Contracts as Modular Mechanisms: Some Propositions for the Study of “Hybrid Forms”

Eric Brousseau


Abstract

This paper proposes a “morphological grammar” intended to describe any type of contract between two economic agents. A contract is considered as a combination of coordination mechanisms that ensure the creation of a quasi-rent and its sharing between contractors. Three types of mechanism are distinguished: those that ensure the technical governance of transactions (compatibility of actions), those that guarantee the enforcement of promises, and those that operate the remuneration of participants. In addition only a few options are available to design each mechanism. Therefore any coordination process can be described through a limited collection of mechanisms that have a limited number of possible designs.

Although the grammar proposed here is open to discussion, the methodology supported by the modular conception of contracts seems particularly powerful. At the empirical level it enables scholars to describe contracts precisely and to compare actual coordination mechanisms. At the theoretical level, it is a way to simplify the analysis of complex decisions (i.e. contract design) and of complex phenomena (i.e. the contracts’ properties).

The “grammar” is used for an applied study of the impact of Information and Communications Technologies on coordination processes among firms to illustrate its analytical potential.

Key words:

Contract theory — Transaction Cost Economics — Agency Theory — Impact of Information Technologies — Inter-firm Coordination

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1. INTRODUCTION

As pointed out by Williamson [1985] and many other scholars (especially MacNeil [1974, 1978], Coase [1988], Imai & Itami [1984] and Aoki [1988]), most of the actual coordination processes take after both the “Market” and the “Hierarchy” (Coase [1937], Williamson [1975]) because they combine mechanisms that resemble the market — e.g. prices, involvements of limited duration — and that are characteristic of hierarchies — e.g. specialized supervision processes, delegation of authority. Theoretical and applied analyses have been carried out to obtain a better understanding of these hybrid forms of coordination. Because of methodological difficulties, however, these hybrid forms continue to be analytically under-used. As a consequence, most theoretical and applied studies on coordination devices continue to rely upon the traditional categories of "Market" and "Hierarchy", even when they are misadapted to the question. This often leads to misinterpretation or, at least, to approximate analyses.

This phenomenon is partially caused by the difficulty of grasping the concept of hybrid forms and, more precisely, of comparing hybrids with each other. This difficulty is linked to the lack of a unified tool able to describe coordination processes. Indeed, most studies on hybrid coordination modes focus on one specific type of contract or organization — e.g. joint-ventures, bilateral governance, long-term contracts, etc. — which is generally compared with "pure" coordination processes (i.e. the "Market" and the "Hierarchy"), but not with other hybrids. This leads to a "weak" definition of each hybrid which is fuzzily described as an "intermediary" coordination mode between the "Market" and the "Hierarchy". It is thus difficult to compare hybrids and, therefore, (i) to build an actual synthesis of the knowledge accumulated on them, or (ii) to take them into account in applied and theoretical analyses.

It would be useful to have at the research community’s disposal a tool able to take into account the diverse categories of hybrid coordination mode because, as pointed out by Coase [1988], the problem today is no longer to identify the properties of the market and of the hierarchy, but to analyze the differences among the multiple types of actual coordination modes, which are most often hybrid. In this paper, we will propose a framework intended to describe and differentiate between the diverse types of hybrid (and also "pure") coordination processes. More precisely, we will develop a “morphological grammar” capable of describing bilateral coordination mechanisms — hereafter qualified as contracts — by precisely qualifying their essential features. Such a grammar will enable scholars to describe contracts precisely, while avoiding the fuzziness linked to complex comprehensive description. This is both the necessary condition for a systematic analysis of “hybrid” coordination modes, and for a systematic use of them in research. The grammar proposed hereafter is axiomatic, but it is based on a synthesis of contract theories (i.e. essentially Transaction Cost Economics (TCE) and Agency Theory; cf. Brousseau [1989, 1993]) and on deductive reasoning of what a contract is in a world of bounded rationality and information failures.
Analytical problems that ensue from the lack of a unified descriptive system of contractual (organizational) arrangements will be first pointed out (§ 2). Then the grammar will be presented (§ 3). The workability and usefulness of these propositions will then be demonstrated through a statistical study of the organizational impact of the use of Information and Communication Technologies (ICTs) in a sample of inter-firm contracts (§ 4). The results of this applied analysis emphasize the analytical insights of our proposals (§ 5).

2. THE PROBLEMS WITH CONTRACT DESCRIPTION

As pointed out by Williamson himself, TCE suffers from limitations due to an excessive degree of freedom (Williamson [1985], p. 390-391) and the description of coordination arrangements is one field in which this problem particularly occurs. Two solutions are often adopted: the first consists in opposing two (or a small number) of radically different types of coordination arrangements; the second consists in describing contract mechanisms in detail. However, these two solutions have severe limitations.

The first — hereafter the “axiomatic definition” approach — is very powerful and convenient. As illustrated by Coase [1937] and Williamson [1985], one of the axiomatic definitions — the “market” versus “hierarchy” framework — made it possible to identify very important issues and led to major insights. However, as pointed out by Coase [1988], a much more precise framework is required when one studies actual contractual and organizational arrangements, because economic agents do not use either pure market or pure hierarchic coordination procedures. This dyadic opposition is nevertheless frequently used to describe contract and contractual choices in theoretical — e.g. Williamson [1985] — and in applied — e.g. Walker & Weber [1984], Anderson & Schmittlein [1984] — works because it simplifies both modelization and applied approaches (especially by the use of probit and logit techniques; see the survey by Masten, Meehan, Snyder, [1991]), but it suffers from two major limitations.

The first ensues from the fact that a single appellation does not have an identical meaning for all scholars. For instance, for some the “market” is essentially a very unorganized and unformalized “natural coordination mode”, but for others it is the neo-classical model, and is therefore very organized and formalized (auctioneer, etc.). Put another way, for the former “market” means essentially decentralization, while for the latter it is synonymous with price based coordination. The same problem arises with hierarchy. For Williamson [1975 & 1985], it is characterized by the use of a “governance structure”. For others (e.g. Holmstrom [1982]), it is a supervision and coercion mechanism. Obviously each of these definitions is individually consistent and these diverse meanings are not strictly contradictory, but as they are not completely identical, it causes problems when one tries to compare the different research.
The second limitation of the “axiomatic definition” approach ensues from the fact that this type of description implicitly assumes that coordination arrangements pertain to exclusive and radically opposed categories. This is, at least partially, in contradiction with the very concept of “hybrid” forms, where to ensure coordination among agents, a contract typically implements several complementary coordination mechanisms. These include routines and authority mechanisms (especially analyzed by TCE; see Williamson [1985]), in addition to incentives and supervision mechanisms (especially studied by incentive and agency theories; see the surveys by Hart & Holmstrom [1987] and Arrow [1985]). When coordination arrangements are described in terms of “market” or “hierarchy” types, one implicitly assumes that, on the one hand, there is a “market type” of “governance” mechanism irremediably affiliated to “market type” incentives and supervision mechanisms, and that, on the other hand, there are “hierarchical” “governance”, incentives and supervision mechanisms that are always used in conjunction. One therefore refutes the idea of “hybrid forms” in which hierarchical coordination mechanisms (like authority) are associated with, for instance, incentive mechanisms that are characteristic of the market. Obviously, to increase the number of axiomatic categories does not solve this problem of “hybrid” forms.

To overcome the limits of axiomatic categorizations, the second methodology describes coordination mechanisms “in extenso” by detailing each of their features (e.g. the work of Goldberg & Erickson [1987] or Joskow [1987] on long term contracts). This type of comprehensive definition is very precise. However, as descriptive methods (and languages) are not standardized, it is difficult to establish comparisons between the diverse contracts studied by various authors.

To sum up, when scholars have to describe a coordination mechanism they typically use either axiomatically defined general categories, or describe them “in extenso” by giving each of their features. The axiomatic definition causes many problems because it leads to a very rough and approximate description of contractual arrangements, and because each scholar chooses his own interpretation. The “in extenso” definitions are very precise but not standardized, thus preventing the collective accumulation of their findings. Most of the methodologies used to describe contracts are, therefore, in a sense deficient because they do not enable the research community to undertake applied research or empirical validation that can be replicated and accumulated.

This suggests the need for some method capable of describing coordination mechanisms more precisely. As mentioned above, contracts are composed of complementary mechanisms — like authority, supervision or incentive mechanisms — that ensure different functions. They can thus be described by establishing the nature of each of these mechanisms. In fact, this is not far from Lancaster’s descriptions of goods [1979]. Rather than designating them by “axiomatic” names, he chose to describe each good by the collection of its features. In this paper a framework aimed at the description of contracts as a collection of coordination features will be proposed.
3. **THE MODULARITY OF CONTRACTS: THE COMBINATION OF SEVEN CLAUSES**

Our morphological grammar relies on a synthesis of contract theories (Brousseau [1993]) and especially TCE (Williamson [1985]), Agency Theory (Hart & Holmstrom [1987], Arrow [1985]) and so-called “Convention” Theory (Revue Economique [1989]). Its aim is to make possible the description of any type of bilateral contractual arrangements.

