{\sigma_{\delta}^2}{2} \right)}, \tag{5}
\]

\[
\bar{\mu} = \sigma_{\lambda}^2 \frac{B \sigma_{\delta}^2}{B(\sigma_{\lambda}^2 + \sigma_{\delta}^2) \left( B \sigma_{\lambda}^2 + (B + C) \frac{\sigma_{\delta}^2}{2} \right)}, \tag{6}
\]

\[
U^* = \sigma_{\lambda}^2 \frac{(B + C) \sigma_{\delta}^2 + 2B \sigma_{\delta}^2}{2B \sigma_{\lambda}^2 \left( B + C \right) \sigma_{\delta}^2 + 2B \sigma_{\delta}^2} + 2B \sigma_{\delta}^2 \beta + 2B \sigma_{\delta}^2 \alpha, \tag{7}
\]

where \( U^* \) is the maximum of the payoff function.

These three equations describe the optimal decisions of the team for a given information structure. The next problem is to choose the optimal information structure. In order to do so one must maximize \( U^* \) over \( \sigma_{\delta}^2 \) and \( \sigma_{\delta}^2 \), with the added constraint that there exist \( \alpha \) and \( \beta \), \( \alpha + \beta = 1 \) such that

\[
\sigma_{\delta}^2 = \frac{\sigma_{\xi}^2}{\beta} \quad \text{and} \quad \sigma_{\delta}^2 = \frac{\sigma_{\xi}^2}{\alpha},
\]

where \( \sigma_{\xi}^2 = \sigma_{\xi}^2/n \).

Maximizing \( U^* \) is equivalent to minimizing

\[
\sigma_{\lambda}^2 \left( B + C \right) \sigma_{\delta}^2 + 2B \sigma_{\delta}^2 \left( B + C \right) \sigma_{\delta}^2 \left( B + C \right) \sigma_{\delta}^2 \beta + 2B \sigma_{\delta}^2 \alpha \tag{8}
\]

\[
= \sigma_{\lambda}^2 + \sigma_{\lambda}^2 \left( B + C \right) \frac{1}{(B + C) \beta + 2B \alpha}
\]
The solution is obviously:

\[
\begin{cases}
\alpha = 1 \text{ and } \beta = 0 & \text{if } B > C, \\
\alpha = 0 \text{ and } \beta = 1 & \text{if } B < C.
\end{cases}
\]

This result is summarized in the following theorem:

**Theorem 1** For the payoff function (1) there always exists an optimal information structure in which either all information is shared by the agents or no information is shared by the agents. Furthermore, except when \(B = C\) one of these information structures is the only optimal information structure.

It is not surprising that a larger \(C\) favors the sharing of information. Indeed, it reflects a higher need for coordination, and hence favors common information which improves the prediction of the action of the other agent.

As can be seen from equations (5) to (7) the optimal information structure maximizes the sum of the optimal \(\bar{\lambda}\) and \(\bar{\mu}\). Because the team is risk neutral, it chooses the information structure that allows the greatest reaction to the information about the state of the world. If coordination is important (high \(C\)), then diversified information will dampen the reaction to information about \(A\). Indeed, the information received by the agents may not be consistent, in which case a strong reaction would incur a large penalty. On the other hand, if coordination is of little importance (small \(C\)), diversified information makes it feasible for the agents to react strongly to the information that they receive.

On the other hand, the “bang-bang” nature of the solution is more surprising. Figure 1 depicts the variation of \(U^*\) as a function of \(\alpha\) for different values of \(B\) and \(C\). For \(B = C\), the payoff function of the team is separable in \(x_1\) and \(x_2\), and the commonness of the information structure is irrelevant. When \(B \neq C\) the payoff \(U^*\) is a concave function of \(\alpha\) which reaches its maximum at one of the bounds of the interval \([0,1]\).

Note that theorem 1 is not a knife-edge result. The slope of \(U^*\) is strictly different from zero at \(\alpha = 0\). The result should be therefore be robust to small enough modifications of the objective function and distributional assumptions.

