An Empirical Taxonomy of Technology Alliance Contracts

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Paper prepared for the

Annual Meeting of the Academy of Management, Philadelphia, August 3-8, 2007

ABSTRACT

Although contracts are characterized by a certain logical and artifactual unity, the typical approach of economic and organizational studies focuses on particular contract clauses. Another common perspective, that addresses contracts as unitary entities, directs the attention to the choice between axiomatically defined alternative governance forms, with little or no investigation of empirical types. This state of things reflects the lack of an accepted framework for the development and testing of hypotheses about contract design. This study tries to redress this situation by analyzing actual contracts as configurations of a wide array of elements. In developing an analytical framework, this study develops a perspective that considers contracts as an organizational phenomenon, expands the set of mechanisms considered beyond incentive provisions and pricing structures, and includes procedural elements inspired both by organizational theory and by the empirical literature on contracting. The constructs so identified are applied to the analysis of a set of pharmaceutical biotechnology agreements. We employed categorical principal component analysis to determine underlying dimensions that differentiate among different contracts. Cluster analysis then produced an empirical taxonomy of these technology agreements.

KEYWORDS: Contracts, configurational research, strategic alliances

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1. INTRODUCTION

Contracts provide an important lens to analyze inter-organizational relationships (IORs) and the cross-boundary activities of organizations (Williamson, 2003). Obviously, contracts in general, and, *a fortiori,* formal contracts, do not exhaust the complexity of the governance of IORs (Sobrero and Schrader, 1998; Ménard, 2004). Yet, the large number of conceptual and empirical investigations focusing on inter-firm contracts is in witness of the fact that this institution is considered to be a fundamental aspect in the structure of inter-firm relationships.

Transaction cost economics (TCE) has been at the forefront in the investigation of governance forms and it has inspired the bulk of the empirical literature on contracting (Shelanski, Klein 1995; Rindfleisch, Heide, 1997; Boerner, Macher, 2005; Furlotti, 2006). One fundamental tenet of TCE is that "transactions which differ in their attributes are aligned with governance structures, which differs in their costs and competencies, in a discriminating (mainly transaction-cost-economizing) way" (Williamson, 1991, p. 277). Yet, by Williamson's own admission TCE has given disproportionately more attention to the dimensionalization of transactions than to that of governance forms (Williamson, 1991, p. 270). The same article that conceded this point also tried to redress the imbalance: it identified a few dimensions along which governance forms differ, proposed a typology of contracts and argued that a close correspondence exists between contractual types and discrete governance forms.[1]

Obviously, considerable progress has been made with regards to dimensionalizing governance since then, as documented for instance in Ménard (2004). Yet, with regards to contracts, the state of the art is still rather dissatisfactory under several respects. First, conceptual efforts

[1] For the sake of preciseness, throughout his 1991 article Williamson argues that different governance forms are supported by different forms of contract *law*. However, several passages in that article may induce the reader to establish a one-to-one correspondence with different contractual types simultaneously available at a given point in time for the governance of different types of transactions.

have not led to a widely shared agreement about contract dimensions.[2] Second, for the large part empirical analyses of contracts have favored a reductionist approach and have focused on selected contractual terms considered in isolation. Finally, as to assigning contracts to classes, we have not progressed much beyond the conceptual typologies developed by Williamson in his 1979, 1985 and 1991 works.

To help redressing this state of things, this study investigates empirically the dimensions of a sample of inter-firm alliance contracts and produces a taxonomy through multivariate analyses. Obviously, any such endeavor would run into formidable practical problems if attempted on as broad ranging a population of IORs as that covered in conceptual typologies. Thus, we have restricted our analysis to a sample of contracts of pharmaceutical biotechnology alliance, in the belief that even at the level of a narrow population we would be able to identify distinct clusters, while reducing undesirable heterogeneity.

Our findings are that it takes a larger number of dimensions than currently popularized, to explain a reasonable amount of the variance in the contractual clauses. The factors we identified can be interpreted pretty clearly in terms of concepts rooted in the theory. However, unlike proposed by TCE, hierarchical intensity does not seem such a distinctive factor of different alliance agreements. Contracts do belong to different groupings. Some of the contractual types are defined by dimensions that are not commonly emphasized by organizational economics and better understood when economic explanations are expanded with insights drawn from classical organizational literature.