A contract is an arrangement between two parties about what each of them shall do to realize value through their relationship. Contracts are designed to regulate spot exchanges as well as long-term interactions. In a world of bounded rationality and information failures, they have three essential functions:

— to enable contractors to co-ordinate their actions successfully. As pointed out by Williamson [1985] (as well as Simon [1951], Mayer [1960], Hess [1983]), since the future is uncertain, and human rationality “bounded”, economic agents do not undertake systematically “compatible” actions. Disequilibrium costs can be economized when some types of mechanism are designed to establish for each party the actions that collectively generate a desirable output;

— to ensure the enforcement of promises. As pointed out by Commons [1934], the value of a transaction is inherently uncertain. Between any agreement to enter into an exchange and the fulfillment of it, intentional or accidental events might arise to threaten its completion. For this reason coordination devices include a “guarantor function” able to require restitution of losses to the remaining party in case of defection by the other (Salancick & Leblebici [1985]);

— to share the quasi-rent. When compatibility is ensured and when promises are enforced, a quasi-composite rent is generated (Goldberg [1976], Klein, Crawford & Alchian [1978], Alchian & Woodward [1988]). The third function of contracts is to share this quasi-rent among the participants.

These elements lead to a functional conception of contracts in which a contract can be perceived as a set of mechanisms designed to cope with these three main objectives. There are three categories of mechanism: the first solves the compatibility problem; the combination of the mechanisms belonging to the second and the third categories solves the promise enforcement and the quasi-rent sharing problems. Thus:

— a first set of “technical governance” mechanisms enables contractors to define the actions that the different parties have to undertake in order to produce the quasi-rent;
— a second set of enforcement mechanisms is designed to avoid opportunistic behavior and to constrain agents to enforce their promises;

— a remuneration mechanism incites agents (i) to adopt efficient behavior, and (ii) to enforce the contracts. It also defines a sharing procedure.

These three categories are present in any type of contract. Thus, one can assume that any kind of coordination process can be described with a limited number of items, or “clauses”, defining each of these mechanisms. Furthermore, there are only a few mutually exclusive options to design each mechanism. Put another way, each clause can only take a finite number of states, each of which corresponds to a possible mechanism design. For instance, the supervision can be operated by (1) each party, (2) a generic mechanism like the court or a specialized supervisor who can be either (3) one of the parties or (4) a third party. Therefore a coordination process can be described through a collection of clauses A_i, B_j, C_k (…) describing the state i,j,k taken by each clause A, B, C. This conception of discrete coordination solutions is defended by Williamson [1985, 1991].

In the following sections these clauses — corresponding to the technical governance of transactions (§ 3.1), the enforcement mode (§ 3.2), and the remuneration procedure (§ 3.3) — and their alternative designs will be described. A last clause, which does not define any mechanism but the contract duration (§ 3.4), is also proposed to obtain a better description of contractual arrangements. This discussion is summed-up in the table I (p. *** and illustrated by diverse examples (p. ***).

### 3.1. The “technical” governance of transaction: authority and routines

To undertake compatible and efficient actions, agents have to design a mechanism that tells them what to do during the co-operation process. These requirements can be conceived ex-ante when the contract is signed or ex-post during its fulfillment. In the first case, the contract is complete. It establishes routines (Nelson & Winter [1982], Favereau [1989]) that fully define the behavior of each contractor given each possible state of the world (e.g. Simon [1951]). If these routines are no longer well designed, there is no possibility of redesigning the contract. A new one has to be renegotiated. When it is too complex or too costly to design a complete contract — because of bounded rationality and uncertainty — one can draw up an incomplete contract. In this case, decisions have to be made at each stage of the co-operation process to define each participant's behavior given the state of the world. This type of arrangement induces the acceptance by both parties of an authority mechanism (Williamson [1985], Hess [1983], Ménard [1990]). Authority is the “the right to decide how the assets are to be used in events unspecified in an initial contract” (Hart & Moore [1990]). Therefore it is the "residual rights" which allow one agent (centralized authority) or
both (decentralized authority, i.e. internal bargaining) to redefine the solutions (i.e. the actual content of the contracts) to the diverse coordination problems that a coalition faces.

As a consequence, when they sign a contract, economic agents can adopt three alternative solutions in order to ensure technical coordination: (1) to define routines (the way of using assets is fixed ex-ante and there is no means of redesigning it during the contract); (2) to implement a centralized authority mechanism (one of the agents has the discretionary right to redefine the use of the resources involved in the transactions); (3) to design a decentralized authority mechanism: the contractors can bargain to re-define the use of the resources involved in the transaction).

In technical coordination, three decision “levels” have to be differentiated because, when they decide to co-operate, economic agents have to decide if the contract is complete or incomplete regarding diverse categories of problems. These include the choice of a collective strategy toward other “coalitions”, the way of using assets, and the modalities of their intervention through space and time. Comparable discrimination among decision levels is common in the organization literature (e.g. Ansoff [1968], Carlson [1989]) since these diverse decision types do not have the same impact (in terms of importance and duration) on assets' valuation, and since each decision level can require a specific solution. This is why we will consider that the technical governance of a transaction is governed by different clauses which are independent of each other.

— The first clause (A) describes the **strategic coordination** mode. It concerns the process that is set up to redefine the objective of the coalition (i.e. its output and therefore the market on which the coalition competes and the way it competes: price discrimination, differentiation, innovation, etc.). The contract defines it ex-ante, but this objective can be redefined when a contingency occurs. This clause states clearly the modality that enables — or not — co-contractors to redefine the output of the co-operation without changing the contractual arrangement. To illustrate, one can take the example of consortia created by companies. The contracts among parents can precisely set the objectives of the consortium in terms of goods to be produced, market segment to be served, and marketing policy to be implemented (like in the European Aerospace industry in which many consortia are created to produce a single type of plane), or it can vaguely define it, relying on future negotiations to precise the consortium’s actual goal and strategy (as it is often the case when a cooperative R&D process is launched). In the first case the strategic coordination is based on routines, in the second cases, it is based on a decentralized authority mechanism.

— The second clause (B) concerns the **“organizational” coordination mode.** It concerns the ability to re-assign tasks among participants or to re-define the nature of the utility brought in by each party without altering the goal of the contractual arrangement (clause A). In other words, when a contingency occurs, this clause defines the way co-contractors can reorganize, or not, the production and the exchange process. To give an example, one can evoke the case of supplying contracts in the industry. The contract can completely define the
technical specifications of the goods (or services) to be delivered by the supplier, or it can leave them open to further definitions by one of the parties (which accumulates experiments or performs R&D). These types of incomplete supplying contracts are increasingly frequent in the automotive industry because of the permanent improvement of cars. They are also frequent in the construction industry because of the high uncertainty of the activity (see Brousseau [1994]). They enable firms to redesign and reassign tasks among them throughout the fulfillment of contracts.

— The third clause (C) describes the operational coordination mode. It concerns the power to modulate, through time and space, the modality of usage of the different assets involved in the transaction. It means defining the intensity of use of one input, the product delivery rhythm, or the schedule to be enforced to adapt the cooperation to short-term and local contingencies. Here again the case of supplying contracts can be evoked. The contract can precisely define the time and place where goods have to be delivered or, it can leave open the date and place of shipment and the quantities to be delivered. A further (cooperative or hierarchical) coordination is then needed, and an authoritarian mechanism is designed to operate it.

For each of these clauses one of the three alternative solutions — i.e. routines, centralized or decentralized authority mechanism — is implemented. These three clauses establish the “technical” coordination mechanism.

### 3.2. The Enforcement Mode

The enforcement mechanisms are designed to incite agents to abide by the terms of the contract. They combine a supervision mechanism and a guarantor mechanism. The goal of the first is to evaluate the behavior of contractors and to compel cheaters to follow the required behavior (Becker [1968], Polinsky & Shavell [1979], Nalebuff & Schartstein [1985], Williamson [1985]). The second manipulates the exit costs to avoid opportunistic behavior by making the pay-off of cheating lower than the costs of breaking the contract (Williamson [1985]). Without a credible commitment system, the supervision mechanism is useless because the supervisor does not have any means to compel contractors to enforce their promises. Hence, the enforcement mode is composed of a set of two mechanisms that are specified by clause D, which organizes a credible commitment system, and clause E, which designates a supervision mechanism.