The result is not the consequence of the presence of increasing returns to information in this setup, which is very similar to that studied by Arrow (1985): there are decreasing returns to scale to the accumulation of more information.
3.2 The consequences of asymmetry

The results derived above do not depend essentially on the symmetric payoff function (1), as will be shown here through the use of the following payoff function:

\[ u_1x_1 + u_2x_2 - \frac{D_{11}}{2}x_1^2 - \frac{D_{22}}{2}x_2^2 - D_{12}x_1x_2. \]  

(9)

Concavity of the payoff function is ensured by assuming that \( D_{11} \) and \( D_{22} \) as well as \( D_{11}D_{22} - D_{12}^2 \) are positive. The \( u_i \)’s are positive.\(^8\) Only the variable \( A \) is random, normally distributed with mean zero. The technology of information gathering is the same than in the previous section.

Solving for the optimal information structure, we obtain the following result:

**Theorem 2**  
- If \( D_{12} \) is equal to 0, all information structures yield the same payoff.
- If \( D_{12} \) is strictly negative, shared knowledge is optimal.

\(^8\)If \( v_1 \), say, is negative, we can find an equivalent problem by replacing it by \(-v_1\), and by replacing \( x_1 \) by \(-x_1\) and \( D_{12} \) by \(-D_{12}\).
• Keeping the other coefficients constant, if $D_{12}$ is strictly positive and small enough, differentiated information is optimal.

• Whatever the value of the other coefficients, for $v_1/v_2$ or $v_2/v_1$ large enough shared knowledge is optimal.

The computation of the optimal solution fills 30 pages and requires the systematic use of a numerical program to check them. Highlights are presented in the appendix, and details are available from the author.

As in Theorem 1, there exists a critical value of the coefficient of the terms in $x_1x_2$ where the optimal information jumps from common to diversified, in this case when $D_{12}$ is equal to zero. Small movements in one direction or the other from a problem separable in the decisions of the two agents have drastic but opposite consequences on the optimal information structure. Once again, the direction of the change is not surprising, and is easily interpretable, but its suddenness is unexpected. If $D_{12}$ is very large and positive shared knowledge may be optimal, depending on the relative size of the other coefficients of the model.

When $v_1/v_2$ becomes very large, shared information becomes optimal: the team wants agent 1 to adjust $x_1$ very strongly to the information he gathers, and agent 2 must coordinate its action with that of agent 1 in order to ensure that the penalty imposed by the quadratic term be not too large.

When the payoff function is asymmetric, we can find values of the parameters for which partially shared information is optimal. This is the case, for instance, if $D_{11} = D_{22} = 1$, $D_{21} = 10$, $\sigma^2_A = 5\sigma^2_e$, $v_1 = 1$, and $v_2 = 10$. In this case the optimal value of $\sigma^2_A/\sigma^2_e$ is 2.44.

### 3.3 Sharing knowledge among many agents

Turning back to the symmetric case, it is possible to examine the consequences of an increase in the number of agents. Let $n$ be the number of agents. The payoff function is

$$A \sum_{i=1,...,n} x_i - \frac{B}{2} \left( \sum_{i=1,...,n} x_i \right)^2 - C \sum_{i=1,...,n} (x_i - \bar{x})^2,$$

where $\bar{x}$ is the average of the $x_i$'s.

We obtain a result very similar to that of Theorem 1:

**Theorem 3** If there are $n$ agents, diversified information is optimal if $B > 2C/n$ and shared information is optimal if $B < 2C/n$. 

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The solution has the same general form than the solution of the previous section, which it generalizes. As the number of agents increases, aggregate uncertainty decreases, each agent can predict the average action of the others with smaller mean error, and the cost of lack of coordination due to diversified sources of information becomes negligible.

The preceding discussion might lead the reader to the conclusion that our model predicts that diversified information is more important in large organizations. I believe that this conclusion is unwarranted. It is not clear whether the proper representation of the profits of General Motors is closer to the payoff function (10) or to the sum of payoff functions of the form (1), representing many decisions made by subgroups of employees. I feel that the second branch of this alternative is a better representation of reality.

4 Why is corporate culture stable?

On the basis of the analysis conducted thus far, it might be possible to build a typology of corporate cultures, and to try to understand their links to the environment. The typology could be built by examining which types of rules, of coding, of knowledge of facts fit together (to take another obvious example, rules that require lots of intra firm coordination would necessitate an extensive common language). This requires much more analysis which is probably better postponed until an analysis of the incentives questions has been conducted. Here, I turn to another question, closely linked to the intuition which launched me on this work. The reader will remember from the introduction that I was trying to understand the personalities of firms and organizations. Personalities refer to characteristics that are constant over time. I therefore turn to a discussion of the stability of corporate culture. This will make it possible, in the second part of this section, to test the fruitfulness of the approach of this paper by tackling the notoriously difficult problem of the limits to the size of a firm.

