CHAPTER 6

The Decisive Role of Information

The organizational architecture of a society is a mix of pyramids, in variable proportions, more or less numerous and high, and of more or less developed markets. It is determined by all the choices made by individuals between these two production modes. Their decision is influenced not only by their personal preferences but also, as usual, by the costs and benefits of each mode.

The costs implied by these two mechanisms differ because they do not rely on the same amount of negotiated transactions and individual information search. Markets use transactions intensively and require the processing of large volumes of information. Conversely, hierarchies economize on transactions and limit the access to information to a few specialists and decision makers. And transactions, exchange and information have a cost.

Transaction costs are defined as all the resources that people or companies need to bring an exchange to its conclusion. They include the transportation costs of goods and people and the information search costs. All actions require a view, a mental image, a good knowledge of the environment, or, in other terms, some information about the conditions in which the decision may be made (here, the potential transaction). In a society that is now moving towards electronic trade,

a service society where the transportation costs of goods and people fall constantly, the main component of the transaction costs is information cost.

When information is costly and rare, the market mechanism is so expensive to use that the polar hierarchical mechanism is more attractive. But when information costs are very low, transaction costs decline and the market mechanism becomes more tempting. Thus, it is the quest for the most effective production conditions that will influence organizational choices and favor the development of either hierarchies or markets depending on the availability of information in the society.

Abundant information encourages a broader distribution of the decision-making power, which will in turn cause the collapse of hierarchies and the rise of markets. Scarce information results in more concentrated decision making and thus encourages the development of hierarchies. That relation is what we call the central theorem of organization.

It implies that no single organizational structure is unconditionally better than all the others, whatever the time and place. The most efficient organization can only be chosen according to the respective costs of the two possible production modes. This explains the developments and radical changes that transformed politico-economic systems during the twentieth century. They first caused an information shortage as capacities of production and transmission of information improved much less than industrial production. But the trend recently reversed, when information became much more abundant with the information revolution.

In this chapter, we will first study the components of markets and transaction costs, then analyze the determinants of the costs of hierarchical management to explain the central theorem of organization, and finally conclude on how the recent flood of information has changed so deeply social and political organizations.

MARKETS AND TRANSACTION COSTS

Strangely enough, the economists—whose work mainly consists in measuring the cost of everything—have often considered markets as a gift from heaven, an equivalent of the famous free lunch which Milton Friedman views as a myth: according to the traditional treaties and textbooks, supply and demand always met without any difficulty as if an invisible auctioneer was able to find the price at which the bidders would accept to buy the precise quantities offered. Thus, it is not surprising that the Socialists were tempted to replace that invisible trader by a real trader, standing at the head of the Gosplan or any other centralizing bureaucracy, who would also define the price of everything in order to balance supply and demand at the level requested by the government.

And it is precisely in reference to the Socialist experience and to the giant western firms that Ronald Coase first drew attention to the real cost of the market mechanism. The good functioning of the market has a cost. It requires that bidders and askers travel, collect information, negotiate, sign agreements and really deliver the goods in the predefined conditions.

Those transaction costs mainly consist of the transportation costs of goods and people and the costs of collecting and processing information.

Transportation and Information

By definition, market production implies multiple transactions between the independent manufacturers of the products that are complementary or competing in the production chain, which starts with the extraction of raw materials and ends with the delivery of the end product to the consumer. The typical example of the Birmingham weapons industry in 1860 shows that the number of potential trans-

actions between the specialized producers of each component can be very high. And each operation implies several cost factors.

The buyers must first make inquiries about the presence of sellers on the market and find out about their names, locations and specialties. They must also check the product range, quality, prices and reputation of their potential trading partner. Once they have selected a product and a supplier, they must enter into negotiations in order to reach an agreement on the quality, prices, deadlines and delivery conditions that will satisfy both parties. They will then draw a contract either instantaneously and implicitly in the event of a cash purchase, or explicitly and often in writing in the event of a large forward order. Finally, the buyer must accept to bear the expenses necessary to monitor the execution of the contract according to the predefined terms.

These various activities require time, efforts and either traveling costs (if people have to go and hunt for information) or information costs (if people receive the information through the mail and telegraph or, more recently, by telephone, fax or e-mail). Not to mention the cost of the transportation of semi-finished goods from a specialized craftsmen to the actor of the next production stage.

Transportation costs fell substantially after the First and Second Industrial Revolutions and many have forgotten how they slowed activity in pre-industrial societies. In the past, they increased sharply the price of the transported good and limited long-distance trade to light and small objects of great value (for instance, precious metals, jewelry, spices and other goods long viewed as luxury products such as oil and wine in Antiquity). Part of these costs resulted from the high risks incurred, whether natural (shipwrecks) or human (pirates at sea and highwaymen on roads).

Those costs are much lower nowadays. First, because of the ever-increasing land use and the development of state power and their legal order.[1] But also due to the gradual urbanization of all societies, the

1. James D. Tracy (ed.), *The Political Economy of Merchant Empires: State Power and World Trade, 1350–1750*, Cambridge University Press, 1991.

improvement of transportation infrastructures, and the physical or economic compression of the distances between trading partners. For instance, medieval fairs and markets reduced temporarily the transactions costs by bringing together the supply and demand in a same place. Towns have the same permanent effects.

As transportation costs fell constantly during the twentieth century, information costs have become the main component of the overall transaction costs.[2] At the same time, the economic distances between the various areas of the world have decreased sharply over the last decades. For instance, advances in shipping technology have reduced average ocean freight charges per short ton from $95 in 1920 to $29 in 1990 (in 1990 U.S. dollars). Between 1930 and 1990, average air transport revenue per passenger-mile fell from 68 cents to 11 cents, and the cost of a 3-minute phone call from New York to London dropped from $244.65 to $3.32 (again in 1990 dollars).[3]

Moreover, as most production activities have been reoriented toward services rather than tangible goods with the increase in living standards, the importance of transportation costs has decreased. And twentieth-century technical advances have reduced them even further. This reflects mostly in the contemporary tourism boom.

It follows that, in modern economies, transaction costs mainly depend on the cost of information and thus on its availability in the society.[4] Indeed, all the other operations that transactions imply are

2. This was underlined by Axel Leijonhufvud who wrote that "data storage, processing and transmission costs have replaced transportation costs which had long existed." In "Information Costs, and the Division of Labour," *International Social Science Journal*, May 1989.

3. Economic Report of the President, 1997, p. 243.

4. Many economists (and especially Williamson) have tried to analyze the complexity of transaction costs, the consequences of a negotiation depending on the trading partners' commitment to the contract, on the possible abuses of monopoly positions. In short, the cost of the commitment to the trading conditions despite all the uncertainty about the future economic environment and the partner's behavior once the agreement is concluded. The detailed analysis of the contracts is much too for-

information collection processes aimed at identifying the products and partners available, finding out about prices and quality, or even at entering into a negotiation that would not have been necessary if both parties had been perfectly informed about the other's capacities and income and about the conditions applicable to all the other market transactions.

Meanwhile, the higher consumption of the growing population also increases the trading volumes between the suppliers, which are themselves more numerous. Indeed, trading volumes generally grow faster than output volumes, which is especially striking when we compare the respective charts of world trade and national products during the last few decades. And the recent globalization of markets has resulted in even greater task specialization, as Adam Smith had suggested.

In an economy where decentralized production is carried out by increasingly specialized craftsmen, growing production volumes necessarily lead to a rise in the number of individual producers. Consequently, each supplier or client can also select his trading partner from a wider range of possibilities. This increase in the trading volumes, number of producers and possible combinations of the semi-finished products of the various suppliers creates a growing need for information collection and processing.

The development of production and urbanization thus had opposite effects on transaction costs with, on one side, declining transportation costs (thanks not only to technological advances but also to safer movement of goods and people) and, on the other side, a wider range of possible transactions due to the increase in both the number and volume of goods available and the population living in this larger market area. As a consequence, the overall demand for information rises significantly and the second component of transaction costs (in-

malized and often fruitless.

Much more simply, most transaction costs are due to the cost of obtaining information.

formation costs) gains importance. The massive increase in the volume of information demanded must increase its cost if its production and transmission techniques remain unchanged.

Information costs have thus become the main component of transaction costs. They deeply influence the organizational choice between pyramids and lattices, given both organizational modes do not require the same volume of information. With market production, every participant must collect information intensively, while the purpose of the hierarchical production mode is precisely to limit transactions, and thus information collection within the production unit.

Participants select their production mode according to the availability of information. When information costs are high, hierarchical production is most likely to be chosen, given it is less information-consuming. On the contrary, when they are low, market production is selected.

These choices between the market and hierarchical mechanisms are made by individuals. The higher efficiency of either production modes, which depends on the transaction costs (in other words, on the information costs), is thus a function of individual information costs.

The Cost of Individual Information Production

As the notion of "information" concerns a wide range of goods and services, it is difficult to give a general definition that will take all of them into account. Following Shapiro and Varian, we consider that this concept should be taken in its broadest sense.[5] According to their definition, information is anything that can be expressed in numbers and more especially 0 and 1, that is all things that can be coded in bits, with the bit ("*bi*nary digi*t*") being the smallest measurement unit of the volume of information. Thus, the score of a tennis match,

5. Carl Shapiro and Hal R. Varian, *Information Rules: A Strategic Guide to the Network Economy*, Harvard Business School Press, 1999, p. 3.

books, databases, magazines, movies, music, stock prices and website pages are all examples of information.

Information is required for all sorts of reasons (for instance, pleasure, business, military purposes), and by all kinds of people. Information is costly to produce and to collect.

According to the traditional economic analysis of perfect markets, information has the same characteristics as public goods since it is available to all participants in the same quantity and freely. As such, it cannot be sold and has no price. Coase was the first to question that postulate, showing that the transaction costs resulting from the functioning of the markets are mainly information collection costs.[6] Hayek added, in two famous articles published in 1937 and 1945, that the information about the production, consumption and trading conditions varies according to the good and place considered. However, it is spread in the participants' heads, and can only be brought together through multiple market transactions. In its most compact and summarized form, it translates into prices. Stigler has reformulated the mechanism described by Coase and explained it in detail, showing how, given the wide range of prices offered by the various sellers,[7]

6. According to Coase, "the most obvious cost of organizing production through the price mechanism is that of discovering what the most relevant prices are. This cost may be reduced but it will not be eliminated by the emergence of specialists who will sell this information." Ronald Coase, "The Nature of the Firm," *Economica*, 1937, p. 326.

He added that "the costs of negotiating and concluding a separate contract for each exchange transaction which takes place on a market must also be taken into account," but we felt that those costs also amount to information costs. Indeed, if two trading partners are perfectly informed about the other's preferences, its capacity to pay, if he generally honors his commitments and the overall market conditions, they do not need to negotiate or even sign a contract. The negotiation which determines the terms of the contract that will be signed is meant to force each party to reveal its preferences according to the other's desires. It amounts to a mutual production of information.

7. George Stigler, "The Economics of Information," *Journal of Political Economy*, 1961, pp. 213–225.

consumers must devote time and effort to identifying the best price if they want to use their resources as wisely as possible.

It follows that information is not immediately and completely available on real markets. And it has in fact a price or cost for the buyer, whether he decides to collect it by and for himself (he does his "shopping") or prefers to buy it from a specialist of information production who has already collected it (an expert, a journalist, a producer of directories or of comparative tests for each category of products) and who sells it to consumers in various forms, such as newspaper articles, specialized magazines, books, radio or television productions and website pages.