The paper proceeds as follows: the next section reviews relevant extant literature and the following develops a conceptual framework. Section 4 describes our dataset and the variables we have selected to observe the contractual structure. The method and the results of our

[2] For example, the framework proposed in Ménard (2004) differs from Williamson's (1991) and from Brousseau's (1995).

quantitative analysis are then explained in Section 5. Section 6 is dedicated to the assessment of our findings and Section 7 concludes with a discussion of the limitations of the present study and of directions for further research.

2. REVIEW OF LITERATURE

This section reviews selected literature that has taken a configurational approach to the question of analyzing governance forms and contractual governance in particular.[3] This discussion may usefully start from the works of O.E. Williamson. Although several of his earlier books and articles are also relevant to the topic, his ideas are perhaps best developed in Williamson (1991). Here, his configurationist stance is clearly expressed by his definition of governance forms as "syndromes of attributes" (Williamson, 1991: 271). Besides, Williamson explicitly mentions the type of contract law that applies as an important differentiating factor of archetypical governance forms. Williamson's stated aim is to establish a connection between the institutional environment and the institutions of governance. While this unifies two areas of institutional economics that until then had remained disjunct, his stance on this point seems too deterministic. The different contract law regimes he mentions (classical, neoclassical and forbearance) are borrowed from Macneil (1978), with some adaptation. However, rather than with contracts Macneil was concerned with 'the response of the legal system' to long-term trends in economic relations and in contracting practices. His argument was that contract law and legal doctrines have evolved over time from the classical to the neoclassical model in response to changing societal needs, which are reflected particularly in the increasing relevance of complex transactions. Projecting such trends into the future, Macneil envisioned a further evolutionary step and the acceptance by contract law of a 'relational' model, although, he added, "no such system as yet exist in American law". By

[3] For the defining traits of configurational approaches the reader is referred to Meyer, Tsui and Hinings (1993) and the other articles in the same issue of The Academy of Management Journal. For a comparison of configurational and complementarity approaches see Whittington et al. (1999).

contrast, although Williamson refers fairly consistently to "contract law" regimes, the impression conveyed throughout his paper is that at any point in time a menu of three alternative contractual forms is offered to contracting parties and that the appropriate form will be chosen basing on the characteristics of the transaction.[4] Perhaps in practice a 'forbearance' legal model may be a foregone conclusion for parties contemplating a unified governance form.[5] However, if we restrict our attention to contracts between independent parties Williamson's point seems questionable from both a historic and a juridical perspective. First, the classical and neoclassical contract doctrines are separated in time by a span of several decades. Thus, after the *Restatement (Second) of Contracts*, that epitomizes the shift of US contract law from a classical to a neoclassical model (Macneil, 1978) archetypical classical contracts may not be a viable option any longer, while before it neoclassical contracts were not.[6] Second, the suspicion that the institutional environment determines the institutions of governance only to a point is particularly strong when the focal institution is the contract. As argued by L.M. Friedman, the law of contract "concerns and provides legal support for the residue of economic behavior left unregulated." As a result, "contract law is basically negative, passive and untechnical" (Friedman, 1965: 23). This being the case, in a given transaction the parties have considerable degrees of freedom with regards to the choice of the contractual configuration, and what types of contracts get selected remains a question open to empirical investigation. Thus we must look for other explanations of the heterogeneity that is observed in actual contractual agreements.

[4] For instance, Williamson mentions the thirty-two year coal supply agreement between the Nevada Power Company and the Northwest Trading Company as a 'neoclassical contract'.

[5] However, it must be noticed that when one manifestation of the model of forbearance, the "business judgment rule" (whereby courts normally do not exercise regulatory power over the activities of corporate managers) comes into play, we are not talking about contract law any longer, but rather of corporate law (Bainbridge, 2002: 269-286).

[6] The *Restatement (Second) of Contracts* are abstract propositions of law, drafted by leading scholars under the auspices of the American Law Institute, designed to clarify and simplify existing common law. We leave aside the question, debated in Gilmore (1995) of whether, and to what extent, actual courts decisions ever reflected a classical model.