4.1 Why a stable corporate culture?

First, a straightforward argument. For the purposes of this paper the culture is a stock of accumulated information. Like any stock, it is built through investment. The Sumimoto factory discussed in 2.6 is a good example: the investment is the foregone output from the workers during their training period. Other costs of investments may include dysfunctional short run outcomes. More pleasant methods of investing in culture involves social
activities, banquets and intramural sports. If building a corporate culture is costly, it will not be optimal to change it too often. But there is more than this. The coding and the rules of action must meet consistency requirements across the organization. These hinder small cumulative changes of either the coding or the rules of action.

Let me first discuss the consistency requirements. The investment required will be more important, the greater the information that must be memorized to know the culture. For an equal gain in efficiency, the culture that requires less learning will be preferred: Accounting principles will be homogeneous throughout the organization. The rules of actions within the firm will be homogeneous.

The fact that the different services need to coordinate their activities also imposes some homogeneity of rules. Let me use an example. Vortran, Inc. produces vort bars for use in widget factories. Most vort bars are of a common type, but there are endless variations to fit different applications. For both the marketing and manufacturing department, there are two different modes of organization. In the “dynamic” mode, the manufacturing department has excess capacity and the ability to modify quickly its product line and its mode of production when needed. In the “efficient” mode, it has adapted its technology to the production of a rather specific line, and trimmed costs as much as possible to produce this line. Of course the efficient mode is cheaper at producing standard products than the dynamic mode. (None of these modes is better than the other, they are adapted to different tasks). Similarly, in its dynamic mode the marketing department is always looking for new outlets, thinking of ways to adapt the product to the needs of clients, helping them use vort bars in new applications. In the efficient mode, its main objectives are to deliver the product to customers as efficiently as possible, to adjust the price policy, and to maintain stocks at the appropriate level. Again, in this case the dynamic mode is more expensive than the efficient mode, but enables the department to do more. For each of these departments, the efficient and dynamic modes will require different organizations and internal rules. It is important to note that these internal rules must be coherent across departments. A dynamic marketing department could not function alongside an efficient production department, and it would be wasteful to have a dynamic production department while marketing is efficient. The fact that the two departments belong to the same firm imposes that they have the same culture. On the other hand, the industry could be composed both of dynamic and efficient firms, each adapted to a different segment of the market. The very important point here is that
the internal rules cannot be chosen arbitrarily.

At any single moment an organization will therefore have an integrated culture. (I use integrated rather homogeneous, to stress the fact that that parts must fit together.) This integration of culture will be greater the more flexible the channels of communication, and the more mobile the employees. This integration will make changes difficult to conduct. Any change in a culture which affects part of the firm will affect, more or less, the whole organization. Hence, progressive reform by piecemeal improvement will be extremely difficult, or impossible. For instance, if Vortran, Inc. decided to go from the efficient to the dynamic mode, it could not first change the operations of production department and then turn its attention to the marketing department. The internal rules of the whole firm would have to be changed simultaneously. This creates high costs on two counts: first, the study of the new mode of operation will require the simultaneous adjustment of many parameters, second, the costs of mistakes will be very high as they will affect the whole organization. For instance, there is evidence that the introduction of robots necessitates coordinated reorganizations of many departments in factories (Berry (1985)).

The difficulty of changing to more complex rules can be illustrated by the following example of a firm where an integral part of culture has been the rule: “the same system of salary determination is applied across the organization”. Suddenly, a change seems necessary to recruit a group of experts in a new field. (See Williamson (1985), page 158, for an example along these lines). What is the cost of this change? At one level, it is the fact that every employee of the firm for whom it is relevant must remember that in that field salaries are different. The other cost is that the rule has actually changed to “same system of salary determination except in some cases”. Every executive in charge of recruitment will have to consider the possibility of creating another salary system for this or that category. Discussions of these possibilities take time and effort (i.e., communications must explicitly state which system is to be applied). The conclusion would be reinforced, as the reader easily imagines, if we introduced incentives considerations.

A number of feedback mechanisms also favor the stability of corporate culture. First, in firms with numerous internal communications, these communications themselves develop the culture and reinforce its principal characteristics. For instance, new specialized words are integrated in the coding, a better knowledge of facts about the rest of the firm is obtained and the rules of actions are made more precise and tested. All this changes the culture, but not its basic thrust. It reinforces the specificity of the relations
within the firm. Second, once established the culture will determine the strategy of the firm. It will focus its activities in areas for which its culture is adapted, for instance where its rules of actions are appropriate. Of course, this will in turn decrease the incentives to change the culture. The same phenomenon arises at the individual level when somebody finds a profession to which his mode of thinking (that is his bounded rationality) is adapted. The exercise of this profession will reinforce it, and it will become more and more difficult to change.