Information Costs in Terms of Time, Effort, and Attention

Conceiving information as a public good is wrong; this does not take into account several aspects of its production and trade. In fact, no information is truly free, for the simple reason that a reader, auditor or spectator cannot assimilate information without spending at least a little time, devoting efforts or, in any case, paying attention. But these human resources are only available in limited quantities. Time is obviously a rare resource and its scarcity increases with living standards.[8] An executive with an hourly wage of $30 will pay $15 for any "freely available" information that will take him half an hour to read.

The total amount of attention that each of us can devote is also limited. And we live in such a complicated world, where consumer goods and activities are so varied that there is permanently fierce competition to catch our attention. Can we pay special attention to the evening news, to what the members of our family are telling us, to the plot of the novel we are reading, to a concert, to the content of the file we brought back home to study "at one's leisure"? That is the

8. Gary Becker, "A Theory of the Allocation of Time," *Economic Journal*, September 1965, and Staffan Burenstam Linder, *The Harried Leisure Class*, Columbia University Press, 1970.

problem raised by Linder and we do not believe it is only a question of time. We can pay more or less attention to a particular activity like reading the newspaper and at the same listen to music, watch television or speak with someone sporadically. And we can also read an article carefully or skim through it. When we pay attention to an activity, we cannot concentrate on the other activities. All activities thus imply an "opportunity cost," a sacrifice, a price in terms of time and attention. And obviously this is especially true of information-collection activities.

It follows that useful information is never universally nor immediately available even if it has (almost) no market price. It is not transmitted automatically nor freely to all the market participants. It is acquired through experience and after a deliberate and expensive hunt in terms of resources. The individual quest for information requires time and efforts that add to the purchase price of the information traded and sold in the form of national and local newspapers, various publications, directories, market surveys and studies, or simply by means of commercial and industrial espionage. And then individuals still have to choose between these information inputs, find out about prices and quality, select those that will be the most useful, assimilate it and possibly store it. This confirms that information has a production cost for the private economic agents who intervene in the market and must collect it and adapt it to their own specific needs. The price itself is one of the easiest pieces of information to find in modern economies, as it is widely and often freely displayed in companies' price tables, adverts, equity quotations and consumer guides. But it quite often requires a comparative study given the large range of products available and the diverse qualities offered by the various market participants.

In other words, useful information is never free, given it must be produced by each of its users. When it is general and undifferentiated, it has little value for decision makers. A wine producer does not care if there is generally little rain and no hail in the region of Bordeaux

in autumn. What he needs to know is if it is going to rain on his land and during the third week of October to decide if he should harvest the grapes earlier or later than usual. Moreover, information must be unique to generate wealth, not easily reproducible and thus privately appropriable. If all the engine builders knew in detail how to manufacture fuel injection engines, it would be impossible to patent and sell the concept to another producer. Finally, information must concern precise places and people as the decisions of each consumer reflect its particular needs and unique conditions.

Assimilation Costs and Human Capital Investments

But it is not the only cost of that "public good" that is supposed to be free. The proper and useful assimilation of a piece of information requires prior knowledge and efforts. It is impossible to understand an economic article, even if it is published in a non-specialized newspaper, without having first devoted a minimum of effort to the learning of economic mechanisms by reading studies or accumulating practical experience. The depreciation cost of our knowledge (that is of our intellectual capital) in this field should thus be included in the acquisition cost of the current economic information, especially as that investment has proved very costly in terms of time and efforts in the past. The same is true, say, of a foreign language or the study of science and technology. In economics, the same unprocessed information concerning the latest inflation data does not have the same meaning and use for someone who has invested in economic analysis and someone who knows nothing about it. Useful and productive information is costly to obtain.

Without competence, a kind of intellectual "software" that is also very costly to acquire, the unprocessed information collected in an article will not be understood and thus useless and unusable. Not to mention the cost, the intensity, of the effort made to understand the new elements of the article itself, which is almost always necessary.

Contemporary analyses of human capital, the competence capital, show that it contributes to making people use information more productively in both market and non-market activities.[9] This is why the best trained people are more capable of treating themselves and thus obtain a higher health capital than those who have little education. Medical information is less costly for the former and thus used in larger quantities and more efficiently.

Information is thus never free for its user, even if he has not created or conceived it by himself. He will nevertheless have to choose his pieces of information from a growing range of available data, assess their quality and, because of the limited amount of time and efforts he can invest, select the information inputs he will examine. This first selection process is in itself costly, as shown by the theory of information-seeking behavior that Stigler was the first to develop. He concentrated on price dispersion but many other fields of application were then found, especially in the study of job search.

As a consequence, individual information production is always specific. Each of us must search our own even if others have already found it and each decision maker must bear the cost in terms of time and other resources. Any market production first implies the simple cost of the search for information about the trading partners and their products. But the resulting negotiation between the supplier and the client is only costly in terms of time and efforts because of the scarcity of information. Its main purpose is indeed to define the precise terms of the transaction (characteristics of the goods and/or services, prices, deadlines, delivery conditions, guarantees). And it would only be costless if the information about both parties had been completely and perfectly collected. Each trading partner would then know precisely what the other wants and what he can offer or pay, how his rivals are faring, the current prices for a given quality, the guarantees the other

9. Finis Welch, "Education in Production," *Journal of Political Economy*, January–February 1970, and Robert T. Michael, "Education in Non-market Production," *Journal of Political Economy*, March–April 1973.

partner usually offers and so on. In that case, none of the parties needs to hunt for information: the agreement is immediately reached. We will see later on that such conditions almost exist on financial markets. And that is why the latter lend themselves so well to the classical analysis of pure and perfect competition which precisely implies exhaustive and costless information that is freely available to all participants. But this model remains a borderline case that is rarely if ever seen in real life where individual information is always rare and expensive.

As it always has a cost and goes through a "final individual production stage," even if it consumes free public inputs on the same occasion, information remains the sole property of the one who has produced it for its own use, if he wants to. He can spread it or keep it for himself. As such, it is a private good, which does not necessarily fall in the public domain. Its price for the producer-user is the cost borne to acquire it, which is always strictly positive. Its quantity and quality are different for every buyer and producer, especially because its cost in terms of time is never the same for two individuals. Consequently, information is thus a product like any other that can be analyzed with the usual economic tools and does not require the development of brand new methods of analysis, a trap into which many economists fell when they tried to study it.

The gist of the problem is that to be usefully associated with actions, decisions or choices, the piece of information must be processed by a brain or a cerebral substitute, an artificial complementary brain such as a computer and its software. Assimilation and processing are thus necessarily individual-specific operations. They remain private, confined to that particular brain or computer unless the latter is stolen or hacked, or the former, if the expert or decision maker is "grilled" to obtain specific information that he was unwilling to share.

It is totally unrealistic to pretend that information is a public good simply because it can, in some specific cases, cost little or nothing for someone to transmit it—verbally for example. The transmission cost can be equal to zero but the reception cost will almost never be.

Neither is information necessarily a public good nor its price equal to zero because, technically, two people can use the same piece of information at the same moment. Generally, the information producer does not gather it in public. He works in his workshop, his office or in the depths of his mind. He has several ways to retain his exclusive rights. If he decides to transmit it freely, it is most often because he has already used it intensively or to reap the fruits of his efforts, for example, by becoming famous in the case of scientific research. It can also be to advertise his products, which are already patented in the case of applied research. Thus, most often, the transmitter had to "pay" for the "free" information he is disseminating.

Finally, it is also false to assume that there is no rivalry between two people using the same information. If my investigations and analyses show me that, say, Amazon is likely to announce benefits in its earnings report that will only be unveiled by its management at next month's press conference, I can make money out of my information by taking position on the company's stock. When the other participants will be informed in their turn, I will cash profits that will pay for my exclusive information. If on the contrary, other financial analysts obtain the same information or if I tell them about it during a conversation, they will also take position, the stock's price will change immediately and my potential gains will be much more limited or could even vanish. Information is the object of rivalry. Information loses value as soon as it is transmitted. The information acquired by some reduces the value of those held by others. This phenomenon is less concrete and more gradual, qualitative, than it would be with tangible goods: if I use a photocopier, nobody else can use it at the same time. There is total rivalry for its use. But this is also true of the information about Amazon: if other people use the same information at the same time, it is much less useful to me. The value of that piece of information is reduced proportionally, less severely but in the same way, as when someone wants to use the photocopier at the same time as I do. In the first case, I can lose 50 percent of my potential gains

on Amazon's stock, while in the second case I lose 100 percent of my gains because of the use of the photocopier by someone else. In other words, the difference with other goods is not a question of nature but a question of degree.

We can thus conclude that information is most often a good that can be produced and privately appropriated just like the other goods and services. This significantly changes our view of organizations.

Information Costs, Profitability, and Imperfect Markets

If transportation and information costs are equal to zero, markets are perfect and everybody is fully informed. There is no transaction risk, no cheating, no complicated negotiation concerning quality and prices, as everything is known from the beginning. The negotiation becomes useless and there is full decentralization.[10] The system is self-regulated: there is no central power, no conscious organizational decision making. It is the organizational optimum or the "ideal society" according to Hayek. But such a society with perfect markets requires the availability of a maximum, if not infinite, amount of information.[11]

As pieces of information are always costly for the end user (who is also the end producer), they always remain rare and expensive in that society. All the potential, "complete," information will never be collected nor produced, and the level of "full" information will never be reached. It follows that markets will never be perfect, contrary to what the theory of the perfectly competitive economy had suggested, as all suppliers and consumers cannot have infinitely abundant information at their disposal at any time and no cost.

10. Harold Demsetz, *Economic, Legal, and Political Dimensions of Competition*, North-Holland, 1982.

11. See also Martin Shubik, "Information, Rationality and Free Choice in a Future Democratic Society," *Daedalus*, vol. 96, 1967, pp. 771–778, mentioned in D. M. Lamberton (ed.), *Economics of Information and Knowledge*, Penguin, 1971.

On the contrary, in real life, information is rare and often hard to find. It has a cost which can be prohibitive. Markets are always more or less imperfect. The individual production of information by both the consumers and producers will never be maximal given its production and assimilation costs.

As that information reflects in the prices, the latter will never summarize all the information spread throughout the society. They will themselves be imperfect. This leaves room for the other production mechanism, hierarchy, which requires much less of this costly information than the market.

Information production always stops before reaching the extremes of full and free information, which is characteristic of perfect markets.

The more imperfect the markets, the more varied the prices for an identical quality of the good or service considered. Information collection is thus necessary to make a choice. Conversely, the more perfect the markets, the less useful the negotiation. In a perfect market, the buyer does not have to negotiate the overall price of a car given all manufacturers will sell an identical product at the same price because of competition. It is no use either for the seller to try and obtain a little more than the market price as he would automatically price himself out of the market. Any available information is priced in and it is no use for the buyer or seller to try and differ from it in a situation of competition.

This market efficiency theory has found its best application in finance. The price of a financial asset, a share, for instance, is determined by the right to receive a fraction of the future benefits that the company will realize all along its economic life. These future benefits cannot be known in advance but they are estimated by each buyer or seller of this stock. New information about the whole economy, the sector the firm belongs to or the company itself that influences its potential benefits (now or in the future) immediately alters the stock's price, as it alters the present value of the expected gains.