In his 1991 paper, Williamson tackles also another hitherto relatively neglected issue, namely that of establishing what are the key attributes with respect to which contractual governance structures differ. [7] Leaving adaptation aside, a quality that is better thought of as a property of governance forms, rather than a mechanism, the two attributes that Williamson considers are incentive-intensity and administrative control. Here we find Williamson's discussion wanting in two respects. First, administrative control is not well defined.[8] Second and more relevant, administrative controls are treated essentially as the dual of incentive intensity. In fact, Williamson argues that when incentives are dampened, administrative intensity has to increase to take the place of the discipline of the market. As a result, the two 'instruments' actually define a single factor. The wider context of the discussion, that extols the virtues of hierarchy when conditions of dependency obtain, further strengthens the impression that despite Williamson's discussion is somewhat nuanced, he simply differentiates governance forms basing on the degree of hierarchical intensity. This seems to be also Oxley's understanding when she writes that "the logic of transaction cost economics suggests that more hierarchical alliances will be chosen for transactions where contracting hazards are more severe" (Oxley, 1997: 388).

The discussion so far should have made clear that 'hierarchical intensity', as intended by TCE, is essentially a label to contrast organizational forms that display extreme levels of autonomous adaptation from those that score high on coordinated adaptation. Thus, this dimension is based more on the properties of governance forms than on their constituting elements and it is unlikely to provide a powerful criterion to tell apart but the most general governance archetypes. Furthermore, from an organizational design point of view, this

[7] Strictly speaking Williamson does not refer only to the formal contractual governance. Yet the examples he mentions are taken from actual agreements or refer to issues that are typically regulated by explicit contractual clauses (e.g.: dispute settlement mechanisms). Thus it is safe to assume that his argument can be constructed essentially as a dimensionalization of contracts.

[8] Monitoring, career rewards, penalties and a few others are mentioned as examples of administrative controls (Williamson, 1991: 280).

dimension tells us little about the extent to which under different circumstance actual contracts ought to incorporate hierarchy, in the specific sense of a formalized system of authority, let alone other coordination mechanisms.

Despite these limitations, the recognition that certain traits of governance forms may vary along a continuum marks an evolution over the strong opposition between market and hierarchy that was typical of early TCE (Williamson 1975). However, Stinchcombe (1985) had already taken a more radical stance. His position is that contracts have to perform the same functions of hierarchies amid the same kind of uncertainty, and that they do so by incorporating the same elements of unified structures. As to which these elements are Stinchcombe proposes a quite detail listing of mechanisms, classified within five classes: 'command structures', 'incentive systems', 'standard operating procedures' 'dispute resolution procedures' and 'nonmarket pricing'. These propositions are corroborated by examples that Stinchcombe draws from a large variety of contractual situations, but do not seem to have inspired much systematic empirical investigation and to-date Stinchcombe is seldom quoted in the TCE-inspired literature.

The realization that extant theories provide too coarse an apparatus to compare and differentiate different hybrids led Brousseau (1995) to develop his own framework, basing on a synthesis of TCE and agency theory. Brousseau summarizes the main functions of contracts in the coordination of actions, the enforcement of promises and the sharing of the quasi-rent generated by the cooperation. From these three functions he derives three 'modes' that can be understood as operational mechanisms to provide the parties with dynamic stimuli to perform certain processes. These 'modes' encompass authority and routines, hostages and supervision, and remuneration and risk sharing rules. Clearly, while still sketchy, this dimensionalization is finer grained than Williamson's. Brousseau operationalized these construct into seven variables and gathered observational data through interview surveys. His dataset included 78

valid responses relating to as many inter-firm coordination arrangements that belong to settings as different as manufacturing, wholesale distribution and financial services. Through multiple correspondence analysis Brousseau extracted two dimensions. The first, labeled *degree of specificity*, measured whether a contract implements or not a specialized governance. The second, labeled *degree of asymmetry*, contrasts the specification of a centralized authority to decentralized decision-making and ex-ante sharing of output. Furthermore, through hierarchical clustering Brousseau obtained four classes that were interpreted as "market-type" contracts, "co-operative" agreements, "long-term" agreements, and "hierarchic" contracts.