4.2 Corporate culture and selective intervention

My analysis of the stability of corporate culture makes it possible to study some of the difficulties of “selective intervention” (Williamson (1985)). One of the great puzzles of the theory of organizations is to explain the existence of decreasing returns to scale to firm size. Consider two firms under different ownerships. They can certainly merge at no cost: tell the managers to act exactly as they did before the merger. Now, one can certainly improve a little on this situation by sharing the parking lot, taking advantage of quantity discounts in the purchasing department, or replacing part of the bonus of one of the C.E.O.’s by a sponsorship to the private club of the other. This little gain is worth taking, and hence we should observe a strong tendency to merge. The question is: what is wrong with this analysis, which does not seem to correspond to reality? The answer to this question has some important practical applications. In recent years, many conglomerates have run into difficulties, in great part, it seems, because they were too difficult to manage. (Vertical integration has been the topic of much recent work, see Williamson (1985, chapter 6), Grossman and Hart (1986) and Riordan (1990). For a non technical exposition see Crémer (1993a), and for an attempt along different lines see Crémer (1993b).)

The presence of a corporate culture imposes a fixed cost of intervention, and the argument that there is always a little something to be gained by a minimum of coordination does not hold. This analysis is broadly consistent with discussions in the business press which attribute the difficulties of conglomerates to the lack of “synergy” between the cultures of their constituent subsidiaries. Selective intervention incurs the fixed cost of learning a minimum about the culture of the organization. Take something as trivial as the joint management of the parking lot. This might create no difficulty. On the other hand, the use of the lot by the two firms might make coordination difficult. For instance, in one the allocation of parking spaces may
be an important element of the coding of relative rank whereas in the other
an informal use of the spaces signals to visitors the informal atmosphere of
the firm. The coordination of purchasing departments can easily be seen to
create many more potential difficulties. Hence, the cost of selective interven-
tion can be quite high. One must learn enough about the corporate cultures
in presence to determine whether coordination problems will arise, and this
learning will be wasted if the answer is negative. This implies that the prob-
lem of computing the optimum amount of selective intervention might have
a corner solution, with a zero level.
References


Appendix

Sketch of the proof of theorem 2

Let $\delta = \sum_{h \in H} \eta_h$ and $\delta_i = \sum_{h \in H_i} \eta_h$, and write

$$x_i = \lambda_i (A + \delta) + \mu_i (A + \delta_i).$$

The variables $\delta, \delta_1, \delta_2$ are independent, normally distributed with mean 0 and variances $\sigma_\delta^2 = \sigma_\delta^2/((1-\alpha)n)$ and $\sigma_{\delta_i}^2 = \sigma_{\delta_i}^2/(\alpha n)$ respectively. Substituting in equation (9), we obtain the payoff of the team as a quadratic form $P(\lambda_1, \lambda_2, \mu_1, \mu_2)$:

$$\begin{align*}
\sum_{i \in \{1,2\}} \sigma_A^2 \left[ (\lambda_i + \mu_i) v_i - \lambda_i \mu_i D_{ii} \right] - \lambda_1 \lambda_2 D_{12} (\sigma_A^2 + \sigma_\delta^2) \\
- \sigma_A^2 D_{12} (\lambda_1 \mu_2 + \mu_1 \lambda_2 + \mu_1 \mu_2) \\
- \sum_{i \in \{1,2\}} D_{ii} \left( \frac{\lambda_i^2 (\sigma_A^2 + \sigma_\delta^2) + \mu_i^2 (\sigma_A^2 + \sigma_{\delta_i}^2)}{2} \right).
\end{align*}$$

(A - 1)

Because

$$P(\lambda_1, \lambda_2, \mu_1, \mu_2) = \frac{1}{2} \sum_{i \in \{1,2\}} \left[ \frac{\partial P}{\partial \lambda_i} \lambda_i + \frac{\partial P}{\partial \mu_i} \mu_i + \sigma_A^2 v_i (\lambda_i + \mu_i) \right],$$

at the optimum the payoff is equal to

$$\frac{\sigma_A^2}{2} (\lambda_1 v_1 + \mu_1 v_1 + \lambda_2 v_2 + \mu_2 v_2).$$