On a perfect or "efficient" financial market, the least information

is captured and used by an investor or another and prompts him to buy or sell the stock, if possible before all the other investors, in order to make a capital gain (the positive difference in the stock's price). Thus, as soon as the information is available, the stock's trading volumes and price vary. And the new price reflects it. We can thus conclude that market prices reflect all the information available in the economy. At every moment, the market price is the "true" price which mirrors the fundamental value of the company. In such a market, we can only hope to make a gain on the current price if we have fresh information that the other investors do not have yet. If not, it would make no difference to buy with complete confidence at the current price, given it would reflect all that is known for the moment about the future benefits of the company. It is impossible to do better than the thousands of participants who all try to determine as well as possible the company's financial outlook and hunt for fresh news.

Thus, professional financial analysts are paid full time to find fresh news. Their very success is an incentive to develop their research activity to the point where an additional piece of information requiring another week of work will cost more to produce than it is worth in terms of increased precision about the exact price of the stock compared with the current market price, and thus in terms of capital gains. As a consequence, a financial analyst earns as much as any other specialist who has the same skills, and both of them rarely, if ever, become millionaires. If other analysts entered the trade, the production of information would increase but at the same time the markets' degree of perfection would improve while the analysts' gains would decrease. The market's informational imperfection will thus be determined by the "normal," competitive salary that an average analyst considers he should earn in view of his education and skills. The higher the average analyst's salary, the more imperfect the market.

However, if the financial research was totally stopped because financial markets were perfect and it was consequently possible to buy and sell at the current price without having to find more information

about the stock, equity news would soon stop being produced. The market would become imperfect. Stocks' prices would no longer reflect the information available in the world. And it would thus be possible to make a lot of money by hunting for better information.

Consequently, the production of financial information and surveys would reach its equilibrium level, which would correspond exactly to the normal profitability of the production of an additional information. As the salary of the analysts is not equal to zero, the market cannot be totally perfect. If the market was perfect, the analysts' work would have no value. They would no longer be able to give pieces of advice that would be somewhat profitable and the trade would disappear as we explained above. On the contrary, if the analysts were well paid, the market would be very imperfect.

Real markets are thus characterized by a certain degree of imperfection which depends on information's production cost. This determines the cost of using transactions, that is, the cost of the market mechanism, as it requires that each participant collects large volumes of information.

Because of the existence of positive information costs, the other production mode, hierarchy, is often less costly than the market. When the markets are less perfect, the hierarchical solution to the production coordination issue seems more attractive.

HIERARCHY AND THE COST OF MANAGEMENT

The hierarchical mode is the other way to coordinate production between a large number of specialized individuals. But what makes it information-saving? How does the hierarchy produce and use information? Basically, the information held by the manager is first replicated and then combined to the human capital of the various subordinates, of which it amplifies the efficiency. It follows that there is a sort of leverage of the manager's information and competence which is multiplied by the number of subordinates who use it.

This production mode does not imply the same transaction costs as the market. First, because it reduces the number of transactions and second, because it spreads the cost of a given piece information efficiently by replicating it and transmitting it for free to the members of the hierarchy who will thus not need to hunt for information by themselves.

Consequently, the hierarchical production mode reduces the cost of information per unit produced. Each unit produced is the result of very few transactions. And as each transaction requires a certain volume of information, each unit produced in the hierarchical mode only requires a small quantity of information (and thus low information costs) given hierarchies manage to transmit information at a low replication cost.

But in that case why are there not just hierarchical productions and no markets? This extreme situation will never materialize in real life as hierarchies suffer information and control losses which increase with the size of the organization. The efficiency of a hierarchy thus decreases with size, which means that its production costs increase with size. When the managerial (or hierarchical) unit costs reach the same level as the market mechanism, the firm stops growing. It has reached its maximum efficiency.

The Hierarchical Advantage

While market production requires that all participants, bidders and askers, hunt for information, the hierarchical production needs very little information: only the decision makers at the top of the pyramid have access to it. They then use it to make decisions concerning the characteristics of the product, its production process and the distribution of tasks among the specialists, the quantities to be produced, the terms and conditions and the selling price. They then transmit the information collected and paid for only once to all their subordinates

in the form of directives which define the actions the latter should undertake without having to hunt for information individually.

Now, only one member of the hierarchy, the manager, seeks information. The advantage of this technique is that information is transmitted to the rest of the hierarchical pyramid at low cost. If each information seeker-producer must bear its overall cost individually, a hierarchical organization consisting of 100 employees (but where only one of them buys the information) has information costs 100 times lower than a market composed of 100 producer-buyers where each of them must collect identical information individually. For example, the books in a library are bought once and read by hundreds of readers. They can also be photocopied at a rather low cost and selectively. The use of information will thus be less costly for both the company and the library than for an individual consumer.

The hierarchical production mode thus amortizes information costs first by reducing both the number of seekers and the number of inquiries each of them will make, then by replicating and transmitting this information at a low cost and in a reduced form easier to use.

In a hierarchical mode, the list of suppliers is mostly limited to internal producers. While information about the clients and suppliers is frequently looked for by each specialized producer in the market production mode, that search is only performed once and by one person in the hierarchy: the manager hunts for the best specialized producers in the economy and hires them to create a rather stable production team. He then specifies the tasks that each team member will have to perform (instead of letting them define by themselves the production conditions of each component of the end product) and the assembly procedure through a long consultation process.

The hierarchy thus avoids several costly information-seeking processes that are inherent in the decentralized market mechanism. First, by giving to the manager and his specialized employees the sole responsibility to seek information about the producers that the company

should work with, instead of letting each independent producer hunt for his own. Second, by selecting only one group of specialized producers that it integrates into its organization and it will not have to constantly negotiate with all the others to define the characteristics of the product's components and the assembly procedures.

It creates a "production chain" that now remains unchanged over several periods and uses it repeatedly to mass-produce an item. It thus amortizes, over a large number of units produced, the cost initially borne to collect information about the specialized producers that were worth recruiting and the characteristics of the production process and the distribution of tasks. It is the high cost of information that encourages companies to make a scarcer use of decentralized exchange procedures based on the price mechanism.[12]

The hierarchy also implies higher task specialization by distinguishing between the production tasks, strictly speaking, and the informational or supervisory tasks. On a market, each participant is both the specialized producer of a product or component and the producer of his own information (technical specifications or information about the markets and his clients, suppliers and rivals). In a hierarchy, the manager does not himself participate in the production process. He only focuses on the tasks for which he is the most productive: using information—that he is the sole to obtain—for the definition of the overall characteristics of the product and all its components and making sure subordinates follow his directives strictly during the production process.

The latter are thus exempted from the design and marketing tasks they had to do on top of their production activity when they were still independent producers on the market. They can specialize in the transformation of products, devote all their time to it and consequently improve their productivity.

12. However, it can increase the production costs given the internal supplier is not necessarily the most efficient among all those who offer their products and services on the market as Malone, Yates, and Benjamin underlined, op. cit., p. 486.

That is why the technologies of information—or, more precisely, its production cost—determine the choices between the two exchange mechanisms: hierarchies or markets. It also conditions the size of hierarchical organizations and society's organizational structure.

Indeed, in a hierarchy, the high cost of information is an incentive to limit its use to those capable of making the most of it. This represents for the community at large the optimal allocation of a scarce resource as we saw in the section about M&As. And this explains the very principle of the hierarchical order as only those who have the information can make effective and sensible decisions. It is thus necessary, when information is restricted to a few, that the decision-making power must be given to the same few. The other producers must not decide for themselves but rather follow the instructions given by the informed.

However, the hierarchy must be able to remain the sole user of the costly information it has collected or bought. Information is thus made more profitable to seek and produce as it gives the firm an advantage over its rivals. It must also manage to amortize the private cost of this information over a large number of production processes.

Command and the Replication of Information: "Managerial Leverage"

According to the principle of command or hierarchical authority, the manager is the only one to collect information and then to transform it into precise directives which will eventually be transmitted to the subordinates. As their exact content and coordination is decided in advance by the manager, the subordinates are given clear and easily understandable indications that do not require a large investment in human capital nor further investigation.

As information is costly to collect or "produce" and to develop by assembling the partial elements that the ones and the others hold,

it is logical to try to use it as rationally as possible and produce it and make it more easily available by reproducing it at the lowest cost.

Obviously, in real-life hierarchies, the manager is not the sole information producer. He is assisted by several employees whose work consists of collecting, sorting out and processing the information as efficiently as possible to help the manager make a choice. But, in the end, that information is stored for the sole use of the latter. It is only transmitted to the other members of the firm once it has been included in directives and instructions, in the existing knowledge and savoir faire, in specific techniques presented as procedures or recipes, and in specific equipment. Once reprocessed and disseminated, it is neither recognizable nor really traceable by the team members. It thus remains the private property of the firm and is difficult to recover or reuse outside it, except in the case of industrial espionage where a rival company would try deliberately to reconstruct it by assembling its various components ("reverse engineering"). Such a dissemination of information at every nook and cranny of the organization guarantees its exclusiveness and private appropriation to the company which produces it. Incorporating information is the key to competitiveness.

Incorporating Information

The best way for a company to retain the monopoly of the information it produces is to structure the organization so that the information collected is incorporated into the machinery and into the specialized tasks. The organization thus forms a matrix for the individuals' behavior, guiding employees without giving them access to all the information disseminated in the whole structure. The matrix is designed only once, as if it was durable equipment, and is then used by all the employees who are successively appointed to a same position in the organization. The information is more integrated to organizational capital than to human capital. It can thus be used and reused at various production stages and be substantially amortized.

That way, the company retains its exclusive property and protects itself against the low replication costs that often characterize information. Once information has been integrated into the production structures and equipment, the specific procedures and the "homemade" directives, it becomes opaque for all the team members as none of them gets a broad view of the system. It cannot be copied in its entirety. It is implicit and private. It cannot be cloned and freely disseminated by rival companies.

But this process, where unique information is integrated into various recipes, procedures and products, does not only apply to firms. For instance, each of us builds his own knowledge about the interaction of chemical molecules or the spread of malaria and the resistance of the various types of germs to medicine. We let specialists who invest in medical research deal with it and we then use their conclusions in their popularized, basic, simplified forms—as it is less costly to assimilate than the original—when we are reading, watching a documentary or using an anti-malarial drug prescribed by our GP. Generally, we do not check in detail the quality of the original information, as we suppose that this has already been done by other specialists who have better access to the original information, a field into which we do no try to venture. For us users, this integrated scientific information is opaque and we cannot trace it. Similarly, a field worker in a firm cannot rebuild all the information he uses every day and that he receives in the form of instructions, equipment or organizational procedures. It makes him more productive but he cannot take the credit for it and use it elsewhere.

There is thus a specialization in information's production levels and fields. We simply apply the directives of our GP or the pharmaceutical company that produces the drug. Similarly, when we are preparing meals, we do not try and understand why we must mix these ingredients and cook them at that temperature nor what physical and chemical reactions this implies. We just apply a partial information

that we consider to be reliable by relying on the knowledge and fame of the cook who wrote the recipe book.

Some cooking recipes are also integrated in "cooking machines" such as electrical ovens. We just have to select a function that the oven then automatically applies during the chosen length of time at a given temperature. The same is true of all the modern equipments which contain information that is much more complicated than what the user is supposed to know, for example, the GPS navigation devices in cars which show you the best way to reach your destination and guide you where you want. IT people would say that these devices are "user-friendly."