**Credible commitments** (clause D) can protect each agent from his partner’s opportunism by modifying the specificity properties of each agent's assets. In a bilateral relationship, there are three alternatives.
1) No credible commitment is implemented: the assets' specificity determine the agents' opportunistic behavior (because it induces exit costs);

2) Unilateral application: one of the agents deposits a "hostage" (Williamson [1985]) in the hands of the other. This hostage is a resource that will become the partner's property if the previous promises are not respected;

3) Bilateral application: a bilateral "hostage" model is implemented to create a mutual reliance relationship. Both partners agree to modify the specificity of the inputs involved in the transaction to guarantee its durability.

The more usual credible commitment system is to pay a deposit as in rental agreements. But it can also consist in an obligation to invest in specific assets as it is frequent in franchise contracts.

To verify that each party to a transaction is respecting its promises, control has to be exercised. Therefore a supervision mechanism (clause E) is instituted. An agent takes on the task of determining how the tasks are performed. When necessary, he tries to persuade the violator to change his behavior for fear of punishment or of termination of the agreement. Four alternative solutions can be implemented

1) Self-enforcement: each party exercises control over the other(s). If one party violates the terms of the contract, the only recourse of the other(s) is to terminate the agreement;

2) External non-specialized arbitrator: the Court and the Law are the only mode of conflict solution. It is an ex-post and external mechanism. If one party violates the contract, the sole solution for the other is to bring the case to the Court where the guilt of the other and the extent of the loss he has suffered will have to be proved;

3 & 4) In the last two cases, an agent is specialized in performing the task of controlling the transactors. He is specialized in supervising this type of transaction and these precise partners. He is therefore more efficient than an unspecialized system (Williamson [1985], Tirole [1988]). He obtains a right of investigation and means of coercion that enable him to oblige both parties to enforce the letter and the spirit of the contract. The supervisor can be one of the co-contractors (3) or it can be a third party, which is paid to supervise the contract (4). To illustrate, the former corresponds to the standard labor contract in which the employer gets the right to evaluate, and punish, or reward its employee’s behavior, while the latter corresponds to contracts between firms when they have to execute highly specific transactions that only expert can audit. In the construction or in the engineering industries, for instance, independent experts are frequently required to evaluate the actual fulfillment of (legal and contractual) obligations.
3.3. **The Remuneration and Risk Sharing Mode**

The *remuneration system* simultaneously solves (partially; Cf. supra) the risk sharing and the effort incentive problems:

— when the future is uncertain, the quasi-rent generated by a contractual arrangement is subject to chance: it can be very different and even negative as compared to that anticipated. The agents have to decide ex-ante how to share these uncertain benefits or losses.

— To pay a supplier regarding its actual contribution to the collective result enables contractors to avoid resource misallocations and has interesting incentive properties. However, because some inputs are not easily measurable, it is often very expensive, and sometimes impossible to remunerate them according to their marginal productivity. Therefore, economic agents choose a remuneration mode by balancing out the properties of incentive systems with their costs.

The different remuneration mechanisms will thus be discriminated through:

— the chosen solution to assume the losses that might be caused by uncertainty. If the remuneration is based on the output, the risk is borne by the two agents who share the profits as well as the losses, but the risk can also be fully assumed by only one agent who takes on the losses as well receiving all the benefits.

— the chosen solution in matter of incentives. Some remuneration regimes are collective in the sense that the agents are remunerated according to the performance of the coalition, whereas others are individualistic in the sense that each party is remunerated on the basis of its actual contribution to the collective performance. In the first case, the output is divided among contractors, but the contribution of each party is not the basis of the sharing process. In the second case, agents are remunerated according to the characteristics and the productivity of their assets.

Therefore, we will distinguish four remuneration systems (clause F):

1 & 2) The remuneration of the contractors is based on the output. In other words the risk is borne by the two agents who share the profits as well as the losses.

1) on a customized basis: each assets' owner is remunerated at its marginal productivity (or according to something that indicates its actual contribution to the collective result);

2) on a collective basis: the output is divided among contractors, but the actual contribution of each party is not the basis of the sharing process; the sharing out is defined by an ex-ante rule that is not influenced by the actual contribution. The sharing rule is fixed.
3 & 4) The risk is fully borne by only one agent who assumes the losses and collects the profits. He remunerates the other’s assets:

3) on a flat rate basis: the input is remunerated ex-ante and the intensity of its actual use is not taken into account.

4) on an intensity of use basis: the assets are remunerated ex-post depending on the effort or the intensity with which they have been used

Considering the example of the relation between the owner of a labor power and the owner of a capital good, the former system corresponds to a pure market contracts (as defined by the standard neoclassical theory) on a perfectly competitive market in which each party is remunerated at its marginal productivity thanks the efficiency of a flexible price system; the second solution squares with the formation of a producers’ co-operative in which each party is remunerated according to a fixed sharing of the collective net result; the two later fit with the classic labor contracts between an employer and an employee, but the third is similar to the contract with a fixed monthly salary, while the fourth resembles to the piece rate remuneration.

3.4. The Contract Duration

Obviously, the efficiency of a contractual arrangement in many cases will depend on its duration (clause G), because this will change the behavior of either agent. This clause can take three different values: 1) Spot contract: the contract concerns only one transaction; 2) Short-term contract: the contract covers several transactions, but no-one can change the characteristic of their assets; 3) Long-term contract: agents have the time to modify their assets.

3.5. The diversity of contracts

Thus, a contract can be described through a set of seven features or "clauses" corresponding to the essential characteristics of a coordination mechanism in a world of bounded rationality and information failures. Moreover, each of these clauses can be considered as varying around a limited number of mutually exclusive solutions. This make it possible to build a "grammar" designed to describe contracts by specifying which solution (1, 2 or 3 and 4 when available) is implemented for each clause (A, B, C, D, E, F, G).

Insert Table 1 about here
The first advantage of this grammar is that it enables scholars to describe any kind of coordination device without using axiomatic definitions (like “market-like contract” or “hierarchy like contract”, etc.). For instance,

— the absolute hierarchy (corresponding, for example, to the labor contract at the beginning of the industrial revolution) corresponds to the case where the strategic coordination as well as the organizational and the operational coordination is regulated through a centralized authority system (A2 B2 C2). The employer controls many pressure mechanisms over the worker through housing, commercial credit, etc. Therefore there is a unilateral credible commitments system (D2). He is also himself specialized in supervision (E3). To exclude the workers from the profit, and because it is not really necessary to incite them (because of the strength of the coercion system), the remuneration mode is based on a flat rate basis (F3). Also the contract is a long-term one (G3). Therefore, the absolute hierarchy can be described as: A2 B2 C2 D2 E3 F3 G3

— the contract corresponding to the spot exchange on a market (like a Walrasian one) is a complete contract that does not use authority. Routines are defined to manage the strategic as well as the organizational and operational decision (A1 B1 C1). There are no credible commitments (D1). Supervision is taken on by the Court (E2). Each party is remunerated on the basis of its marginal productivity (F1). The contract is a spot commitment (G1). Thus the contract can be written as A1 B1 C1 D1 E2 F1 G1

— Joint Ventures are created toward a precise objective (A1). However, the organizational and operational decisions are negotiated by the partners within the collective direction of the common subsidiary (B3 C3). As the two partners invest means in a specific subsidiary, one can consider that there is a bilateral credible commitment system (D3). The board of trustees of the common subsidiary is a specialized system of supervision (E4). Through the common subsidiary, risks and profits are shared given the capital distribution. Therefore, the remuneration system is collective and does not exactly reflect the real contribution of each party (F2). The agreement is a long term contract (G3). As a consequence a standard joint-venture agreement can be described as A1 B3 C3 D3 E4 F2 G3

Thus, despite its simplicity, this grammar enables us to describe contractual arrangements through their essential features rather than to name them. It avoids the frequent misunderstanding caused by categorical denominations that are not always recognized by the whole research community. But, the most interesting point is that it enables us to take into account original contracts that do not belong to the standard and well-known categories because they can be identified though the grammar. This grammar also makes it possible to “think” of contractual innovations. Last but not least, it becomes possible to compare through different properties the numerous contractual arrangements that are used by actual economic agents.
Let us now illustrate the usefulness of this framework in the study of an empirical phenomenon: the impact of ICTs on coordination processes among firms.

4. **A STATISTICAL STUDY OF THE IMPACT OF ICTs ON CONTRACTS**

4.1. **Problems and methodology**

4.1.1. **Contractual impacts of ICTs and the “Market vs. Hierarchy” framework**

As supported by much empirical evidence, the emergence and spread of Information and Communications Technologies (ICTs) seems to have an impact on coordination processes within and between institutions (see, for instance, Freeman [1987], Antonelli [1988], Scott-Morton [1991]). Indeed, thanks to their ability to transmit and process information ICTs affect bounded rationality and information asymmetries, two determining factors in the design of coordination arrangements.