This study supports our contention that Williamson's dimensionalization was too straight a jacket to compare for empirically observable governance forms. At the same time it leaves some important questions open to further investigation. One is whether the contractual heterogeneity that Brousseau observes owes only to the extreme diversity of the setting, or it is a reflection of contextual variables more specific to the firm, the task or the transaction. Another is whether the application of correspondence analysis to a set of only seven variables defined axiomatically can produce enough new insight into the dimensions of contracts or "tautologically echo[es] one's pre-existing cognitive schema" (Suchman, 1994: 315).

Suchman (1994), on his side, carried out a multivariate analysis of 78 venture capital financing agreements that addresses particularly the second of these concerns.[9] His investigation is part of a wider inquiry into the role of institutional intermediaries in the structuration of an organizational field. Through content analysis, Suchman measured about 400 variables, spanning 16 substantive areas, that were connected more to contracting practices than to organizational economics theories. Several of those variables directly mirror the content of rather standard contract language. Using INDSCAL, a variant of multidimensional scaling, Suchman reduced the complexity of venture capital contracts to

[9] The contracts analyzed by Suchman relate to a wide array of industries, though it appears that most of the agreements related to ICT and biotechnology deals.

two dimensions. Through a regression of selected variables against the INDSCAL coordinates Suchman determined that dimension 1 reflects the extent to which a financing agreement explicitly delineates the various rights and obligations of the contracting parties, while dimension 2 seemed to be related with the anticipated duration and intensity of the relationship between the start-up and its investors. The hierarchical clustering carried out by Suchman on the INDSCAL dimensions yielded five groupings that were amenable to interpretation as meaningful contractual archetypes.[10] These results support the idea of a multidimensionality of contractual agreements. Contractual dimensions "seem to counterpoise "rights" issues on the one hand against "relational" issues on the other – recreating a dichotomy frequently invoked" (Suchman, 1994: 223). Equally interesting is that data reduction techniques *fail* to find a dichotomy of 'pro-company' and 'pro-investor' contracts, which is how the trade press and incomplete contract theory often frame the discussion.

Another valuable contribution on contract dimensions is provided by Ménard (2004). Strictly speaking this conceptual article is not a review of literature, yet it brings to bear a large amount of empirical evidence on hybrids that had been collected by different authors. Although it is more concerned with multilateral than with bilateral hybrids and it investigates also complementary governance mechanisms, this article has a lot to say also about the dimensionality of formal agreements in dyadic interfirm relations. According to Ménard, contracts have at least five dimensions: the number of partners, duration, the specification of requirements, the specification of how adaptation is to be achieved, and the extent to which they specify safeguards. Other mechanisms that can fit into contracts, like the use of authority or restrictive provisions, are discussed in the section on complementary mechanisms. Ménard takes a configurational view ("none of these characteristics is entirely specific to hybrids. It is their combination that gives hybrids a typical content" (p: 363)). However complementarity is

[10] The clusters so identified were labeled 1) weak contracts; 2) pre-programmed contracts; 3) legalistic contracts; 4) close contracts; 5) flexible contracts.

assumed rather than established and little or no indications are provided as to which mechanisms need to combine.

The articles reviewed so far describe a trajectory of progressive expansion of the concept of contract. As argued in Masten (2000) the origin of this trajectory lies in the works of Arrow and Debreu that equated (complete contingent claims) contracts to pure market transactions. Gradually, contracts came to be understood as instruments that can incorporate elements of conscious adaptation, notably command structures and enforcement mechanisms. However, both mechanisms require that it be possible to specify proper behavior. Thus, when this condition does not obtain these mechanisms should come under strain. Moving from these considerations Grandori (2005) proposed that under conditions of radical uncertainty an alternative and more efficient contracting strategy to the specification of task obligations would be centered on ensuring a continuing association of resources "no matter what", as a pre-condition of a progressive discovery of desirable outcomes. This element of uncontingent commitment is the basic defining characteristic of an association, and is best typified by a marriage contract. Accordingly, Grandori (2005) proposed that beside greater or smaller incentive and hierarchical intensity, contracts have an "associational" dimension and that agreements would score high along it under conditions of radical uncertainty. Three case studies of ICT alliances were found to be broadly supportive of this expectation (Grandori and Furlotti 2006a).