Similarly, in a company which accumulates specific information, the directives that are given by the top manager—once he has collected and sorted out the external information from the information that has been created by the internal R&D departments—are "user-friendly" for the subordinates that have to follow them. They are passed on from one grade to the next until they reach the field producers in their most specific and simplified forms. These subordinates need much less knowledge than the designers of these products or directives. However, they need some competence or human capital, a "software" or in other terms a "business culture," that enables them to understand and apply efficiently those directives. There, as in any human activity, human capital improves the worker's productivity or its use of information. Culture is productive. Thus, the business culture shared by all the employees has the advantage of helping them use easily and quickly the information integrated in the directives coming from the top, without having to know or understand completely its precise content to apply it efficiently. A good knowledge of the firm's methods, habits and organization scheme is useful to deal with the sometimes not completely specific directives given by the management.

The information obtained by the manager is thus disseminated so that all the members of the firm can use it in various forms. That

way, all the subordinates can share their knowledge and competence, which is kind of reproduced and reused in as many copies as there are subordinates in the firm.

This method of reproducing the same information is a way to make it much cheaper to use for a layman, a person that has not made the human capital investments that would have helped him understand directly and completely the original information. It also enables the specialist to disseminate his incomparable competence by combining it with that of its subordinates or of the people that buy his recipes in the market. It thus makes the employees more competent at every level of the hierarchy. It represents "managerial leverage." And the larger the informational gap between the bottom and top of the hierarchy, the stronger the managerial leverage.

In a market, the information produced does not benefit from such a leverage effect. The buyer can use the one pre-selected by the specialist and thus benefit from their high competence and productivity to improve his own. But he must first seek information—about the information specialists (for instance, doctors, cooks, financial analysts). In hierarchies, the search is much more limited as each of its members directly submits to the decisions made by his superiors without having to choose between several of his superiors' prescriptions. All subordinates accept in their job contract to submit to the instructions coming from the top of the hierarchy concerning the definition of their task and the methods that they should use to accomplish it. And each of them in turn imposes its informational production and knowledge to the following grade of the hierarchical production process.

He thus abandons the idea of producing his own information and only relies on the information he gets from the company's specialist (who is generally his superior). As it is the superior that makes the final choice at each decision-making level, it is in fact the decision maker at the top of the hierarchy that integrates his own information in the decisions of all his subordinates. His information, which is

deemed the best, is then used by all the members of the hierarchy. In that process, the manager will need the help of information producers specialized in marketing, production and finance. But he is the only one to collect all these particular data about the company's environment to transform them into simplified and ready-to-use directives.

He is the only one through which all the information used in the company flows. He thus replaces—with the help of a few specialized advisers—all the individual decision makers in a market that would have had to hunt for information if it had been a decentralized production process like the one of the Birmingham weapons industry in 1860. A same directive coming from the top can thus improve the productivity of tens, hundreds or thousands of employees just because of its informational content.

The total volume of information that needs to be collected is thus much lower in a hierarchy. Admittedly, it is bad news given information will be much less varied and choices will be less justified and consequently more risky. But, on the other hand, it avoids costly searches for information and, as the manager's capacity of assimilation is limited he will rapidly reach a saturation point, which will reduce even further the volume of information bought and the total purchase cost.[13] Because of his reduced information-processing capacity, the manager will probably not make the best decisions. But the money saved is worth some deterioration in the quality of decision making.

Hierarchies are thus less information-consuming decision-making devices than markets. And it is because information is rare and costly that this low consumption of information is advantageous. The hierarchy allocates this scarce information to the employee that uses it the most efficiently, the most productively or, in other words, that makes the most of it. And it is logical that the person who uses information so efficiently and for whom the company collects it, be also

13. Martin Shubik, op. cit., wrote that it is charitable to consider human beings as a channel for information transmission. It is more of a bottleneck, according to him.

the one that makes the main decisions that will then be disseminated to all those in the company who do not have access to such information. The ultimate information and decision-making specialist is thus the manager. He must make sure that the other members of the productive team properly implement his directives.

Thus, when information is scarce, hierarchies contribute to spreading it optimally in the economy. The concentration of the decision-making power depends on how information and the people that use it efficiently are distributed between the existing companies. And this allocation mechanism plays a major role in M&As, as they are aimed at obtaining the optimal management skills (the optimal management of information) in the economy by changing the number of companies, and thus the number of decision makers.

Replication or the Economy of Memes

Before going through the details of this process, we would like to underline the great similarities between the mechanisms of information replication in the hierarchy and information duplication in biological life. Alfred Marshall saw economics as "a branch of biology" and not of physical sciences. And the economics of information within firms proves him right.

All the directives and conceptions of the company managers, on which are based the products and the tasks/activities of the subordinates, are ideas: ideas of products, ideas of production processes and organizational methods. According to Paul Romer, ideas—which are an informational structure, a coherent group of information—are crucial for technical progress and thus for economic development.[14]

But ideas are immortal. They do not depreciate with use. They can be indefinitely reproduced and reused, depending on the variable success they have in different environments.[15] Although ideas that met

14. Paul Romer, "Ideas and Things," *The Economist*, 150 Economist Years Issue.
15. Thomas Jefferson anticipated the partially public good characteristic of ideas

the expectations and needs of the Greek society in the fifth century BC can be of little interest for the Chinese society of the twenty-first century, some can also be reused indefinitely in all kinds of societies, as is the case of plane geometry, for example.

As Richard Dawkins underlined, ideas have exactly the same general characteristics—replication, productivity, immortality—as genes in biology.[16] Genes are immortal. They replicate indefinitely and identically. They contain information that enables the development of organisms and the metabolic processes of which they are the essential complement. Economically speaking, genes are life's production factors. But they are faced with more or less favorable replication conditions depending on the environment.

Like genes, the development of ideas will depend on the success, the degree of replication, of the vehicle that conveys it: the phenotype, that is ourselves in the case of the genes, and the organization and the products in the case of ideas. The ideas of products and production methods, which favor the growth of the hierarchical organizations within which they are developed and implemented, spread within the society at large at the same time as the products and processes they have given birth to.

It is a similar mechanism that explains the endogeneity of ideologies that we have previously underlined. Ideologies propagate according to the development of the organizations that they represent and which expansion favors. In other words, they are the instruments or auxiliaries but not the source or the prime factor. A market society will first spread a market ideology. A hierarchical society will first (and sometimes only) propagate an ideology of command and authority.

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in some limited personal interactions when he wrote in 1813: "He who receives an idea from me, receives instruction himself without lessening mine, as he who lights his taper at mine, receives light without darkening me." "No Patent on Ideas: Letter to Isaac McPherson," August 13, 1813. In *Writings*, New York, Library of America: 1286–94.

16. Richard Dawkins, *The Selfish Gene*, Oxford University Press, 1976, Chapter 11: "Memes: the New Replicators."

However, ideas blend together and evolve. New ideas appear because of a mutation of the existing ideas or their application to new fields. They also cross. Given they resemble genes so much, Dawkins decided to brand them "memes" by analogy. Ideas and concepts indeed influence the development of the social organisms or products that are the vehicles that convey them and enable them to replicate. They spread from one brain to another where they are blended with other ideas to develop tangible goods, services or organizational methods. However, the selection of phenotypes determines the selection of their memes.

Hierarchies' productivity is thus due to the replication of rare and useful information through the most efficient organisms, managed by the people the most capable of using productively this costly information.

But the savings on information costs that are made with hierarchies are not boundless. The propagation of information to a growing number of subordinates generates information losses, a distortion of the messages and control losses, as employees are increasingly hard to supervise because of their rising number. Beyond a certain size of hierarchy, managerial costs increase and limit the optimal size of the hierarchy by offsetting information savings.

The Loss of Information, the Cost of Management, and the Firm's Boundaries

The hierarchical team production mode thus saves money on information costs compared with the market production mode, but it implies specific costs that we will call the cost of management. Team production poses problems of cheating, control and supervision as it is not easy to measure the productivity of each team member when the production is the fruit of mutual efforts.[17] It follows that cheating

17. Armen Alchian and Harold Demsetz, "Production, Information Costs and Organization," *American Economic Review*, 1972.

and laziness become tempting as the economy of efforts that they allow correspond, for a given monetary salary, to a rise in the real pay received. Indeed, in a wage-earning system, each employee is paid according to his expected productivity. If he manages to reduce his effective productivity and his efforts, he will increase the effective remuneration of his work-effort unit accordingly.

If everybody did so, the production would stop and the firm would have to file for bankruptcy. Team production is thus only viable if there is a control and supervisory body in charge of cutting these losses. But the supervisory body itself has flaws. First, it propagates imperfectly the directives coming from the top, like a message which is whispered from ear to ear by twenty successive people becomes incomprehensible or a document that is Xeroxed thirty times becomes illegible. Moreover, cheating cannot be ruled out in the supervisory body itself.

Monitoring the Employees

The remedy against cheating in the productive teams is the administrative body proper, the hierarchical pyramid whose members are not directly producers but whose work consists in supervising the producers and making sure that they follow the manager's directives. In fact, they produce information about the performances of direct producers.

Monitoring is easier and more efficient when the workers' tasks are simple. Only a lawyer can supervise another lawyer. But with the standardized and simplified assembly line production designed by Taylor and introduced by Ford, one person can supervise the work of ten, fifteen or twenty field workers performing basic tasks. The hierarchical pyramid and task simplification are meant to make supervision more effective.

The methods of Taylor and Ford thus result from the information shortage on two counts. The choice of hierarchical production rather

than market decentralization is justified by the fact that information costs make the latter ineffective. But then, as it is difficult to produce information about the performances of individual employees in the hierarchical production mode, work is made as simple, repetitive and measurable as possible so that it becomes easier to supervise the producers and realize the required performance.

This is true not only of industrial hierarchies but of any other hierarchy, especially in private or public services. This transposition of the Taylorist and Fordist methods to the bureaucracies was made by Max Weber. When he described the bureaucratic organization of work, he simply applied Taylorism to service companies.

Bureaucracy as a Service Factory

Bureaucratization is basically the equivalent of assembly line work in the service sector. It improves managers' control and thus reduces managerial costs, that is the productivity losses that can result from teamwork. Max Weber indeed suggested both that the hierarchy's productivity could be increased and that managerial costs could be cut. According to him, bureaucratization (the development of hierarchical pyramids) enabled processing information better, while rationalization (the representation of people as standardized files) enabled using less of it. The latter method consists in destroying or ignoring the useless part of the information to make it easier to process the essential part. This selection simplifies the information and thus reduces its processing cost. This is especially true of the management of personal relations by means of a series of objective and impersonal criteria, for instance, by using forms.

But in fact, bureaucratization is essentially meant to monitor the transmission and implementation of information. It increases managerial costs but reduces the user's cost of information. Like in the large car plants that symbolize twentieth-century industry, it is the standardization and simplification of the administrative tasks that re-

duces the supervision costs of the vast bureaucracies of which Kafka described the prototype: the insurance company he worked for in Vienna.

The Agency Problem and the Capital Market

The monitoring problem concerns not only the field workers at the bottom of the hierarchical pyramid and the intermediate supervisors, but also the manager, who is often also a salaried employee in big modern businesses. Because of their huge size, the latter require a lot of capital to guarantee the fulfillment of contracts concerning large volumes and significant amounts of money. In most cases, the amount of capital necessary to run General Motors, Pepsi-Cola or the French car maker Renault is much higher than the amount of savings amassed by private individuals. That capital must thus be fragmented by spreading it between a large number of savers who will each hold a small share of the firm's equity. In the end, shareholders are too numerous to manage the company themselves. Because of their number, making a common decision would be a very long and expensive process. There again we are faced with the problem of the cost of market transactions and negotiations.