In the literature relying upon TCE to study the impact of ICTs, two radical and antagonistic theses are opposed (Brousseau [1992b]). According to the first (Malone, Yates & Benjamin [1987], Brynjolfson, Malone & Gurbaxani [1988]), ICTs enable the market coordination to be more efficient. Therefore the whole economic system will evolve toward market-type coordination processes. The second thesis sustains that ICTs contribute mainly to improving the efficiency of hierarchies (Black [1981], Antonelli [1986]). Therefore concentration will increase within the productive system.

The first thesis is based on the assumption that electronic media could become the technological basis for more transparent, and therefore more competitive, markets. The development of “electronic brokerage” (Malone, Yates & Benjamin [1987]) brings down the costs of market transactions and enables the market to become more efficient. By making it possible to reduce the imperfection of the informational environment, ICTs enable the real world to evolve toward the assumptions of perfect competition where the best coordination mode is the market. As a consequence, ICTs should lead to the disintegration and decentralization of large institutions through externalization strategies, and the implementation within them of more market-oriented coordination procedures.

On the other hand, some scholars point out that institutions, especially the larger ones, are more able than markets to implement sophisticated information systems based on ICTs. Therefore ICTs tend to push down the hierarchical costs of coordination rather than the market costs of coordination. The demonstration relies on the following evidence (often based on case studies): the development of costly and technically complex information systems increases the market power and competitiveness of certain large companies (e.g. Keen [1988]). This first phenomenon is reinforced...
by the necessity for these large firms to include their business partners in their “systemic rationalization” (Deiss [1988]) effort. It leads to the “hierarchisation” and the tightening of inter-firm relationships (see, for instance, the case studies quoted in Bar, Borrus & Coriat [1989]). This movement toward a “quasi-integration” of many business partners is also caused by the necessity to keep information private. This thesis is reinforced by the historical experiments of the telegraph and the telephone. As pointed out by Chandler ([1962, 1977]) or Coase [1937] (end of II), the development of rapid and long distance means of communication supported the development of large firms.

As illustrated by Antonelli [1988], the trends toward more “market” and greater “hierarchy” are, in fact, simultaneous. As a consequence, it is difficult to conclude and predict what kind of evolution in organizational arrangements will be induced by the spread of ICTs.

This rapid analysis of TCE's main work on the organizational impacts of ICTs reveals the limits of the “market vs. hierarchy” approach. Although most of the articles quoted above tell us a lot about the organizational evolution resulting from the implementation of ICTs when they describe actual experiences, the richness of these analyses is not maintained when the conclusions are synthesized in the “market vs hierarchy” framework. As pointed out above, when such a framework is used it leads to contradictory or indeterminate solutions. By using a more precise description of coordination arrangements (E.g. our grammar), one can make the analysis of these phenomena more subtle. We will show that ICTs do not breed a radical switch between coordination modes (from “market” to “hierarchy” or vice-versa). However, we will point out that these technologies transform some mechanisms (i.e. some clauses) in each type of coordination arrangement.

4.1.2. A sample of coordination arrangements between firms

To analyze how ICTs affect coordination procedures, our own attention has been focused on the impact of ICTs on coordination processes among firms. During the first half of 1989 and the first half of 1990, two surveys were conducted on the impact of telematic systems on coordination mechanisms used by firms in the US and France, respectively. These surveys were essentially based on detailed interviews with diverse business executives — e.g. information system, purchasing, sales, marketing, (etc.) managers — in companies that had implemented inter-firm communications systems based on telematic technologies (i.e. systems that combine data processing and communications technologies). The information thus gathered was matched with data collected in other firms and in the literature (e.g. Bar [1989], Clemons & Row [1988], Keen [1988], Venkatraman & Zaheer [1989], etc.). This enabled us to write detailed case studies describing how specific coordination processes changed (or not) with the implementation of ICTs between firms (Brousseau [1990b; 1990d]). As most of the companies studied had implemented several inter-firm systems, different types of systems (and, therefore, inter-firm relationships) have been analyzed.
through each case study. This article is thus based on the observation of 78 different systems implemented by 35 companies.  

Obviously, from a statistical point of view, this sample is not representative of the whole economic system. This is not surprising, since, despite their rapid spread, inter-firm telematic systems remain scarce. Moreover, as the methodology required interviews, the size of the sample is necessarily limited. Nevertheless the sample reflects the diversity of the industry — it contains firms belonging to several manufacturing and services industries — and also the variety — in terms of technical functionalities — of the inter-firm telematic systems that are implemented. Likewise, a wide range of inter-firm relationship types is covered: the sample covers contracts signed between manufacturers and their suppliers, sub-contractors, large clients, or small retailers; transportation companies, wholesalers, banks or other services companies and their clients; insurance agents and insurance companies; companies exchanging raw materials or semi-finished products; companies involved in an alliance; etc... These contracts regulate very diverse coordination processes in which goods or services are exchanged or co-produced.

The detailed case studies enabled us to build a database using qualitative data to describe the 78 coordination arrangements set-up by these 35 companies with their partners before and after the implementation of the telematic systems. The qualification of each contractual arrangement was derived from crossing our “morphological grammar” with the observations. The written contract together with the interviews enabled me to understand in detail the principles of the coordination arrangements: Whose is the authority? On what is the remuneration based? etc... These observations were then translated into the categories of the grammar, and the interpretations were validated by interviews with my business interlocutors.

Thus, the set of variables used operationalizes the main attributes of the inter-company contract. Seven of them — hereafter named “ex-ante” variables — describe the contractual arrangement between the companies before the implementation of any telematic system. The seven others — qualified as “ex-post” variables — describe the agreement after the implementation. These variables describing the contractual arrangement were the only active variables during the statistical processing. However the nature of the transaction was also qualified using the standard categories of Transaction Cost Economics (i.e. asset specificity, frequency, etc.). These variables remained passive in the statistical process.

4.1.3. The Statistical Methodology

The statistical analysis of the data was designed to produce a synthesis of all the variables and a taxonomy of the observed contracts. First, the studied sample can be described along a few major dimensions, each of which corresponds to a combination of variables that best explain the inertia
within the sample. It also points out the major discriminating characteristics of the contracts within the sample. Second, a taxonomy identifies contrasted groups of contracts and makes it possible to build categories within which contracts share numerous common features.

The data were processed with the Spad-N software according to two statistical methods: multiple correspondence analysis and hierarchical clustering (Lebart, Morineau & Warwick [1984], Tenenhaus & Young [1985]).

The former is similar to principal component analysis but deals with categorical variables, which are converted into a set of dummy variables among which the chi-square distance is computed. The principal components to be considered are those which are associated with Eigen values whose percentage of the total of Eigen values is greater than the inverse of the number of variables; or those that occur before a dramatic fall in the explained inertia by the following components. Such principal components summarize more information than any one variable individually.

The taxonomy is obtained by a clustering method which is based on the Ward criterion. This method measures the distance between two groups of observations. The two closest observations are grouped, then this procedure is repeated until the whole sample is covered. The number of classes to be considered is identified by finding the point where the Ward criterion drops the most significantly in the classification tree, when moving back down from a single class to n classes. The resulting taxonomy is analyzed by examining the correlation between each class and the categorical values.

In the two cases, the strength of the result was tested by processing the sample after eliminating the most discriminating individuals or variables. As the results remained unchanged one can consider that the analysis was not affected by non-standard individuals or variables. The detailed results, that are not published here, are available in the Working Paper from which this article is drawn (See note 5, p. ***).

### 4.2. The sample of contracts before and after ICTs

First, to describe their main features, the “ex-ante” and the “ex-post” population of contracts have been analyzed separately. It will be shown that although there are differences among the two samples, they have numerous common features. This invalidates the thesis of a radical switch toward one type of coordination (even the market or the hierarchy). This first analysis will then be confirmed by a second analysis focusing on the main changes (§ 4.3).

#### 4.2.1. The multiple correspondence analysis
Concerning the “ex-ante” contracts, as the proportion of the explained inertia falls dramatically between the second and third axes, the set of variables used to describe the sample can be synthesized in a satisfactory way by the first two dimensions\(^9\). One can interpret the construction of these first two axes by studying the contribution of each variable to each axis. It is interesting to note that most of the contractual features contribute significantly to at least one of the two axes.

— The first axis can be interpreted as discriminating between contracts that do not implement specialized governance, and enforcement mechanisms (on the negative side) and involvements that implement specific (and sophisticated) coordination mechanisms (on the positive side)\(^10\). I will further refer to this axis as the **degree of specificity** of the coordination mechanism.