3. A CONCEPTUAL FRAMEWORK

So far we have referred rather loosely to contracts in general. Perhaps it is time to make clear that our concern goes first and foremost with contractual relations that involve at least some degree of joint actions or of common use of resources. Contract that deal exclusively with

transfers of property rights fall outside the scope of this study. Accordingly, the framework that is developed here is tailored primarily to the analysis of contracts of the former type.

As mentioned in the Introduction, previous literature has for the most part neglected the investigation of the internal fit that under conditions of efficiency is likely to bind various contractual clauses, and has focused typically on just one or a very small number of provisions at a time, in the belief that they could be considered as 'sufficient statistics' of the contractual complexity.[11] While such hypothesis has seldom been the object of systematic investigation, the studies it inspired have helped defining the array of elements contractual governance is made of. Accordingly, our attempt to develop a conceptual framework may be configured essentially as an exercise into ordering the variety of the contractual mechanisms.

All the contributions reviewed hitherto may be usefully summarized by making reference to Ian Macneil's famous 1974 article. Probably, the central message in that study is that contracts are projections of exchange into the future: doing something now that limits choices otherwise available in the future (Macneil, 1974: 719). This way of seeing contracts emphasizes a basic tension which is inherent in all contracts: that between *planning* – our present representation of what the future ought to be – and *adaptation* – the alterations and further specifications of the original plans that need to be done, or to be resisted, as the future unfolds. Moreover, this perspective draws attention to the *duration* of the contractual relationship, a dimension that obviously affects heavily the precision and the means by which we can plan the future. The contractual dimensions mentioned in the articles reviewed can rather accurately be described as instantiations of these three elements. The tension between plan and adaptation is certainly at the core of the contractual problem and will be reflected also in our conceptual framework. The relation between these two terms mirrors that between

[11] "Previous literature [focused] only on the strictly 'monetary' aspects of the contracts" (Arruñada, Garicano, Vazquez 2001: 257). "Empirical transaction-cost research on contract design has looked primarily at three types of provisions: incentive provisions, pricing structures and price adjustment methods" (Masten, Saussier 2002: 285).

substance and *procedure* (Simon 1976). Thus, contractual elements can be usefully distinguished between those that structure the relation and display considerable stability during the life of the contract, from the procedural elements that are designed to provide the contract with flexibility and dynamic adaptation.

However, focusing on the tension between plan and adaptation is closely related to seeing inter-organizational relations as goal-directed systems, and bears also the limitations of that perspective (see, for instance, Vanberg, 1994). To counter that risk we need to concentrate not only on what IORs are directed at, but also on what they are based upon. Such view emphasizes the type of resources, and the extent, to which they are combined for common use. This seems to be one of the messages in Grandori (2005) and will also be integrated in our framework. If resource commitments provide the foundations a system of collective action is built upon, they may usefully be subsumed within the substantive part of the contract.

Contractual elements that affect the governance properties of the contract are observed at different levels. While we have characteristics that can be predicated of the contract as a whole, others mechanisms and processes are observed only at an intra-contractual level and are often located in specific clauses. Duration is certainly one characteristic that pertains to the level of the contract as a whole. Another is the length of the contractual document, which can be considered as a proxy of how much in detail the future is planned in a given relationship. At the level of the contract we must also gauge the extent to which the contract displays a conscious awareness of the future and sets devices to deal with future contingencies that are explicitly spelled out. The attitude towards the future is an expression of time sense, which, according to Macneil (1974) is a primal root of contracting. Following his terminology we shall call this construct the contract's degree of presentiation.

When applied at the intra-contractual level, our framework help us identifying among the core substantive elements of the contract those that regulate the allocation of the output of the IOR

(be it a flow of revenues or an item of stock, like new inventions) and the basic obligations undertaken. For each of these – remuneration provisions, the assignment of property rights and the commitments concerning tasks and resources – in principle it would be relevant to ascertain the degree of their specification (how in detail they are planned) and how they distribute among the contractual parties.