The solution is to have the stockholders appoint a representative—the manager of the enterprise—at their general assembly or, more indirectly, a board of directors which will appoint its representative: the chairman or CEO. The latter can hold shares in the firm he manages, but his main financial compensation is a wage. He is thus, in theory, a subordinate of either the shareholders or the board of directors. But, in practice, neither of them can make collective decisions and convert the information they have into ready-to-use directives designed to influence the manager's strategy. In fact, it is the manager who gathers the information, makes the decisions and manages the company by issuing directives, whose good implementation is then controlled by his own staff.

But, being an employee, he does not share the same targets as the owners-shareholders. Their aim is simple: they purchase stocks to receive a share of the company's future gains during its whole life cycle. Thus, they want the present value of that future expected flow—which determines today's stock price—to be the highest possible. They want the manager to maximize the stock's value, that is, the firm's market capitalization.

The manager wants both high wages and significant fringe benefits: a company car or even a company plane, pleasant working conditions, comfortable business trips and many efficient assistants and colleagues who relieve him of some of his work. But wages and fringe benefits depend on the size of the firm. First, because large companies have often been growing quicker than the others—because they were the most effective initially—and can consequently pay their managers more. Second, because a manager's financial compensation is a fixed cost which will be all the lower by unit produced that it will be spread over a larger output volume. Finally, because the management of larger firms requires greater skills which justify a higher pay. The same is true of fringe benefits: it is easier to amortize a company plane on high output volumes, while the cost per unit produced can be prohibitive for a small company.

For all these reasons, the salaried manager will often set growth as his top priority, especially as he will gain more social recognition and prestige from managing a big firm than a small one.

He will then focus less on achieving the highest possible stock value for the shareholders. This is the problem when the manager is not also the owner of the firm. It first appeared with the advent of giant companies, especially in the United States in the early twentieth century, and was identified by Berle and Means in their famous 1932 book *The Modern Corporation and Private Property*. This is called the "agency issue" in modern literature. The owner indeed gives the manager—his "agent"—the mandate to manage his capital in a way that

best serves his interests. But given the divergence of interests, he must supervise his representative's management strategy.

In a big firm owned by many shareholders, it is difficult for them to avoid losing some control. Small shareholders have at most a weak financial motive to devote their time and efforts to the analysis and supervision of the leader's management. It is not in the advantage of someone holding three shares in a company for a total amount of $240 to spend a dozen hours studying the balance sheets and business plans if his own hourly wages are $20, because that study would cost him his full investment. And even if he did and ended up criticizing the management of the company head, his three voting rights at the general meeting would hardly give him a chance to be heard by the board of directors or the manager, and his investment in time and information would then be lost. Thus, the shareholders' "rational ignorance" is economically justified. On the contrary, a big shareholder, whose votes—put together—can thwart the plans of the firm's head and even force him to resign, would have good reasons to have a close look at the management strategy because the cost of the analysis could be amortized on his significant investment in stocks. Besides, such a study can be beneficial to him as he can change the CEO and the management strategy to better serve his own interests.

The drawbacks of separating ownership from management—because of a large number of shareholders—can be limited by various means. First, by giving the managers a share of the profits in the form of company stocks or stock options. If they amount to large sums of money, the manager will start thinking like a shareholder rather than as an employee since he will earn more from his shares than from his wages. Second, by making the board of directors more independent of the managers through all the means of control, better known as "corporate governance," that have emerged because of more mobile and increasingly competitive capital markets. That way, the shareholders regain some of their decision-making power. There are also the legal measures that make takeovers easier and thus put the man-

agers in competition with other management teams for the control of the firm. That competition encourages managers to offer more than their rivals in order to be chosen by the shareholders. Thereby, the managers are compelled to meet the shareholders' demand, that is, to increase as much as possible the firm's value. Finally, the re-concentration of the shares into the hands of a few persons by financial intermediaries such as pension funds, gives the managers of these funds a real control over the managers of the firms in which they have invested and of which they hold a large fraction of the capital. The managers of these funds are themselves faced with harsh competition on transparent stock markets, where their performances are easily comparable and where investors are quite mobile.

All these techniques reduce the agency problem. And since that problem usually worsens with the size of the firm, they should in theory improve the company's efficient size.

But as they are all imperfect, the size of the firm will be limited by the control losses of managers over subordinates and of shareholders over managers.

There will also be differences of size between firms belonging to the same industry, as managers do not all have the same competence and skills. A more efficient manager will collect information better and at a lower cost, make better strategic decisions and supervise the employees' productivity more efficiently. Thus, he will be able to increase the size of his company more than the others because he will be more productive and will enjoy a cost advantage that will be reflected by larger sales.

A more efficient manager will gain permission to manage a larger volume of human and capital resources. That greater efficiency in collecting and managing the information, which justifies the existence of the firm, will thus result in a larger allocation of resources to the most efficient managers. Consequently, the human and capital resources available in the economy will be distributed between the companies proportionally to the information processing abilities of the

various managers. That distribution changes either with the internal growth—or shrinking—of the existing companies or with the external growth of a firm that results from the full shrinking of another company which is taken over by the former.

Thus, in a competitive economy, the decision-making power is optimally allocated between the managers. The mechanism of that competition for the right to decide on the use of the resources is clearly visible during M&As and explains some of their aspects that had long seemed enigmatic.

We can thus explain organizational choices by looking at the respective, relative or comparative costs of the two existing coordination modes: the pyramid and the lattice. Their operating costs—which directly depend on information costs—are different because they use information differently. As a consequence, it is the cost of information that determines the choice of the production structures: either the market model or the hierarchical model.

THE CENTRAL THEOREM OF ORGANIZATION

As for all the other goods and services, the quantity of information depends on its price or cost. For a given demand, if its availability increases, its price falls, or conversely if the price declines, the quantity demanded increases. That inverse relationship between price and quantity, all other things being equal, is the law of demand, which is the cornerstone of economic analysis.

Since information is mostly an economic good like the others—we showed previously that it was indeed a private good—it follows the law of demand in its traditional form. But as information is also the result of a final user's individual production, one cannot observe its price directly on a market. The production of information has a different cost for each individual producer, for each of us, depending especially on the value of time for us, which is usually not the same as our neighbor's.

But what we can study is the price and volume of the informational inputs traded and of the objects containing information: books, newspapers, videotapes, subscriptions to databases and storage means such as hard disks. We can also measure the exchanges of information like for instance the amount of mail, the number and the length of the messages by phone, fax or modem and the radio and TV broadcasts.

Digital Production

Ideally, all these items could be measured the same way, since any information can be translated into "bits," that is, zeros and ones. The total number of zeros and ones circulating in the society would be recorded during the storage or transmission of information and would thus give us a global measure of the overall quantity of information, of its stock and flow. We would thus have a quantitative estimate of the society's "digital production," which would give us an idea of its informational production.

For lack of such a knowledge, which will sooner or later complete the data already provided by the national accounts, we can nevertheless assert, in view of the evolution of the partial data on the volumes of information produced and of the decline in their price and the price of data transmission and storage, that the information revolution often mentioned since the 1960s has resulted in a surge in the volumes available and a sharp fall in the price.

The increase in the quantity of energy available after both Industrial Revolutions, and the concomitant plunge in its price, transformed all the modern economies and societies dramatically. So, in what respects is the current information revolution changing our economies and societies? How can we understand these deep changes and evaluate them? So far, we have only limited ourselves to stating the obvious about the most visible direct consequences: over-information, or rather the saturation of our minds with second-rate information,

the invasion of entertainment and the virtual, the plethora of possible choices if you want to read, see pictures or communicate.

But the increase in the global quantity of information in circulation can be analyzed more fundamentally by looking at its effect on all the productions and exchanges that characterize life in society. We have indeed seen earlier on that the purpose of any social organization is production, whether public or private, goods or services. The very choice to live in large societies and not like Robinson Crusoe or in small groups of hunters-gatherers that had to be made since the beginning of human history a million years ago can be explained by the search for a greater number of exchanges and a higher consumption of tangible and moral goods—"mental nourishment" being obviously as important as tangible consumption once the subsistence level has been reached.

But the study of production choices belongs to the realm of economic analysis. Especially as information, as a non-freely-abundant resource, is a decisive production factor, just like labor or capital. It is simply impossible to produce or consume without information. If the Neolithic societies did not produce TV sets, computers or plastic materials, it is because they had not created the information necessary for these productions. Yet, they had labor and the same availability of raw materials as the twenty-first century societies. That is why information is an essential production factor.

If tomorrow all the objects of the post-industrial civilization vanished from earth, would it be a greater catastrophe than the disappearance of all the libraries and the loss of collective memory? Certainly not. Within a few months or years, technologies would reemerge and all the objects that would have vanished could be recreated. On the contrary, the loss of the information stored, the overall knowledge, would take us back, and maybe forever, to the "natural state" of the Paleolithic hunters and fishermen.

In that view, the information revolution can be defined as a swift and sharp increase in the storage and transmission capacities of this

production factor, which is the most essential for human activities. We must analyze the consequences of that increase just like we would do for the other production factors. A job for the economists.

Information as a Production Factor

For instance, we know what impact an increase in the quantity of a production factor can have on the structure of a country's activities. Given the production technologies and when the prices of goods are relatively stable, an increase in the quantity of capital available in the economy leads to the development of all the capital-intensive productions, the quantity of labor remaining unchanged.

That is why the European and American economies, which have a lot of technical and human capital and relatively few unskilled workers, produce a growing number of sophisticated goods which require top-range equipment and higher skills, and handed over the easiest productions, such as saucepans, traditional textile and mass-produced clothes, to the economies that have less capital and skills and thus more low qualification workers. Economists will have recognized the "Rybczynski theorem" named after the British economist who rigorously expounded the conditions of that mechanism.

That theorem, which completes Heckscher-Ohlin's classical theory of international trade, shows how an increase in the available quantity of a production factor can lead to the decline of the sector that uses it scarcely, and simultaneously to the development of the sector that uses it intensively.

This analysis of the impact of the sudden abundance of a production factor can also be applied to everyday life. When tangible goods abound, a defining characteristic of our consumer societies, while the time we have at our disposal cannot exceed twenty-four hours per day, how can we take the best advantage of the new relative availability of these ingredients necessary to the fulfillment of our satisfactions? As Gary Becker showed, all consumers are, as such, also

producers. We do not consume the meat and vegetables in the state they were when we bought them in the local supermarket. We use our time, skills and equipment (for example, an oven or a food processor) to transform the food (raw material) in order to obtain a higher gastronomic satisfaction than if we had consumed them without a personal finishing touch, that is, without what Becker calls a "domestic production," which uses the following production factors: time and marketable goods, domestic appliances and raw food.

When goods become increasingly abundant (for instance, domestic appliances) while the quantity of our time remains the same, then we will make an increasing use of these goods by unit of time. And indeed the structure of our domestic production becomes increasingly "good-intensive." As a consequence, we concentrate on the activities which make an increasing use of goods and we give up those which mostly take time.

Swedish economist Staffan Burenstam Linder analyzed in depth and with great skill the adaptation of the ways of life to the new abundance of goods and to the resulting relative time shortage.[18] We try to use as many goods as possible by time unit when we read a newspaper while we are watching TV, having a drink and smoking a cigar while our meal is heating up in the microwave and both the washing machine and the dishwasher are on. We call people with our mobile phone as we drive our car. And our spare time is less and less spent resting and thinking: during our leisure we use things, such as a house in the country, tennis rackets, skis, TVs, boats, planes, books, magazines, bikes, sportswear, in short, all that can enable us to use more of these abundant tangible goods per rare unit of time.

All these aspects of our behavior are typical to the modern civilization and result from the abundance of material goods, which is the other component, besides time and competence, of our personal production function.