— The second axis can be interpreted as discriminating between contracts that are asymmetric in the sense that one of the parties is the leader of the agreement (as in a principal-agent relationship), and contracts that are “egalitarian” in the sense that the two parties implement governance as well as enforcement mechanisms in which they have a symmetric position\(^11\). I shall refer to this axis as the **degree of asymmetry** in the arrangement.

Let me now consider the “ex-post” contractual arrangements. The result of the multiple correspondence analysis are very similar to those obtained with the population of “ex-ante” contracts. Two principal axes can be pointed out\(^12\). These two axes are explained by the same type of variables as in the “ex-ante” population. Thus, the ex-post contracts are mainly discriminated by the degree of specificity of the enforcement mechanism (along axis 1) and the degree of asymmetry in the arrangement (along axis 2).

In figures 1 and 2, these similarities are pointed out. An analytical representation is drawn of the main discriminating characteristics of the contracts combining the two principal components which emerge from the multiple correspondence analyses. It can be seen that there are only a few differences. Although the population of contracts has not exactly the same features ex-ante and ex-post, this suggests that they did not dramatically change with the implementation of ICTs. This will be confirmed by the hierarchical clustering.

Insert Figures 1 and 2 about here

### 4.2.2. A taxonomy of contracts

To determine contrasted patterns of contracts, a clustering of the sample was undertaken. The statistical criterion previously described supports the partition of both samples into four main classes, each of which can be described on the basis of the categorical values with which it is correlated.
The projection of individuals on the plane determined by the first two axes is represented in figures 3 and 4. The four patterns of contract are visualized. These projections emphasize that the four classes of contract are clearly separated within each plane\(^\text{13}\). As the two axes receive roughly the same interpretation for the two populations, the two projections can be visually compared.

As shown in these two figures (and confirmed by numbers), very similar categories of contract — i.e. characterized by similar features — are found within the two populations. This similarity invalidates the thesis of a radical switch toward one type of coordination mechanism.

By relating the four-class taxonomy to the interpretation of the two principal dimensions depicted in figures 1 and 2, and by analyzing the main features of each class (by studying the correlation between these classes and the categorical values), the features of the four identified classes of contract can be synthesized in the following way:

— class 1 is composed of contracts that are characterized by the absence of credible commitments (D\(_1\)), a self-supervision mechanism (E\(_1\)), a short-term duration (G\(_2\)) and a governance mechanism based on routines (for strategic, organizational and operational decisions: A\(_1\), B\(_1\), C\(_1\)). They can be interpreted as “market” type contracts because each partner is lightly “engaged” vis-à-vis the other and because they do not implement “sophisticated” coordination mechanisms;

— class 2 can be interpreted as being composed of co-operative agreements because the supervision is done by a specialized third party (E\(_4\)), and the remuneration is collective (F\(_2\))\(^\text{14}\). These contracts combine the symmetry of the “market” type contracts and the specialization of the hierarchical coordination mechanisms;

— class 3 groups long-term agreements. These contracts are distinctive because they use a unilateral system of credible commitments (D\(_2\)) and require long term involvement (G\(_3\))\(^\text{15}\). These agreements have some common features with the hierarchy (centralized authority, asymmetric remuneration system, long term involvement), but they are less asymmetric and use less specialized governance and enforcement mechanisms;

— class 4 comprises contracts that can be qualified as “hierarchic”. They are based on the implementation of centralized governance systems (Strategic and organizational centralized authority: A\(_2\), B\(_2\)). The party that assumes the authority is also the supervisor (E\(_3\)) and the other party is the sole to give him credible commitments (D\(_2\)). This type of arrangement is of long duration (G\(_3\)). Therefore the contract is very asymmetric. One of the parties — who becomes the “principal” — negotiates the right to implement a specialized coordination mechanism that he controls. He is the “boss” in the sense that he cumulates the authority and the supervision rights.
These first results lead to several remarks. Here, comments will be restricted to questions related to the impact of ICTs. In section 5, however, they will be discussed from another perspective because they lead to interesting insights concerning the knowledge of hybrid coordination mechanisms.

Because the two samples of ex-ante and ex-post contracts have very similar features (same principal components, same classes, roughly the same population within each class), the quoted above theses of a radical switch of coordination mechanisms toward a given type of arrangement are largely invalidated. On the contrary, this analysis emphasizes that despite the implementation of ICTs, contrasted patterns of coordination mechanisms persist. However, there are only a limited number of common features between the ex-ante and the ex-post population of contracts. The principal components analyses gave a first indication because there were some differences between the variables defining each axis. The hierarchical clusterings confirm this first observation because they indicate that the classes — and especially class 2 and class 3 — do not have exactly the same distinctive features, even if they are open to a similar interpretation. Moreover, the population of each class is not exactly the same ex-ante and ex-post. These elements suggest that there is an actual impact of ICTs on contractual arrangements.

4.3. The analysis of the transformations

To try to obtain a better understanding of this impact the data on ex-ante and ex-post contracts were processed simultaneously. In other words, the individuals are not any longer the ex-ante or the ex-post contracts but a bilateral relationship characterized by its ex-ante and the ex-post agreements. Thus the evolution of the contractual arrangement can be captured by the statistical analysis. The results are highly convergent with the previous ones. The reader will see that contracts remain stable over a wide range of their characteristics, but also that ICTs have different types of impact on the diverse categories of contracts.

Here again a multiple correspondence analysis lead to the identification of two main dimensions:

— On the basis of its main features, the first axis can be interpreted as discriminating between relationships in which short-term contracts that do not implement specialized coordination mechanisms are instituted ex-ante and ex-post (on the negative side) and the relationships in which long term involvements that implement specific governance and enforcement mechanisms are drawn up ex-ante and ex-post (on the positive side).
Likewise, the second axis can be interpreted as discriminating between the relationships in which ex-ante and ex-post asymmetric contracts are signed and the relationships in which symmetric contracts are designed\textsuperscript{18}.

The fact that the two principal components are defined by contractual features which are common to the ex-ante and the ex-post contracts means that most of the clauses are stable in most of the bilateral relationships. This confirms the invalidation of the thesis of a radical change in coordination processes because ICTs modify only some features of the contracts.

An agglomerative hierarchical clustering confirms this in showing the existence of four types of bilateral relationship in which ex-ante and ex-post contracts share several common features. The projection of individuals on the plane determined by the first two axes (figure 5) visualizes them, and the following synthesizes their main features:

— class 1 is composed of bilateral relationships that are regulated by “market” type contracts (as defined above) before and after the implementation of ICTs. Most of these contracts are characterized ex-ante and ex-post by the same types of clauses. ICTs do not seem to have a major impact on these contracts (even if within a class the different contracts are diverse);

— class 2 is composed of “co-operative agreements” that remain mostly unchanged in terms of operational coordination (C), credible commitments (D), supervision (E) and remuneration (F). However, the strategic and organizational coordination modes (A and B) and the duration (G) are not distinctive features even ex-ante and ex-post;

— class 3 comprises relationships that are regulated by “hierarchic” contracts. Most of the clauses, with the exception of the operational coordination mode (C) and the remuneration system (F), remain uninfluenced by ICTs.

— class 4 groups "long-term agreements" that, ex-ante and ex-post, are characterized by the same types of clause concerning credible commitments (D), supervision (E), remuneration (F) and duration (G). However, the ex-ante and ex-post strategic, organizational and operational coordination modes (A, B and C) do not seem to be distinctive features of this class;

Thus, most contractual arrangements are roughly stable with the implementation of ICTs. Again, this invalidates the thesis of a radical switch of coordination mechanisms from one category to another.

At the same time, these results show that ICTs do have an impact on these coordination mechanisms. The fact that each category — instead of class 1 — is defined by a reduced number of
“stable” clauses indicates that changes occur in the other clauses between the ex-ante and the ex-post situations. Put another way, ICTs do not induce a shift from one category of contract to another, but they can lead to a transformation of the contracts within each category.

The impact of ICTs on several clauses can be seriously underevaluated through this statistical method since only the proximity (similarity) among “ex-ante” and “ex-post” contracts is described, and since the considered proximity (among individuals) is only an “on average” proximity. For instance, two similar contracts can have one or two different clauses that change with the implementation of ICTs, but from a statistical point of view, they will remain similar in many respects since they continue to share several common features. Thus, the impact of ICTs will be erased by the aggregate statistical results. As a consequence, several impacts of ICTs that do not statistically emerge from this analysis are ignored and misinterpreted.

4.4. The clause by clause analysis

To obtain a better understanding of the influence of ICTs on contractual arrangements, one can abandon the analyses of the contracts as a whole and analyze the impact of ICTs on each of the seven clauses. To analyze the changes between the ex-ante and the ex-post contracts, two complementary methods were used.