As to the procedural aspects, *decision making*, *monitoring*, *enforcement*, and *dispute resolution* are obvious processes serving the purpose of adaptation on which there seem to be a certain consensus in the literature. Others, like *procedural coordination*, are normally considered to be aspects of extra-contractual governance (e.g.: Sobrero and Schrader, 1998). However, prior investigations (Grandori and Furlotti 2006b) and a cursory glance at the contracts in our sample, reveal that technology alliance contracts are replete with mechanisms for procedural coordination. Thus we think it important to try to measure this aspect as well. *Restraints* are the final mechanism we consider. This expression refers to contractually-imposed restrictions on the behavior of the parties. On account of their stability, restraints might be considered a substantive aspect. However, in a business context it is unlikely they can be described as being at the 'core' of the contractual matters. Restraints may be considered as a means to apply an organizational pressure on the contracting parties in order to infuse predictability in their behavior. If restraints are understood as mechanisms to limit undesirable flexibility of the relation, it may be appropriate to include them among the procedural aspects of the contract. As for the substantive elements, an empirical investigation should try to measure at least the presence or absence of these procedural mechanisms and, whenever possible, it should try to determine the degree of their specification as well as their distribution among the parties. For the reader's convenience the contractual elements mentioned above are enlisted in Table 1 in the Appendix, which summarizes the framework just exposed.

4. DATA AND MEASURES

Our study analyzes a sample drawn from a population of technology alliances in the field of pharmaceutical biotechnology. Several characteristics of this industry make it a particularly convenient setting to explore issues of contractual governance. First, since the eighties the industry has been characterized by a vibrant alliancing activity. Second, although many collaborations are supported only by handshake deals (Powell et al., 1996: 120) a large number of alliances is established through a formal contractual agreement. Furthermore, many participants of this industry are small start up companies. These firms are under the combined pressure of the need to raise finance through public offerings and to gain legitimacy through an accurate disclosure of company information. As a result many biotech agreements are filed as material contracts to the U.S. Securities and Exchange Commission (SEC), despite the SEC's rules that mandate public filing are not free from ambiguity.[12] Finally, although plain licensing also abounds, many pharmaceutical biotechnology collaborations involve the production of novel outcomes through joint activities, which makes coordination a non-trivial task.

The contracts have been provided by Recombinant Capital (Recap), a San Francisco Bay Area-based consulting firm that manages some of the largest and most detailed biotech business intelligence databases in the world. As of October 23, 2006 Recap's databases contain 23,687 high-level summaries of biotech alliances commenced since 1973. In order to take advantage of additional information that Recap collects from the business press, companies' presentations, and various additional sources, as well as to cross-check our coding of variables with that accomplished by professional contract analysts, we focused on those alliances that have been analyzed in detail by Recap. As of the date of accessing it,[13] the

[12] It is estimated that over 40% of biotech agreements are filed as material contracts. Source: Recombinant Capital website (www.rdna.com) accessed November 13, 2006.
[13] November 11 2005.

database included about 1700 alliances, clearly too many given our purpose to carry out a detailed analysis of contract content.

Our sampling criteria excluded first of all those alliances where one of the parties was a non-business organization, in the belief that that might introduce excessive heterogeneity in the sample. Second, being interested primarily to technology cooperation we excluded those alliances that did not include any element of R&D, and focused exclusively on the granting of licenses, production, marketing, the setting of standards, the assignment of assets or options, etc. The selection was based on the value of a measure of contract type coded by Recap's analysts. We excluded also alliances where both parties were pharmaceutical companies. While it might be interesting to investigate whether industry membership made a difference in terms of alliance governance, these alliances were numerically too few to expect statistical significance.

At the next step, we assessed that we would like to have both 'early stage' and 'late stage' alliances equally represented in our sample. By 'early' and 'late', we mean an alliance entered before or after a lead molecule has been discovered. It can be argued that having determined or not whether a molecule shows activity against a certain target is one important factor that is likely to impact significantly on the tasks to be pursued, and a reasonable proxy of the technological uncertainty facing the alliance partners (see, for example, Lerner and Merges 1998). Through random choice we selected a total 280 alliances stratified in such way that each class encompassed 50% of the alliances. At this stage we noticed that Recap's database offered us a coarse but convenient means to bias the sample toward successful alliances. In fact, it contains a flag to identify those alliances that were terminated ahead of time. While not necessarily the result of governance inadequacy, early termination may be an indication of some unforeseen trouble in the relationship. This allowed us to exclude an additional 40 alliances. Then, through random selection we picked the 79 alliance contracts that compose

our sample, again with a constraint of approximately equal representation of early stage and late stage alliances. Finally, a team of two raters analyzed the contracts during the period from December 2005 to August 2006 and measured those contract attributes that are described in the next section.