18. "The Harried Leisure Class," op. cit.

The Theorem

The example of our "personal production of consumption" (or of satisfaction) thus concurs with the Rybczinski theorem concerning international production and trade. And the very same reasoning can apply to the use of all the production factors and especially to the factor we are analyzing here: the information factor.

We can thus conclude that, like for the more traditional production factors (labor and capital), the conditions of use of information in the various types of production vary according to their relative abundance in the various countries.

We will call this the "central organizational theorem,"[19] according to which the choice between centralization or decentralization depends on the quantity of information available. When the quantity of available information increases, the overall structure of the production activities will shift toward the most information-intensive, and especially the decentralized structure, the market mechanism.

The theorem first indicates that we will use goods and services containing an increasing amount of information. This is the case, for example, of the intelligent machines or other robots. Nowadays even the plainest car incorporates microprocessors which regulate the consumption of fuel, the transmission of the engine's power to the wheels according to the state of the road and the risk of skids. It also manages the brakes in the place of the driver and is often equipped with an on-board computer that calculates the distances and the consumption, the time of arrival together with the latitude and the longitude thanks to the GPS system. A contemporary car certainly takes on board a greater calculation and data-processing power than a World War II aircraft carrier. It becomes, above all, a computerized machine.

But the second and most important consequence of the organizational theorem concerns the choice of the production's organizational mode.

19. Or the "Coase-Rybczynski theorem."

As we saw earlier on, goods and services can be produced according to two different modes: the market mechanism, which is very information-consuming, and the hierarchical mode, which only requires small volumes of information as it aims at using the least possible.

When the price of information diminishes relatively to all the other goods and services or, in other words, when its quantity increases even quicker than that of the other goods and services, a direct implementation of the Rybczinski theorem to the two types of production activities—decentralized and centralized—reminds us that the information-consuming process will develop constantly while the information-saving process will be less and less used. As a consequence, the decentralized production mode will develop to the detriment of the hierarchical production mode that has become comparatively more expensive and less competitive.

The theorem indicates that the hierarchy will replace the market each time the cost of information increases, and conversely when it diminishes. It thus fundamentally explains, in a general way and in compliance with all the other economic laws, the worldwide development of the market organization and the parallel decline of the hierarchical organization that characterizes our time.

It also stipulates that the new balance of organizations will remain, as long as the capacity to produce goods will not develop quicker than the capacity to store, process and transmit information. The information society must be a decentralized society, a market society where the hierarchical values are given a pounding, simply because the hierarchies decline and are no longer able to impose on public opinion the moral criteria the most appropriate to their functioning.

All in all, the information revolution has deeply altered human societies' organizational system. Until now, authors have always tried to explain this with a multitude of incidental reasons, but without discovering its profound unitary origin. Some of them, like Dudley—

who completed the precursory work of Innis[20]—have tried to explain the geographical expansion or shrinking of states through history by various types of technical advances. Depending on its characteristics, each innovation would have different effects: either the increase or the reduction of the organization's size. That explanation is thus not really satisfactory because we have to explain in detail why each given innovation should increase or reduce the organization's size, so that no general effect of innovation can be inferred.[21]

The analysis we propose is much more simple and general. Whatever the innovation, its effects will result from the ratio between the quantity of information and the quantity of the goods produced in the economy. Any innovation that increases the ratio leads to decentralization. Any innovation that reduces it leads to centralization. So that it is not necessary to wonder about the mechanism—which would be different each time—through which an innovation affects the organization size. Here, the mechanism is always the same and the question is whether the innovation makes information more abundant than goods or the other way round.

The transformations undergone by firms, the new cultures, and the growth and decline of states and political ideologies are all consequences of the new abundance of information generated by the digital technologies invented in the second half of the twentieth century.

The Critics

That relation is sometimes criticized on the grounds that the mere advances in information technology and especially one machine—the computer—cannot affect all human activities. But that would be disregarding the universal influence of information, which directly im-

20. Harold A. Innis, *Empire and Communications*, 1950.

21. Moreover, Dudley distinguishes between two types of techniques which, combined, determine the size of the states: the administrative techniques and the military techniques, so that a new analysis is necessary for each historical case.

pacts all the individual and collective choices, all the personal and commercial productions, and whose cost depends on the storage, processing and transmission techniques, that is, above all on the effectiveness of the computers and telecommunications. The universality of the search for information explains the universality of the social upheavals generated by the progress of these seemingly limited and specific techniques.

The speed of these transformations is spectacular but not unprecedented: in the past, technological progress has often been at least as sudden as is the case for example of the invention of telegraph, railroad, car, television, plane and chemistry. But the current advances concern a small number of techniques that are used in all productive activities. Their impact is only comparable to the energy revolution that replaced human and animal muscles with the steam engines in the early nineteenth century, and later on with the fuel and electric engines. With the information revolution, the human brain needs much less to memorize, calculate and even think. It is above all a cerebral revolution, which thus impacts all the social activities even deeper than the "muscle revolution."

After a brief reminder of the scale of the revolution under way, we will clarify its deep organizational consequences in contemporary societies as a decentralizing revolution succeeds to the long centralizing phase of the first twentieth century.

We thus propose an economic and rational explanation of the great cycle of the twentieth century that resulted in exceptional advances in living standards, health and demography, but also in the conflicts, revolutions and mutations that represent the major intellectual challenge of contemporary social sciences.

THE INFORMATION REVOLUTION AND ITS CONSEQUENCES ON THE ORGANIZATIONAL SYSTEMS

About an Apparent Cultural Paradox

Because of its growing abundance over the last two or three decades, information has been used in a less and less productive way. As its cost has been falling constantly, marginal information has also become less and less interesting and useful. Like for all the other goods and services, the latest unit used tends to produce an utility that adjusts to its cost. When that cost is lowered, the marginal utility is also reduced.

That fits in with the most basic economic law according to which the scarcest resources must be used parsimoniously and as efficiently as possible. Efficiency is obtained when these resources are allocated to the users who make the most of them, who use them in the most productive way.

On the contrary, more abundant resources can be allocated to less wealth-creating, less productive, uses. And immensely abundant resources are nearly costless and can be wasted almost without any drawback. They can be used without caring about their productivity or efficiency.

Hence, the constant deterioration in the quality of information because of its recent flood. This explains the so specific characteristics of communications in the contemporary society and its marginal cultural poverty, although this is not in contradiction with the highest average level of culture ever reached by human societies.

The Information Revolution

The demand for information to coordinate collective productions increases with the number of exchanges possible, that is, the number of people and the number and the variety of the available goods.

Thereby, the cost of a transaction that did take place increases with the number of potential transactions, that is, with the number of products and the number of market participants, since we must inquire about a larger range of possibilities before making a choice. But each of us can only assimilate a limited volume of information. As Martin Shubik wrote:

> Men live in an environment they know very little about. They ignore not only how to estimate the range of possibilities that is offered to them but also its existence. Their perception skills are rather limited; their calculation power is in most cases smaller than that of a computer and their ability to search, process and memorize data varies with time. Given the rising speed of transmission and the volumes of messages, individual skills are increasingly limited compared with those of the society as a whole.[22]

The information revolution increases those limited capacities and take them beyond their natural limits.

The very expression of "information revolution" has been commonplace for long.[23] Since the Industrial Revolution, firms have always tried to have more information at their disposal. They increased their internal information about their own activities by developing accountancy and other bureaucratic techniques such as files, forms, charts, reports and other circulars, and by adopting new technologies such as the typewriter and the calculator. But they also improved their external information thanks to the telegraph or the telephone. And that will to control and coordinate dates back to the first civilizations, as Jack Goody showed in his book about the origins and the function of writing.[24] But today, these cumulated efforts have given birth to the "information society."

22. Martin Shubik, in Lamberton (ed.), op. cit., p. 359.

23. Jacob Marschak already considered the notion of "information revolution" as being well-known in 1968 in "Economics of Inquiring, Communicating, Deciding," *American Economic Review*, 1968.

24. Jack Goody, *The Domestication of the Savage Mind*, Cambridge University Press, 1977.

The concept was first introduced in the late fifties by economist Fritz Machlup, who was the first to understand the importance that new sector would gain in the U.S. economy and which would play a major role in the "production and distribution of knowledge."[25] He listed about thirty information industries classified into five categories: education, research and development, means of communication (the media), information-processing devices (such as computers) and information-providing services (finances, insurance, housing sector). The sector first employed more than 10 percent of the working population in the late 1880s and this rate then reached 25 percent in 1930, 42 percent in 1960 and more than 45 percent in the 1970s.

At that time, the information sector boomed thanks to the combined development of several technologies: mass media, telecommunications and computers. At the same time, digitization (the binary encoding of any information) blurred the boundaries between the various forms of information (words, figures, drawings, charts, pictures and sounds), and the progress is such that one day it will be possible to digitize, store, process and transmit in a binary form all the human feelings, tastes, smells and touches.

Many authors pointed out that acceleration of the information revolution long ago, like McLuhan and his global village (1964), Phillips and the communications age (1975), Evans and the Micro-Millenium (1979). Touraine and Bell spoke of an information-consuming post-industrial society in 1971 and 1973 respectively, and Mead underlined the increasing importance of information and knowledge in modern culture (1970).[26]

25. Fritz Machlup, *The Production and Distribution of Knowledge*, Princeton University Press, 1962.

26. Marshall McLuhan, *Understanding Media: The Extensions of Man*, McGraw-Hill, 1964; Kevin Phillips, *Mediacracy: American Parties and Politics in the Communications Age*, Doubleday, 1975; Christopher Evans, *The Micro Millenium*, Pocket Books, 1979; Alain Touraine, *The Post-Industrial Society*, Random House, 1971; Daniel Bell, *The Coming of Post-Industrial Society: A Venture in Social Forecasting*, Basic Books, 1973; and Margaret Mead, *Culture and Commitment: A Study of the Generation Gap*, Doubleday, 1970.

As in all the other industries, the advances concerned the conversion, storage, and transportation of basic products. In the case of information, this overall process amounts to encoding (a form of conversion and processing), storage, and transmission (a form of transportation).

Encoding, Storage, Processing, and Transmission

The advances in encoding, storage, data processing, and transmission began long before the modern technologies of the information revolution. The invention of writing and numbers was one of the first stages. The art of writing was even the first administrative technique according to Goody.

The same was true much later of the Morse code and the telegraph. In the information technology age, the main encoding means are the screen and keyboard, which have replaced the punch cards devised by Joseph-Marie Jacquard in 1801 for his looms, and later perfected by Hollerith for his tabulators in the late nineteenth century. These cards were still commonly used in computers in the early 1970s before the PC boom.

Progress continued with the invention of the scanner and the voice-recognition devices: the former allowed to decode (and thus encode) written texts by transforming them into zeros and ones and the latter did the same with language, which is indisputably the first information encoder and transmitter.[27]

In terms of storage, semiconductors' memory capacity has been increasing at a stunning pace since the early 1970s, while their price has been falling quickly.

The number of components on a memory card has increased by 50 percent every year since that date and there is no sign of a slow-

27. See Michael S. Scott Morton (ed.), *The Corporation of the 1990s*, Oxford University Press, 1991, and more especially the chapter written by Joanne Yates and Robert I. Benjamin, "The Past and Present as a Window on the Future," pp. 65–67.

down.[28] At the same time, the cost per megabyte fell by 35 percent every year. The steady reduction in the size of transistors allows continuously improved performances of these memory cards. Mass storage is made on hard disks or floppy disks, whose cost per megabyte collapsed by 38 percent every year between 1983 and 1994. The capacities are such today that storage is costless. Besides, with the new optical disks, it will be possible to store information much longer than with the current magnetic disks. In the future, digital disk storage will probably supplant all the other methods, even for videos. So that in the future, the libraries, especially with the e-Books which begin to appear on the market, will be contained in a few hard disks, floppy disks or movie archives.