(A - 2)

Deriving (A-1) we obtain the following equations, where $j$ is taken to be different from $i$:

$$\frac{\partial P}{\partial \lambda_i} = \sigma_A^2 (v_i - \mu_i D_{ii} - \mu_j D_{12}) - (\sigma_A^2 + \sigma_\delta^2) (\lambda_j D_{12} + \lambda_i D_{ii}) = 0,$$

$$\frac{\partial P}{\partial \mu_i} = \sigma_A^2 (v_i - \lambda_i D_{ii} - \lambda_j D_{12} - \mu_j D_{12}) - (\sigma_A^2 + \sigma_{\delta_i}^2) \mu_i D_{ii} = 0.$$

This implies

$$\mu_i = \lambda_i \frac{\sigma_\delta^2}{\sigma_{\delta_i}^2} + \lambda_j \frac{D_{12}}{D_{ii}} \frac{\sigma_\delta^2}{\sigma_{\delta_i}^2}.$$
Solving for the \( \lambda_i \)'s and the \( \mu_i \)'s is hard work. We introduce the variables:

\[
\theta = \frac{D_{11} D_{22} (\sigma^2_A \sigma^2_{\delta i} + \sigma^2_A \sigma^2_{\xi} + \sigma^2_\delta \sigma^2_{\delta i}) + D^2_{12} \sigma^2_A \sigma^2_{\delta i}}{\sigma^2_{\delta i}},
\]

\[
\rho = D_{12} \frac{\sigma^2_A (\sigma^2_\delta + \sigma^2_{\xi}) + 2 \sigma^2_\delta \sigma^2_{\delta i}}{\sigma^2_{\delta i}}.
\]

Then,

\[
\lambda_i = \sigma^2_A \frac{v_i \theta D_{ji} - \rho v_j D_{11} D_{22}}{\theta^2 - \rho^2 D_{11} D_{22}}
\]

and

\[
\mu_i = \sigma^2_A \frac{\sigma^2_{\delta i}}{\sigma^2_{\delta i}} \frac{\theta (v_i D_{ji} + v_j D_{11}) - \rho D_{ji} (v_i D_{1i} + v_i D_{12})}{\theta^2 - \rho^2 D_{11} D_{22}}.
\]

Substituting in (A-2), we obtain that for given information structure the optimal payoff is equal to

\[
\frac{\sigma^2_A}{2} \frac{A}{B}
\]

where

\[
A = \theta \left[ (v_1^2 D_{22} + v_2^2 D_{11})(1 + \frac{\sigma^2_\delta}{\sigma^2_{\delta i}}) + 2v_1 v_2 D_{12} \frac{\sigma^2_\delta}{\sigma^2_{\delta i}} \right] - 2\rho v_1 v_2 D_{11} D_{22} (1 + \frac{\sigma^2_\delta}{\sigma^2_{\delta i}}) - \frac{\sigma^2_\delta}{\sigma^2_{\delta i}} \rho D_{12} (v_1^2 D_{22} + v_2^2 D_{11}),
\]

and

\[
B = \theta^2 - \rho^2 D_{11} D_{22}.
\]

Our problem is now to optimize this payoff over all feasible information structure. We know that

\[
\frac{\sigma^2_\xi}{\sigma^2_{\delta i}} + \frac{\sigma^2_\xi}{\sigma^2_{\delta i}} = 1.
\]

Hence

\[
\frac{\sigma^2_\delta}{\sigma^2_{\delta i}} = \frac{\sigma^2_\xi}{\sigma^2_{\delta i}} - 1.
\]

Substituting we obtain

\[
\theta = D_{11} D_{22} \frac{\sigma^2_\delta}{\sigma^2_{\delta i}} (1 + \frac{\sigma^2_A}{\sigma^2_\xi}) + D^2_{12} \frac{\sigma^2_A}{\sigma^2_\xi} \sigma^2_\delta - \sigma^2_A),
\]

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and

\[ \rho = D_{12} \left[ \sigma_3^2 (1 + 2 \frac{\sigma_A^2}{\sigma_3^2}) - \sigma_A^2 \right]. \]