First, the ex-ante and the ex-post frequency of each alternative to each clause within the whole population of contracts were calculated. Then for each alternative the difference between the two frequencies was calculated (ex-post frequency minus ex-ante frequency) (see Figure 6). This difference indicates if ICTs favor (if the result is a positive number) or penalize (if it is negative) the use of the given alternative to the clause. This method indicates the evolution of agents’ contractual preferences due to the impact of ICTs. However, this first method can underevaluate this impact because it masks compensations among contracts. For instance, if ICTs induce the evolution of a first contract from clause A\textsubscript{1} to clause A\textsubscript{2} and of a second contract from clause A\textsubscript{2} to clause A\textsubscript{3}, the simple calculation of the “difference of frequency” will record only one change.

Second, to avoid this statistical bias, a set of new variables was designed to characterize for each clause the evolution between the ex-ante and the ex-post contracts. For instance, when one compares the ex-ante and the ex-post duration for each contract, it is possible to say if the duration of the arrangement increases, does not change, or decreases. For the other clauses there is no actual ranking among the different variables. For the three coordination clauses (A,B and C), one can measure if the flexibility increases or not. By flexibility, we mean the ability to redesign the coordination arrangement and therefore the existence of an authoritarian mechanism (for instance A\textsubscript{2} and A\textsubscript{3}) as opposed to the use of routines (for instance A\textsubscript{1}). This is because the implicit hypothesis is that ICTs reduce decision costs and therefore favor, other things remaining equal, the adoption of
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authoritarian mechanisms. Concerning supervision (E), one tests the possible increase in the specialization of the supervision mechanism: the less specialized is E₁, the more specialized are E₃ and E₄, and E₂ is at an intermediary level on this scale. Concerning remuneration, one tests the possible increase in the degree of customization (which is proven when there is a shift from one of the two collective remuneration systems — F₂ and F₃ — toward one of the two customized remuneration agreements — F₁ and F₂ —). These new variables describe each bilateral relationship with a “sense of variation” attached to each category of clause. One can then describe the distribution of these “variation” features. This distribution is synthesized in figure 7.

Figures 6 and 7 are two graphical representations of two contingency tables. Each histogram is to be read line by line. As an example, the first line of figure 6 means that the frequency of clause A₁ decreases from two points in the ex-post population of contracts as compared to the frequency of the same clause in the ex-ante population. Clause A₂ is as frequent within the two samples. Clause A₃ is more frequent in the ex-post population (plus one point). The first line of figure 7 means that within 99% of the bilateral relationships the strategic coordination mode is not changed even if in 1% of the cases (i.e. 1 case) the strategic coordination mode becomes more flexible (i.e. an authoritarian mechanism — A₂ or A₃ — replaces a routine based mechanism — A₁).

First comment: For most of the clauses — except for operational coordination — the majority of contracts are stable. This is coherent with the previous statistical analysis confirming the tendency towards the stability of each contract type. However, this analysis enables us to obtain a better understanding of the impact of ICTs. When the marginal transformations (that affect less than 5% of the sample) are ignored, these results show the following effects:

— ICTs induce the adoption of more flexible organizational and, above all, operational coordination modes (B, C). This means that ICTs favor the implementation of coordination mechanisms based on “authority” (incomplete agreement) rather than on routines (complete contract);

— ICTs favor the adoption of specialized supervision mechanisms and, especially, of mechanisms in which one of the contractors is the supervisor (E₃);

— ICTs seem to induce the implementation of more customized remuneration systems and especially of remuneration conventions based on marginal productivity (F₁);

— Lastly, ICTs seem to increase contract duration (G).

The other clauses (A and D) are not significantly impacted. However, the last two effects seem to be less important than the first three — on organizational coordination, operational coordination and supervision — especially because there are also contracts that evolve in the opposite
direction to the majority. This is due to the fact that ICTs have an impact on contractual arrangements through two mechanisms which are revealed by a more detailed analysis.

4.5. ICTs and contracts: a “correspondence” problem

When the analysis which focuses on contracts as a whole is matched with the “clause by clause” analysis, one gets an interesting insight into the role of ICTs in the redesigning of coordination processes among firms. On the one hand (§ 42 & 43), ICTs do not seem to radically transform the contractual arrangements in general, but on the other hand, ICTs seem to have an actual impact on some clauses (§ 44). They favor the adoption of contractual clauses that are inherently efficient, but that are not implemented when ICTs are not available because they are too costly in information exchanges or processes. This suggests that ICT-based systems are used to enhance the efficiency of coordination arrangements that were already quite well adapted to the features of a given transaction. It would not have been efficient to implement a completely different type of arrangement. This means that there is no one coordination mode which is intrinsically better than any other, and that would be adopted by economic agents if they were not confronted with informational “frictions” (as implicitly argued in Malone et al. [1987], for instance). These results are coherent with the TCE framework. “Frictions” that justify the adoption of very diverse coordination mechanisms are not only due to information gaps and costs but they also originate from bounded rationality, opportunism, and uncertainty, all of which have connections with information asymmetries and information processing problems, but which are also partially independent of them. As a consequence, the diversity of actual coordination arrangements does not draw from information gaps and costs. Other sources of friction generate very diverse coordination failures that, to be corrected, require different contractual arrangements. The functioning of these arrangements induces various needs for information exchanges and informational processes.

This relationship of “correspondence” among transaction features, contractual arrangements, and information needs is the reason why there is no “radical switch” among coordination devices when ICTs are implemented. As there is no one-to-one causality relationship between information exchanges or processes and coordination mechanisms, the potential transformation of these information exchanges and processes does not radically transform the coordination mechanisms. However, the potentiality of ICTs enables contractors to adopt coordination mechanisms that are better suited to the diverse transaction features and that were not previously adopted because of the costs of certain information processes. Thus the implementation of ICTs does not modify the general architecture of contracts (because they are adapted to transactions), but can marginally induce the transformation of a reduced number of clauses (because ICTs enhance information handling capacities).
This interpretation of our results converges with the more detailed observations we have made elsewhere (Brousseau [1991]). In fact, very diverse types of ICT-based systems are implemented among companies. They are used to convey very different categories of information. This is because contractors develop systems to solve very diverse types of information gaps because they have very different information needs (Brousseau [1994]). These results are also coherent with many inter-transaction (Bensaou [1991]) or inter-industry comparisons of the use of ICTs (Faulhaber et al [1986], Brousseau & Rallet [1993], etc.). As information needs are diverse, ICT-based systems are various and produce several types of organizational effect. Most of the time, they are not used to cause radical changes in the coordination procedures. However, contractors use them to enhance the existing procedures. This induces marginal adaptation of existing contractual arrangements, even if they can be dramatic in terms of efficiency.

5. CONCLUDING REMARKS: THE INTERESTS OF A MODULAR CONCEPTION OF CONTRACTS

Beyond the question of the contractual impact of information technologies, this paper proposes a methodology aimed at better describing contractual arrangements. Through the examination of an applied problem, I have tried to demonstrate the operationallity and usefulness of the proposed modular perception of contracts. This methodology has at least two main advantages: first of all, it makes it possible to construct actual operational research; and second, it could constitute the foundation of a synthesis of contract theories.

The framework presented above facilitates applied analyses. As pointed out by Arrow [1985], today it is difficult to match theory and empirical analysis because most real contracts do not resemble those described by theory. The proposed “grammar” makes it possible to describe actual contracts because they often combine different types of coordination mechanisms (i.e. authority, routines, incentives, coercion, supervision...). Second, the proposed description system is a compromise between the imprecision of the axiomatic general categories and the non-replicability and the difficulty of usage of “in extenso” definitions (see § 2). Even though the proposed grammar could probably be improved (essentially by expanding the number of clauses and alternatives), and although it is surely open to discussion, it seems to be a satisfactory compromise.

The use of such a precise description of contractual mechanisms is an important tool in the avoidance of misinterpretation. In this research work, it made it possible to obtain more precise results than those obtained with the “market vs. hierarchy” framework. When one studies how ICTs influence contracts, one observes transformations. If a scholar uses a “rough” framework to describe contractual arrangements, he is led to describe the evolutions in terms of switching from one type to another. The proposed grammar makes a subtler analysis possible.
Beyond these considerations, the above applied analysis generated two interesting results about contractual arrangements:

— the multiple correspondence analyses revealed that most contracts can be differentiated by two essential characteristics (i.e. their specificity and their asymmetry). As stressed in section 2, this suggests that the “market vs. hierarchy” axis is either too poor or inadequate to discriminate between actual contractual arrangements.