But having such large-scale storage capacities would be useless if it was too costly to hunt for information afterwards. Hence, the decisive role of the new data-processing techniques. It must be possible to give a few search criteria to a computer whose data-processing speed is high enough to scan these huge information reserves and then find, file and extract the data likely to meet the request. And in that field too, the progress has been—and still is—remarkable.

From the very start of the revolution, in the mid 1960s, one of the pioneers of the Silicon Valley, Gordon Moore, CEO and founder of Intel Corporation, the world specialist in semiconductors, reported that, extrapolating the recent experience the number of transistors on a single silicon chip would double every year. Since then, it has been noticed that the doubling takes a little longer: about eighteen months. Yet, data-processing capacities thus increased geometrically, in a relation whose never-denied stability justifies its name of "Moore's Law."[29]

28. Lars Groth, *Future Organizational Design: The Scope for IT-based Enterprise*, Wiley, 1999, p. 193.

29. Stephen Cohen, John Bradford de Long and John Zysman, "An E-economy?," *Brad de Long's Home Page*, December 1999, www.j-bradford-delong.net. The original Moore contribution is: Gordon Moore, "Cramming More Components onto Integrated Circuits," *Electronics*, 39 (8), 1–4.

One of the most used microprocessors, the Intel 80-86 saw its calculation power increase by 50 percent each year between 1978 and 1997, while the price of a MIPS (Million of Instructions Per Second)—a unit measuring that power—fell by an average of 25 percent each year. As a result, the power was multiplied by 200 over twenty years, and the price/performance ratio improved three-hundred fold. Above all, these advances allowed the miniaturization of hardware, from the first ENIAC computer which weighed 30 tons to the latest palmtop of less than 300 grams. In 2010, computers' data-processing capacities will most certainly be ten-million fold higher than those of the 1975 computers. That evolution over such a short period of time led some science-fiction authors to predict that a computer would reach the data-processing capacity of a human brain between 2030 and 2040. But that will undoubtedly remain science fiction.

The progress was just as impressive with regard to communication and information transmission. Although mail already existed in Sumer, it is not until the invention of the optical and then electric telegraph in the eighteenth and nineteenth century that information technologies really took off. But the telephone, the radio and the computer gave them another dimension. For instance, the time necessary to transmit one page of text from New York to Chicago—over slightly less than 1,000 miles—fell repeatedly and at an increasing pace between 1840 and 1850 (before the railroads), and then after 1850 (advent of the railroad) and again after 1988 with the communication of computer data. From 252 hours initially, the time fell to 48 by rail, then to 0.083 by the telegraph and to 0.0019 by modem. At the same dates and with the same means, the speed of transmission was respectively of 3.37 mph, then 17.7, and eventually 10,240 mph with the telegraph and 447,000 mph with computers. The cost of the transmission of that page was 0.35 dollar in 1840, then 3 cents by rail after 1850, 7.50 dollars by the telegraph and 31 cents by computer and modem.

That results, all in all, in a performance in terms of miles covered

per hour and per dollar of 13.5 in 1840, 590 in 1850 by rail, 1,370 at the same date by the telegraph, and 1,440,000 in 1988 thanks to computers.

Under such circumstances, it is not surprising that all the curves representing communication volumes have expanded relentlessly in the recent decades. The phenomenal decline in costs generated exponential demand. The number of words, pictures, figures and sounds exchanged in the world is soaring. Already between 1960 and 1980, the number of words displayed in the various media had increased by more than 8 percent each year on average in the United States and by almost 10 percent each year in Japan.[30] Because of that accelerated fall in costs—in fields where figures play an essential part, like for instance finance—the "end of geography"[31] was even evoked. Thus, while the cost of a transaction in a retail bank is 1.07 dollar when it is performed in a branch, it falls to a mere 68 cents by telephone and 8 cents by Internet.[32]

As a production factor, information is just as necessary as capital and labor. It is a complement to both of them for their coordination in production. But it is used more intensely in the decentralized market production mode than in the hierarchical mode. When it becomes more abundant relatively to the other factors and the other goods and services, it is logically used more intensively. And the cost of the information-intensive production mode will decrease more sharply than that of the information-saving production mode.

30. Ithiel de Sola Pool, Hiroshi Inose, Nozomu Takasahi and Roger Hurwitz, *Communications Flows: A Census in the United States and Japan*, North-Holland, 1984.

31. O'Brien, *The End of Geography*. Conversely, although it recognizes the importance of the decline in the cost of transportation of people, goods and information, the new economic geography shows how the localization of several activities in the same place, and especially in cities, increases companies' comparative advantage and attracts investment. Far from being insignificant, localization becomes essential to explain investment flows and economic growth.

32. Larry Downes and Chumka Mui, *Unleashing the Killer App: Digital Strategies for Market Dominance*, Harvard Business School Press, 1998.

That surge in the volumes of information, thanks to its falling costs, also reduced the coordination costs in the economy. Thus, it lowered the relative cost of the information- intensive coordination mechanism—the market—compared with the information-saving coordination mechanism—the hierarchy. The information revolution explains the organization revolution.

The Downsizing of Corporate Hierarchies

Cheap information does not need to produce large cash flows to be as wealth-creating as scarce and expensive information. Its lower cost makes it easily profitable, even in less productive uses. Thus, it is no longer as necessary to save it and limit its use to a few people who know how to make the best of it. Its use becomes more widespread, more democratic. The decision-making power can thus be more widely distributed and the number of decision makers can increase.

In these new economic conditions, the great monolithic hierarchies tend to be replaced by a multitude of small pyramids which have given up the idea of producing everything by themselves. Instead of integrating the whole production process, from the extraction of raw materials to the delivery of the end product to the final consumer, they specialize in a particular stage of the production process. That vertical disintegration marks the resurgence of the 1860 Birmingham model. While in the late nineteenth century, the U.S. weapons industry had replaced a town and its hundreds of craftsmen by hierarchical corporations such as Colt or Remington, the reverse process is under way today.

In our aforementioned automobile example, a contemporary U.S. firm purchases various car components that it sells under its brand to companies all over the world, in Japan, Korea, Italy and Germany. It is thus almost in the same situation as the boss of a small firm in Birmingham who had only one warehouse, where he stored the var-

ious components of the rifle that a specialized subcontractor would then assemble before marketing the end product under its own brand.

The substitution of the Birmingham model for the Colt or Ford type 1911 models has recently resulted in a pick-up in market transactions between the smaller pyramids that have replaced the vast autarkic hierarchy. Today, when General Motors or Ford purchase car components in Europe or Asia, the transaction takes place on an interfirm market. The market develops when the pyramids get smaller.

The Disintegration

But the decentralization process takes many other forms than just vertical disintegration. That disintegration concerns the choice between manufacturing the "inputs" of the production process internally and purchasing them externally. But the company can also choose to have its own distribution system—as car manufacturers, bankers and insurers used to—or to use the services of independent distribution firms, as it is often the case with food and domestic products. It can also create joint subsidiaries with its competitors to exploit a particular product or market. Finally, it can opt for a strategy of diversification which almost turns it into a conglomerate, a kind of portfolio of businesses that have but few things in common, except the financial resources of their "internal capital market," and are managed rather independently.

Thus, depending on the starting point, the disintegration of the large pyramids can use different de-conglomeration processes: (1) joint-ventures are created to replace formerly fully owned foreign subsidiaries, (2) the exclusive distribution network is abandoned, (3) some of the departments dealing with specific products are sold, (4) part of the capital of some subsidiaries in which the company nevertheless holds a stake can be listed on the stock exchange ("spin-off"), (5) some of the managers can buy back the subsidiaries ("management buy-out") or (6) internal profit centers with a decentralized

management can be created and function almost like independent firms.

We must thus keep in mind the fact that the erosion of the pyramids is a protean phenomenon. With the decline of large-scale hierarchies, the company's external boundaries first tend to blur. We no longer know exactly the limits of its business. The disintegrating pyramid company first takes the shape of an amorphous group. Hence, the current fashion for "networked firms," "alliances," "participative organizations" and "virtual companies." They only mirror the loss of power undergone by the hierarchies and their effort to get closer to a decentralized market organization. But the latter is in reality only an extreme case.

Indeed, nothing suggests that we will fully return to the Birmingham model. As always in economics, the optimum solution is a mix of the extremes. Nobody wants to eat only steak-fries or pizzas. The optimum most often lies in variety. The decline of hierarchies does not lead to a world of craftsmen only. But the age of the Taylorian and Weberian administrative giants—public or private—is over.

Thus, the total number of decision makers and hierarchies in the economy has increased, but each hierarchy now has a smaller size on average. Hence, the reduction in the number of command levels. Businesses become "flatter," less hierarchical. In fact, less intermediate administrative managers are required to supervise a smaller number of field producers. Since each supervisor can control a given number of subordinates—which has not changed significantly—the structure resembles that of very small companies, where the boss manages and supervises his employees almost on his own.

Obviously, the relation between the information revolution and the decline of large-scale organizations has been underlined by many observers, if only because both phenomena occurred simultaneously. But so far there has been no convincing explanation about possible causal relations between the two phenomena. The development of markets is often explained by a change in political or economic ideas.

And the restructuring and downsizing of companies is justified by financial markets' and shareholders' greater demand for high profitability—while before, they were thought less concerned by this issue or were not entitled to their say—but without giving the reasons for such a reversal. Besides, despite many studies that belong to the Coase-Williamson tradition, very few specialists view the development of markets as the necessary complement to the decline of hierarchies since both mechanisms are substitutes. But we must say we still lack really general data about the overall reduction in firms' average size. This explains why current misconceptions survive. All in all, the general conception is that markets developed because of the ever-increasing greed of the capitalists, while firms restructured to become larger and not smaller.

Obviously, the first interpretation is no explanation: it is difficult to understand why the market supporters would have suddenly let their greed awaken in the 1980s. The second is contrary to the facts, as shown previously.

A few authors admit the causal relation between information and organization but without explaining the reasons, however. For instance, Malone, Yates and Benjamin have published an article about "electronic markets and hierarchies," in which they explained that the new information technologies reduce the coordination and transaction costs as these activities require an intensive use of information flows. Taking up Coase and Williamson's market/hierarchy alternative, they indicate, like Coase, that markets involve high costs due to the numerous transactions they require. Consequently, "an overall reduction in the *unit costs* of coordination would reduce the importance of the coordination cost dimension (on which markets are weak) and thus lead to markets becoming more desirable in situations where internal transactions were previously favored. In other words, the result of reducing coordination costs without changing anything else should be an increase in the proportion of economic activity coordinated by markets."

This intuition is right, but there remains to be proved the reasons why the markets are "weaker" than the hierarchies in terms of coordination costs. It was empirically confirmed in a very interesting 1994 study carried out on several companies of various large U.S. sectors from 1975 to 1989 that their IT investments were negatively correlated to their size.[33] The larger volumes of information and the reduced costs that this equipment involves thus easily explains the choice of smaller hierarchies. That corroborates the previous assumption.