4.1. Identifying contract terms

From a wide roster of governance variables we selected an initial set of 27 variables to sample the conceptual domains described in Section 3. The variables are enlisted in Table 2. Most of the variables are binary, one is three-category polychotomous, and one is continuous. In questions about the presence of a certain governance mechanism in the contract, a value of two corresponds to an affirmative answer, whereas a value of one indicates that the mechanism is not used. Five variables require selecting a category that describes the type of a contractual mechanism. In these cases, the lower value indicates the type we suppose to be associated with arms' length contracting and higher values corresponds to the types presumably associated with increasing relational governance. Here we briefly describe each of the 27 variables.

At the level of the contract as a whole we measured the length of the collaboration agreement, in double-spaced page equivalents (#1) and the project duration (#2). In empirical studies of contracts it is common to measure contract duration. However, in the context of pharmaceutical biotechnology alliances the duration of each contract is essentially a random variable. In fact, since the sought for outcome is one or more patentable inventions, a typical contract establishes its own term at the expiration of the royalty payments on licensed technology. Except in the case when it preexists the collaboration, licensed technology could be patented at any time during a period of several years, and then it would enjoy patent protection for 20 years from filing date. As a result, the agreement would last for as many years from the filing date of the last patented invention. Thus, rather that focusing on contract

duration we preferred to observe whether the research and development activities envisaged in the contract are assigned a specific time bracket (whether strictly close ended or extensible) or are to be conducted as ongoing activities. Theoretically, the specification of a time bracket has been identified as one of the defining elements of the temporary organization (Lundin and Söderholm, 1995).

The second group of variables measures whether the contract deals with uncertain events by means of presentiation. In particular we ask whether the amount of compensation to be paid to the R&D firm is affected by any contingency at all, like, for instance, the level of sales of competing products grabbing a certain market shares in a given country (# 3). Moreover, we ask whether the parties explicitly establish who among them shall bear the cost of third party licenses that may become needed to achieve the goals of the alliance (# 4).

The third set of variables addresses the degree of specification of certain contractual commitments. Task specification (# 5) is measured by asking whether research and development activities the R&D party is required to perform within the framework of the alliance are simply mentioned or are articulated in greater detail.[14] In those cases where the R&D party is not requested to carry out any such activity, we entered a missing value and later we treated it in the analysis as a separate category. Some alliances explicitly specify the number of scientific personnel employed by the R&D firm, often on a year-by-year basis (# 6). Others prescribe that the personnel assigned to alliance-related activities have sufficient skills (# 7).

As to monetary rewards, we ask first whether the parties share the costs of the project or whether one of them acts as a financier and reimburses the R&D firm of expenses incurred (#8). Then we observe whether lump sum payments (called ‘milestone payments’ or

[14] For the purpose of this item, research and development activities were considered only those carried out at the discovery and pre-clinical stage. The segmentation imposed upon drug development activities by FDA regulations and by industry practices helps detecting them quite unambiguously within contracts.

'benchmark amounts' in the jargon of technological alliances) are tied to the achievement of certain verifiable events, like the filing of an Investigational New Drug application, the completion of Phase I clinical trials etc. (#9). Finally, we ask whether the allocation of the continuous rewards – that are envisaged by the vast majority of pharmaceutical biotechnology alliances – is just based on revenues (usually in the form of royalties on net sales) or it is based on profits and margins, thus requiring a higher level of mutual disclosure and risk sharing.