— the agglomerative hierarchical clustering showed that the contracts in this sample are polarized around four major types (i.e. “market”, “hierarchy”, “co-operative agreements” and “long-term involvements”). This suggests that despite numerous potential combinations of clauses (3,888), and although the contracts in the sample are very diverse, some polar types of contractual arrangements emerge. This is interesting for at least three reasons. First, as these categories resemble some coordination mechanisms identified with axiomatic definitions, the findings of research using these definitions can be synthesized because the grammar makes it possible to position these diverse contracts in relation to each other. Second, it suggests an important research agenda since the questions are: Why such a polarization? How many contract types? Answers will be obtained through detailed examinations of the complementarities and incompatibilities of the different mechanisms that can be implemented in an arrangement. Third, these results also show that contracts have many differences within each category even if they are characterized by a core of common features. This then confirms that an analysis based on an axiomatic definition of contracts can miss things that are taken into account by analyses based on “grammatical” descriptions.

Thus, the potential of the grammar is obvious. When the problem studied is generic and consists of comparing the different types of contractual arrangements, one can use these synthetic categories that are precisely defined (by a set of \( A_i B_j C_k D_l E_m F_n G_o \)) and that can be brought together or opposed through their different dimensions. On the other hand, when the question is focused on one of the contractual mechanisms or on the differences between arrangements belonging to one category, a detailed description of contracts is available. The grammar makes more flexible analysis strategies possible.

From a theoretical point of view, considering contracts as the conjunction of different mechanisms makes it possible to build an analytical framework that could constitute the basis of a synthesis of contract theories. Agency theory focuses on incentives and supervision mechanisms. TCE focuses on governance. French scholars currently deepening the concept of “conventions” (Revue Economique [1989], Orléan [1994]) are studying routines and “rules”. Most of these mechanisms co-exist in the actual coordination arrangements. Building bridges among those theories may be a useful means of analyzing the actual properties of arrangements combining several of these mechanisms.
The splitting of the contract into a set of diverse mechanisms could also help obtain a better understanding of the contract design process. If a contract is a highly complex mechanism, it is difficult to understand, and to model how agents design such mechanisms. But when one considers a contract as a modular mechanism, one can imagine that agents design it by choosing the best alternative solution for each clause given the transaction features. Therefore, a complex decision is perceived as a succession of decisions which are more easily understandable. Moreover a large part of these decisions has already been modeled by the different branches of contract theories. Last but not least, this way of seeing the contract design process is coherent with the framework of bounded rationality. This research direction has already been explored by studying how transaction features influence the design of each clause (Brousseau [1991; 1993]).


2The idea of establishing a grammar was primarily developed in a paper by Salancik & Leblebici [1985]

3 This grammar is designed to be as generic as possible by being able to describe any type of bilateral contract. However, it obviously simplifies reality and alternative grammars could be proposed. Rather than developing a framework that claims to be the sole possible, the intention here is to propose a workable framework that is interesting because of its underlying way of thinking.

4The proposed framework — hereafter qualified as a grammar — is designed to describe any kind of contractual arrangement between two economic agents (human or institutional) who link their resources to produce an output. However, it is not designed to describe all the possible types of organizational arrangements within a society, including the contract between a supplier and a household, or the coordination processes within a family.


6The sample was built to study the impact of ICTs on inter-firm coordination processes. The hereafter presented statistical results are significant only for this topic. It must therefore be clear that I do not assert that the sample is representative of the whole variety of inter-firm contracts that can exist. However, I think that the methodological conclusions that will be drawn from this study are of interest for studying very different topics that the one that is analyzed here. Moreover these results draw interesting insights about the right way to discriminate different type of contracts.

7 The chi-square distance is calculated according to the following formula:
\[ d^2 (i,j') = \frac{1}{n_{ji}} \left( x_{ijl} - x_{i'jl} \right)^2 \]

In this formula, \( x_{ijl} \) takes on the value 1 when in observation \( i \), variable \( j \) takes on the categorical value \( l \); \( x_{ijl} \) takes on value 0 in the opposite case. \( n_{ji} \) is the frequency of the categorical value \( i \) of variable \( j \).

\(^8\)This method measures the distance between two groups \((G_1, G_2)\) of observations with the following formula:
\[ d^2 (G_1, G_2) = \frac{(n_1 n_2)}{n(n_1 + n_2)} \cdot d^2 (g_1, g_2) \]

In this formula, \( n \) is the total number of observations, \( n_1 \) and \( n_2 \) are the number of observations in \( G_1 \) and \( G_2 \) respectively; \( g_1 \) and \( g_2 \) are the centre of gravity of \( G_1 \) and \( G_2 \) respectively; \( d \) is the chi-square distance.

\(^9\)The two principal axes account for 42.16 % of inertia (21.71 % for the first and 20.45 % for the second). The third axis contributes only for 12.52% of the explained inertia.

\(^{10}\)When one focuses on the alternative of each clause (i.e., categorical value) that most contributes to the first axis, one can see that it discriminates between:
— the short-term contracts \((G_2)\) that implement only self-supervision mechanisms \((E_1)\) and that do not require credible commitments \((D_1)\) (on the negative side);
— and long-term contracts \((G_3)\) associated with a unilateral system of credible commitments \((D_2)\) and a unilateral authoritarian mechanism that regulates the strategic and organizational coordination \((A_2 \text{ and } B_2)\) (on the positive side).

\(^{11}\)The vertical axis (axis 2) opposes:
— the contracts where a centralized authoritarian system is implemented for the strategic as well as the organizational decisions \((A_2 \text{ and } B_2)\) (on the positive side);
— and the arrangements which are characterized by a decentralized authority mechanism as regards organization and operational decision \((B_3 \text{ and } C_3)\); a bilateral credible commitment system \((D_3)\); a specialized supervisor (who is not one of the contractors) \((E_4)\) and a collective remuneration system based on an ex-ante fixed sharing-out \((F_2)\) (towards the bottom).

\(^{12}\)These two axes account for 39.11 % of inertia (20.52 % for the first and 18.60 % for the second).

\(^{13}\)In fact, in the two figures (3 and 4), the contracts that are described in a 7-dimension space are projected onto the plane drawn by the two principal components. As a result, two contracts can seem close together in the plane even if they are faraway from each other in the space. This is why some contracts belonging to one class seem to be “geographically” included in another class. To avoid visual misinterpretation, I draw the outline of the class without taking into account the points (contracts) that are too far-away from the barycentre of the class within the plane.
However there are some differences between the ex-ante and ex-post contracts. The ex-ante contracts are characterized by a bilateral credible commitments system (D3), that is not a distinctive feature of the ex-post “co-operative agreements”. On the contrary, the ex-post “co-operative agreements” are stand out because of the implementation of a strategic decentralized authority system (A3) which is not a distinctive trait of the ex-ante “co-operative agreements”. Despite these differences, one can consider in both cases that these contracts can be qualified as “co-operative”.

The ex-ante contracts are also characterized by a flat rate remuneration system (F3), a centralized authoritarian system for operational co-ordination (C2), and a non-specialized supervision system (E2); whereas the supervision assumed by one of the contractors (E3) and fixed sharing (F2) are two distinctive features of the ex-post long-term agreements.

The two principal axes account for 38.74 % of inertia (19.83 % for the first and 18.91 % for the second)

When ones focuses on the state of each of the clauses that most contributes to the two axes, one can see that axis 1 discriminates between:
— on the one hand, the bilateral relationships in which ex-ante and ex-post short-term contracts (G2) with self-supervision mechanisms (E1) and which, in addition, do not implement credible commitments (D1) are signed (on the negative side);
— and, on the other hand, relationships in which ex-ante and ex-post long term contracts (G3), associated with a specialized supervision mechanism (E4) and with remuneration based on a fixed sharing (F2). However these relationships are also characterized by contractual mechanisms that are not perpetuated ex-ante and ex-post. Ex ante, these bilateral agreements are characterized by the implementation of credible commitments (D2 and D3) and a unilateral authoritarian mechanism as regards organizational coordination (B2), whereas, ex-post, the relationships are characterized by the implementation of an operational decentralized authority (C3) (on the positive side).

The vertical axis (axis 2) opposes:
— the relations regulated ex-ante and ex-post by contracts where a centralized authoritarian system for the strategic as well as the organizational decisions (A2 and B2), a unilateral system of credible commitments (D2) and a supervision mechanism assumed by one of the parties (E3) are implemented (on the positive side);
— and the arrangements which are ex-ante and ex-post characterized by a decentralized authority mechanism for operational decisions (C3); a bilateral credible commitment system (D3); a specialized supervisor (who is not one of the contractors) (E4), and a collective remuneration system based on an ex-ante fixed sharing-out (F2) (towards the bottom). These relationships are also characterized by the implementation, in the ex-ante contract of a decentralized organizational authoritarian system (B3);
This is confirmed because the different ex-ante and ex-post clauses do not have exactly the same weight in the construction of each class. There are also differences between the percentage of presence of the ex-ante and ex-post clauses in a class.