We have thus a first confirmation that the evolution of information costs does account for the downsizing and disintegration of large hierarchical structures but also for the refocusing on core business, for the dismantling of conglomerates and for the secession movements in the most heterogeneous nations. This latter assertion follows from the fact that basically a state is, in economic terms, a firm, a production team run by a hierarchy (a bureaucracy) offering a range of services, even if these are not individually priced on markets but offered as a block-selling proposition for a single, compulsory, fee. Indeed, "Max Weber has pointed out that all hierarchically structured organizations (bureaucracies) are run by managers whose functions are broadly similar, whether they manage government bureaus (civil servants), corporate business firms (executives), churches (clerics), armies (officers), political parties, labor unions, hospitals or other modern organizations (functionaries)."[34]

While commercial, for profit, firms downsize by the means of carve-outs, spinoffs, and breakups, states, which are basically territorial firms, downsize by privatization (refocusing on their core business) and/or by divestiture from colonies abroad or whole regions at

33. Erik Brynjölfsson, Thomas W. Malone, Vijay Gurbaxani, and Ajit Kambil, "Does Information Technology Lead to Smaller Firms?" *Management Science*, December 1994.

34. Martin J. Beckmann, *Tinbergen Lectures on Organization Theory*, Springer-Verlag, 1988, p. 54, quoting Weber's *Wirtschaft und Gesellschaft*, 1925, part III, ch. 6, pp. 650–78, translated in English as *Economy and Society*, Berkeley: University of California Press, 1978.

home which obtain some management leeway or complete independence, that is, secession.

Just as some middle managers in commercial firms take over parts of their firms through LBOs, local and regional political managers see an opportunity when the size of the centralized state does not fit anymore the equilibrium range. They become advocates of secession because they believe that they can run more efficiently, and with greater benefits for themselves, a former region of a large state as a newly independent entity. This is the reason why secessionist movements acquired such a growing following in recent years. Many of them represented a winning proposition.

The cause of the decline of hierarchies and the great comeback of markets is the new abundance of information, whose quantity grows faster than that of any other good or service. As a result, the ratio between the quantity of goods and the quantity of information decreases, so that a larger amount of information can be included in each unit of goods produced. As the relative cost of information falls, its use increases and the most information-intensive production modes see their comparative advantage develop.

Markets develop to the detriment of hierarchies and especially to corporate hierarchies. But the effects of the information revolution are not limited to business firms. They also concern the state as a firm and consequently political organizations and regimes.

The Explanation of the State's Growth and of Privatization

Analyzing the relative efficiency of the hierarchical organization gives a simple and direct answer to the widely-debated mystery of the century: the growth of the state. Many economists have tried to explain it, but all their analyses were strongly criticized.

At first, in the early twentieth century, the "welfare economists" developed a theory about market failure that prefigured the analysis of public goods made later on. The state was supposed to step in

whenever competition was imperfect, when there was a private monopoly or when the markets were unable to produce a good or service by themselves. But in retrospect, it appears that this argument is faulty. The simple fact that markets do not work very well or fail to produce certain goods or services is not enough to justify public intervention. As Harold Demsetz underlined, state intervention can itself be imperfect.[35] Then, it must be proven that the state is less imperfect than the market. But in many cases it is not the case. Many authors of the public choice school supported the opposite view: generally, policy makers focus on the short term given the brevity of their tenure. They have no time to bother about the efficiency of the public administrations and, besides, they cannot be efficient managers given their vast fields of action. Finally, the various lobbies will compete to obtain ever larger rents and will thus impede the search for efficient policies.

All in all, public choice literature concludes that chronic political malfunctioning is the rule. The states' internal growth would generally deteriorate the collective welfare. And the private interests that it involves always take the upper hand against general interest.

But, once again, the debate was recently revived by developments in the analysis of public choices reversing the perspective. According to this new current of thought, the democratic system or the competition among pressure groups would make political interventions efficient. There would not be more "political failures" than "market failures."[36] Then, the growth of the state could no longer be explained by the virtuous correction of market imperfections or by the imperfections of political life itself, which encourages each individual to ask for more state interventions to his own advantage.

Other explanations have been put forward suggesting that the

35. Harold Demsetz, "Information and Efficiency: Another Viewpoint," *Journal of Law and Economics*, 1969.

36. Gary S. Becker, "Competition Among Pressure Groups for Political Influence," *Quarterly Journal of Economics*, 1983. Donald Wittman, *The Myth of Democratic Failure: Why Political Institutions Are Efficient*, University of Chicago Press, 1995.

state's growth resulted from a succession of accidents that occurred over the years, such as the great wars, and required an immediate and sharp increase in public spending. Once the financial efforts were made and the new civil servants and habits introduced, there would be a kind of ratchet mechanism preventing from turning back. But where would that "ratchet effect" come from? Why would it be impossible to cut taxes and public planning once peace is restored?

According to some economists, it is because of the rise of bureaucracy, which had already started at the very end of the nineteenth century. As they have a monopoly in the supply of some services, bureaucrats can impose their own views and interests on policymakers and obtain in particular steady increases in their budgets, as Niskanen suggested. But why do taxpayers not protest against those growing expenditures if they are useless or simply inefficient? In other terms, why would they let the state rob them of their purchasing power to the benefit of the civil servants?

We can thus conclude to the existence of a "fiscal illusion" saying that taxes that are widely distributed among the whole population are relatively painless and can thus go relatively unnoticed, while the lobbies—which are highly aware of the precise amount of aid they receive—campaign efficiently against political authorities to obtain ever more public aid. In those conditions, the taxpayer would structurally be the victim of the lobbies. But that illusion must have its limits, otherwise the triumphant bureaucracy would already have monopolized the whole national income to redistribute it to the various organized groups that live on public income transfers.

Other authors, like Richard and Meltzer or Peltzman, suggested that in a democracy the skewed distribution of wealth would encourage a majority of voters with incomes lower than the median to always increase the fiscal burden weighing on a minority of high incomes. But, in that case, we would have to suppose that there is a widening gap between the median and average incomes—that is a growing asymmetry in the distribution of wealth—that explains this continu-

ous move toward more state growth rather than just a stable equilibrium level at which the proportion of the state in the economy would settle lastingly. Has there really been a steady trend toward a more asymmetrical statistical distribution of income in all the countries over the century? Did it indeed reverse in the mid-century? No. On the contrary, all the available data show that the range of wages and incomes tended to narrow from World War I to the 1960s and then widened again during the recent decades. Thus, the explanation based on the disparity between incomes and the demand for a redistribution seems faulty too.

So, we are left with the ideological hypothesis. According to this theory, the contemporary decline in state control (which was made obvious by the general privatization wave) can be explained by the return of the Liberal ideology, notably the free-trade and lower state protectionism policies adopted and supported by the International Monetary Fund and the World Bank in the form of the so-called "Washington Consensus." But explaining the recent and relative slowdown in the state's growth by the revival of the liberal conceptions only shifts the problem, as the factors explaining the revival of liberalism remain unexplained.

And must we admit that ideological changes determine political changes? Are political ideas totally impervious to the supposedly discretionary social realities?

The Perspective of Optimal Organization

This explanation becomes much simpler and less arbitrary if we consider that any organization must have an optimal size. As a state is a firm producing public services, its size depends on the same general factors as any other hierarchy. In the geographical framework of a given nation, it is the optimal dimension of the hierarchy that determines the size of the state firm within the economy.

The larger the optimal size of the state or private hierarchy (both

depending on the cost of information, assumed to be the same for private and public bureaucracies alike) for a national economy of a given size, the more the state-firm will be eager to take control of numerous activities to reach its optimum. Just like expanding private firms and conglomerates, an expanding public hierarchy will tend to absorb all types of activities that are private by nature (for instance, car makers, chemical factories, mines and shipyards). It is the greater efficiency of centralized administrative management that drives the expanding state, just like any private firm, to take over other companies, including those whose activities could as well be managed by private centralized hierarchies. It should be clear that states are efficient because they are submitted to competition, both internal and external, but in a different way from private enterprises. They do not try to maximize profits. They maximize their political efficiency (maximization of votes or of survival prospect in power) by redistributing income, according to the demands on political markets, and relying on their comparative advantage in coercion which is their basic and original raison d'être. The state-firm does not absorb private companies simply to produce cars, chemicals or computers but rather to use their resources—their cash flow—to achieve its targets, that is, the production of services that redistribute wealth to various electoral clienteles. They do this as far as they value, for their own purpose, firms more than private investors do, as I showed in my theory of nationalization and privatization, that was confirmed empirically by the OECD countries' experiences.[37] It means that they develop the public sector as long as the state's cost of capital is lower than the private investor's cost of capital.

When the integration of various private activities into the state conglomerate becomes cheaper—either because the optimal size of the administrative pyramids increases or because the purchase cost of private pyramids falls—the state's field of action—the public sector—

37. Jean-Jacques Rosa, "Nationalization, Privatization, and the Allocation of Financial Property Rights," *Public Choice*, 1993.

grows. And conversely, it shrinks when large-sized pyramids become less efficient while the purchase cost of private companies increases.

This explains the development of vast public sectors which tended to operate as monopolies in various industries that are private by nature during the first twentieth century, and thus the trend toward privatization in the second twentieth century. That downsizing of the state resulted in a de-hierarchization, a reduction in the society's centralization rate.

Another consequence of the analysis concerns the choice of the internal political regime. There again, we are led to think that it is not the result of an absolute preference nor of an ideology, but of the costs involved or abundance of information since it depends on the size of the state pyramid.

This confirms the importance of information in a democracy, which has already been underlined by many classical authors. But they consider that, ideally, information is necessary for a democracy to run smoothly and to be effectively managed by the citizens. We just say in a positive and non-normative way, that in reality, the democracy will be all the less expensive and all the more efficient as information is abundant. Information is indeed more widely used when it is cheaper and more efficient.

After having developed these analyses, it is interesting to mention Shubik's intuition who, studying the functioning of the information economy, understood its impact on politics in general and the overall characteristics of the civilization of Enlightenment but without explaining it:

> The 18th and 19th centuries will probably be remembered as the brief interval during which the growth of communication means and knowledge compared with the population, the speed of social and political changes and the global amount of knowledge favored individualism and independence.[38]

38. Martin Shubik, "Information, Rationality and Free Choice in a Future Democratic Society," *Daedalus*, vol. 96, 1967.

Conclusion

In the analyses we have just developed, we implicitly suppose that the state is a nation-state with a given geographical size.

But the twentieth century also saw major geographical transformations in nation-states with imperialism and nationalism, colonialism, the concentration of the world's nations, then the reverse movement with the disintegration and collapse of all the empires. Can the theory of information and organization also explain these changes? Does the creative disintegration phenomenon also affect the external organization of the state-firm and the system of nation-states?

Does the analysis of organizations also explain the changes in the state's external dimensions? The answer is clearly yes because the state-firm is an organization which, like any other firm, has two ways to develop: either by selling more services to a given clientele (this is called "intensive" growth) or by broadening its clientele by itself (this is called "extensive" growth).

The state thus grows by offering more services, mostly redistributive ones which form a kind of retrospective insurance policy, a mutualization of risks after the accident has occurred. For example, the government will help people after oil slicks and droughts but also aid the people with no income, ill or maladjusted living on its territory. It finances that "internal growth" by increasing its fiscal and parafiscal revenues, and thus the "sales" corresponding to that clientele. But it can also use "external" and "extensive" growth, through the conquest and takeover of new territories, populations and "customers." In that case, it is the size of the nation-state that adjusts itself to the optimal size of the state's hierarchical apparatus and to its increasing capacity to produce services.

We will analyze this in the next chapter.