Letting \( u = \sigma_3^2 / \sigma_A^2 - 1 \), we get

\[ B = u^2 \left[ (D_{11}D_{22}(\sigma_A^2 + \sigma_e^2) - D_{12}^2 \sigma_A^2)^2 - D_{11}D_{22}D_{12}^2 \sigma_e^4 \right] \]
\[ + D_{11}D_{22}(D_{11}D_{22} - D_{12}^2)(\sigma_A^2 + \sigma_e^2)^2(2u + 1), \]

and

\[ A = u^2(D_{11}D_{22} - D_{12}^2) \left[ \Delta(\sigma_A^2 + \sigma_e^2) + 2v_1v_2D_{12}\sigma_e^2 \right] \]
\[ + u \left[ \Delta D_{11}D_{22}(2\sigma_A^2 + \sigma_e^2) + (v_1^2D_{22} + v_2^2D_{11})(D_{11}D_{22} - D_{12}^2)\sigma_e^2 \right] \]
\[ + \Delta D_{11}D_{22}(\sigma_A^2 + \sigma_e^2), \]

where \( \Delta = v_1^2D_{22} + v_2^2D_{11} - 2v_1v_2D_{12} \). Therefore the payoff can be written as the product of \( \sigma^4/2 \) and the ratio of two quadratic forms: it is equal to

\[ \frac{\sigma^4}{2} \frac{au^2 + bu + c}{du^2 + eu + f}, \]

where

\[ a = (D_{11}D_{22} - D_{12}^2) \left[ \Delta(\sigma_A^2 + \sigma_e^2) + 2v_1v_2D_{12}\sigma_e^2 \right], \]
\[ b = \Delta D_{11}D_{22}(2\sigma_A^2 + \sigma_e^2) + (v_1^2D_{22} + v_2^2D_{11})(D_{11}D_{22} - D_{12}^2)\sigma_e^2, \]
\[ c = \Delta D_{11}D_{22}(\sigma_A^2 + \sigma_e^2), \]
\[ d = (D_{11}D_{22}(\sigma_A^2 + \sigma_e^2) - D_{12}^2 \sigma_A^2)^2 - D_{11}D_{22}D_{12}^2 \sigma_e^4, \]
\[ e = 2D_{11}D_{22}(D_{11}D_{22} - D_{12}^2)(\sigma_A^2 + \sigma_e^2)^2, \]
\[ f = D_{11}D_{22}(D_{11}D_{22} - D_{12}^2)(\sigma_A^2 + \sigma_e^2)^2. \]

The derivative of the payoff as a function of \( u \) is of the sign of

\[ u^2(ae - bd) + 2u(af - dc) + bf - ce. \]
The rest of the proof consists in computing the coefficients of this quadratic form (this is very long and involved). We obtain

\[
\frac{ae - bd}{(D_{11}D_{22} - D_{12}^2)\sigma_\varepsilon^2D_{12}} = \\
\sum_{i \in \{1, 2\}} -v_i^2\left[D_{ii}D_{jj}D_{12}(\sigma_A^2 + \sigma_\varepsilon^2)(3\sigma_A^2 + \sigma_\varepsilon^2) + \sigma_A^4D_{jj}D_{12}^3\right] \\
+ 2v_1v_2D_{11}D_{22}\left[D_{11}D_{22}(\sigma_A^2 + \sigma_\varepsilon^2)^2 + D_{12}^2\sigma_A^2(3\sigma_A^2 + 2\sigma_\varepsilon^2)\right];
\]

\[
\frac{af - dc}{D_{11}D_{22}D_{12}(D_{11}D_{22} - D_{12}^2)\sigma_\varepsilon^2(\sigma_A^2 + \sigma_\varepsilon^2)} = \\
- D_{12}(2\sigma_A^2 + \sigma_\varepsilon^2)\sum_{i \in \{1, 2\}} v_i^2D_{jj} + 2v_1v_2\left[(D_{11}D_{22} + D_{12}^2)\sigma_A^2 + D_{11}D_{22}\sigma_\varepsilon^2\right];
\]

\[
\frac{bf - ce}{D_{11}D_{22}D_{12}(D_{11}D_{22} - D_{12}^2)\sigma_\varepsilon^2(\sigma_A^2 + \sigma_\varepsilon^2)^2} = \\
- v_1^2D_{22}D_{12} - v_2^2D_{11}D_{12} + 2v_1v_2D_{11}D_{22}.
\]

Theorem 2 follows by direct observation. For instance, part b is proved by noticing that \(D_{12} < 0\) implies that \(ae - bd, af - dc,\) and \(bf - ce\) are all strictly negative.