This hypothesis and those following on the impact of ICTs on coordination mechanisms were inferred from a deductive reasoning in Brousseau [1991] and [1993 b]. In fact, even if the analyze here is (for convenience and to be short) essentially presented as an inductive one, the original research work was a deductive one, associated to tests of the conjectures drawn from the deductive reasoning. In the following lines, the reader will find the essence of this deductive reasoning.

By providing richer and less costly information on the efficiency of the coordination process used by agents, ICTs enable partners to make better decisions on organization. Therefore contracts are conceived to allow future enhancements that will enable the coalition to benefit from its accumulated experience by reorganizing the coordination process (i.e. B2 and B3). It also permits the coalition to reorganize its internal processes when contingencies occur.

By accelerating the circulation and the processing of information, teleprocessing technologies enable agents to deepen the cybernetic control over processes. Moreover, an increasing number of decisions is automated or assisted by decision-support systems. These two elements result in more flexibility because response times to changes can decrease dramatically. Since economic peers have a greater ability to face changes that occur in their environment, they implement more often flexible operational coordination systems (i.e. C2 and C3).

Thirdly, inter-firm telecomputing systems enable coalitions to reinforce supervision. Supervision can be to a large extent automated. Hence, coalitions are able to implement specific and specialized supervision processes (i.e. E2 and E4) that have the great advantage of being more efficient than unspecific ones (like the court and the law). Consequently, ICTs contribute to reducing the risk of opportunistic behaviors in bilateral relationships because they reduce information asymmetries.

Last but not least, telecomputing systems enable agents to benefit from richer and more accurate information on the real contribution of each member of the coalition. Therefore the principal obstacle to the implementation of a customized remuneration mode (i.e. F1 and F4) disappears. Agents thus implement this type of remuneration arrangement because they are more motivating.

As a consequence four dimensions of the contracts should be affected by ICTs. Inter-firm telecomputing systems should favor the implementation of flexible mechanism to ensure the organizational (B) and operational coordination (C). Also, they should lead to the institution of more specialized supervision mechanisms (E) and the adoption of more customized remuneration mechanisms (F).
Obviously, tests of independence — especially Chi-Square Tests — have been performed to be sure that these changes are not due to chance. They showed with a high level of confidence that they are not an artifact. Moreover the statistical results are corroborated by the detailed case studies that pointed out how information technologies actually transform coordination processes.

More precise statistical and clinical studies of the sample (Brousseau [1991 & 1993 b]) showed that the global effect of ICTs on contractual relationships results from the combination of two mechanisms. The first can be qualified as “generic”. Like many technologies, ICTs change the features of some transactions (e.g. they enable the development of more information-intensive transactions) thereby inducing the adaptation of contracts (since contracts are fitted to transaction features). The other mechanism is “specific” to ICTs. These technologies modify agents’ abilities to process and manipulate information. Thus ICTs impact on the relative efficiency of alternative solutions to each clause (through the lowering of information costs and the enhancement of information processes). Other things remaining equal, ICTs favor the use of clauses that are more information-intensive (like authority mechanisms, specialized supervision mechanisms, etc...). Thus, Inter-firm telecomputing systems favor the implementation of an authoritarian mechanism to ensure the organizational (B) and operational coordination (C). Also, they lead to the institution of more specialized supervision mechanisms (E) and the adoption of more customized remuneration mechanisms (F). However, the strategic coordination mode (A), the credible commitment system (D) and the contract duration (G) are not significantly influenced by the specific impact of ICTs.

Obviously, these general conclusions have to be relativised by the high specificity of our sample. As pointed out above (Note 6 p. ***), it cannot be considered as representative of the whole variety of inter-firm contracts. As a consequence, if the sample was wider, more than two discriminating dimensions, and more than four main categories could perhaps be pointed out. However, our results show that even in a small sample of specific coordination arrangements (those where ICTs are implementable), the “market versus hierarchy framework” is too simplistic to depict and study certain situations. However, it must be clear that I do not infer from these results that any type of inter-firm coordination process can be described in the “two dimensions-four categories” framework that inductively result from our statistical analysis of this specific sample. If the sample of contracts was wider (in size and in term of diversity) one would probably be able to identify a greater number of synthetic types of contractual arrangement.

It is interesting to note that in research on the patterns of strategic alliances performed by Dussauge, Garrette and Tenenhaus [1992] similar discriminating characteristics appear. These scholars use the same statistical methods to examine 171 alliances to build a taxonomy based on qualitative features. Although the issue they investigate is different from mine, and while they use a different methodology than mine to describe the main attributes of arrangements, they identify three main dimensions, two of which are very similar to those found above. The first discriminating dimension is the asymmetry among partners (the resulting axis is similar to my second axis). The second dimension evaluates the impact of the arrangement on the competition intensity (this is not taken into
account in my grammar). The third axis opposes simple contractual agreements to structured partnerships (this is very close to my first axis). This convergence suggests that this dual discrimination principle is a very powerful means of comparing contracts.

These two statistical analyses suggest that the mono-dimensional analysis of the “Market vs. Hierarchy” framework is too poor since at least two main dimensions are necessary to compare contractual arrangements.
## Table 1

**A grammar to describe bilateral contracts**

<table>
<thead>
<tr>
<th>Object of the clause</th>
<th>Possible clause alternatives</th>
</tr>
</thead>
</table>
| **A** Strategic Coordination | 1 Routine | 2 Centralized Authority | 3 Decentralized Authority | **  
| **B** Organizational Coordination | 1 Routine | 2 Centralized Authority | 3 Decentralized Authority | **  
| **C** Operational Coordination | 1 Routine | 2 Centralized Authority | 3 Decentralized Authority | **  
| **D** Credible Commitments | 1 No CC | 2 Unilateral hostage | 3 Bilateral hostage | **  
| **E** Supervision Mechanisms | 1 Self-Enforcement | 2 Non-Specialized Supervisor | 3 Contractor Supervisor | 4 Specialized Supervisor | **  
| **F** Remuneration System | 1 Marginal Productivity | 2 Fixed Sharing | 3 Flat Rate | 4 Intensity of Use | **  
| **G** Contract Duration | 1 Spot Contract | 2 Short-term | 3 Long-term | **  

### Figure 1: Ex-ante contracts

**Axis 2: Asymmetry in the Arrangement**

**Asymmetric**

**Unspecialized**

- D1: No Cred. Commit.
- E1: Self-Supervision
- G2: Short-Term

**Specific**

- A2: Strat Centr. Authority

**Axis 1: Specificity of the Coordination Mechanism**

**Unspecialized**

- B3: Org. Decent. Authority
- C3: Oper. Decent. Authority
- D3: Bilateral Cred. Commit.
- E4: Specialized Superv.
- F2: Fixed Sharing

**Specific**

- A2: Strat Centr. Authority
- D2: Unilateral Cred. Commi
- G3: Long-Term
Contracts as Modular Mechanisms: Some Propositions for the Study of “Hybrid Forms”

Figure 2: Ex-post contracts

Axis 2: Asymmetry in the Arrangement

Asymmetric

B2: Org. Central. Authority

Unspecialized

C1: Oper. Routines
D1: No Cred. Commit.
E1: Self-Supervision

Specific

A2: Strat Centr. Authority
D2: Unilateral Cred Commit.
E3: Contractor Sup.
G3: Long-Term

B3: Org. Decent. Authority
C3: Oper. Decent. Authority
D3: Bilateral Cred. Commit.
E4: Specialized Superv.
F2: Fixed Sharing

Symmetric

Axis 1: Specificity of the Coordination Mechanism

Figure 3: The Mapping of the "Ex-ante" Contracts

Axis 2: Asymmetry in the Arrangement

"Market" Type Contracts

Long-Term Agreements

Hierarchical Contracts

Axis 1: Specificity of the Coordination Mechanism

Cooperative Agreements
Figure 4: The Mapping of the "Ex-post" Contracts

Figure 5: The Mapping of the Ex-ante and Ex-post contracts
Figure 6: Frequency Differentials of Each Clause between the Ex-ante and the Ex-post Contract

- A Strat. Coord.
- C Oper. Coord.
- D Cred. Comm.
- E Supervision
- F Remuneration
- G Duration

Clouse 1  2  3  4

Figure 7: Variation Direction of each Clause

- A Strategic Flexibility
- B Organizational Flexibility
- C Operational Flexibility
- D Credible Commitments
- E Supervision Specialization
- F Remuneration Customization
- G Duration

- Decrease
- Stability
- Increase
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