The next group of variables measures whether the R&D firm (#11) or the client (#12) are constrained in the way and extent they can carry out, alone or with third parties, research or commercial activities concerning the same subject matter as the alliance. Moreover, another item in this group asks whether the R&D firm is subject to any other kind of restraint at all, like extensions of the non-compete requirement to a certain period after the expiration of the agreement, non-solicitation of employees, applying the research funding only for the principal purposes of the alliance, etc. (#13)

Another cluster of variables assesses the mechanisms that are used to reach decisions during the life of the agreement on broad classes of problems or on particular issues. First we ask whether decisions concerning organizational problems (that is, on specification of the tasks of participants beyond the basic roles outlined in the contract, on adjustments and reassignment of tasks) are to be selected by routines (that is, prescribed by the contract itself), by a centralized authority (like a joint-steering committee or a party vested with decision making power) or are left to the negotiation of the parties (# 14).[15] Next we asked whether the contract assigns decision rights on certain matters that are of particular concern in alliances in general and in technological alliances in particular. This is surely the case with the right to

[15] We borrowed this item from Brousseau (1995) who measured, through questionnaire items, also the mechanisms adopted to select actions concerning problems at the strategic and the operational level. In the focal context we observed that alliance contracts almost never allowed changing the strategic decisions agreed in the contract. As to actions at the operational level, we assed that contracts were often too ambiguous on this point to enable reliable measurement.

influence the timing of publications of the research findings, an issue that may put in conflict the academically-oriented biotechnology firm and pharmaceutical firms, which are more strongly concerned with securing patent protection (# 15). Other relevant decisions concern the scope of the alliance, in particular whether the technologies under development can be expanded (# 16), whether the project can be extended (# 17) or whether one party or both can terminate the alliance without cause ('at will'), that is, without the insurgence of the typical causes for termination: bankruptcy, uncured payment default or uncured material breach (# 18).[16]

Items relating to coordination ask whether the contract mentions the use of budgetary control of the alliance activities (# 19) or institutes liaison roles with primary responsibility for communication between the parties (# 20).

As to monitoring, we assessed whether the contract grants the client the right to audit the counterparty's records of expenditures concerning research and development activities (# 21) and the right to inspect the scientific records or other records of process (# 22).[17]

Helm and Kloyer (2004) have argued that several provisions may institute hostages in alliances for R&D interfirm cooperation. One that can be assessed quite unambiguously from content analysis of contract documents is the requirement that the client makes significant payments upfront to the R&D firm or that it places firm orders of supplies (# 23). Another one is the agreement that one party makes a non-negligible equity investment in the other's capital (# 24).[18]

[16] Items 15 to 18 have been inspired by Lerner and Merges (1998).

[17] As to auditing rights, the focus on those concerning project expenditures has been advised by the realization that the assignment of auditing rights of royalty accounting is a boilerplate provision in virtually all of the alliance contracts. As to the right to inspect scientific records, we distinguished it from prescriptions of periodical reporting and from generic duties to disclose information

[18] It could be argued that equity investment serves more the purpose of extending the control of the financier over the R&D firm, rather than that of handing over a hostage to the R&D firm. One reason why the equity investments observed in our sample are of little use for the purpose of control is that they are usually limited to minority shares, and often exclude the possibility for the financier to make further purchases of shares. Moreover, control is often limited by the fact that despite the equity investment, the financier does not obtain a seat on the

A final set of variables assesses certain dispute resolution provisions. First we ask whether the contract provides that one party has a final say in disputes concerning particular matters (e.g.: the client may decide unilaterally in case of disagreement over sales promotion activities) (# 25). Then we observe whether there are particular problems for which decision-making authority is explicitely assigned to outsiders, besides those disputes that are to be solved expressly through formal arbitration. A typical occurrence thereof is to entrust industry experts of the solution of disputes on the inventorship of inventions made under the research plan (# 26). Finally, we ask whether the contract allows the parties to settle their disputes through court litigation (# 27).[19]

A cursory glance at the table reveals that there is no variable to measure the governance element of one cell of our framework, namely, property rights. The reason is that two items devised for the purpose had very little variance. In particular, the provisions regulating the ownership of jointly-made and individually-made inventions almost invariably establish that the former shall be "jointly owned", while for the latter "each owns its own".

Although 27 items are a tiny fraction of the contractual characteristics of an alliance agreement that are theoretically salient, they are still too many to be modeled individually.[20] Thus the application of data reduction techniques is in order to identify fundamental, uncorrelated dimensions.

5. MULTIVARIATE ANALYSES

partner's board (in our sample a seat is obtained in only 20% of alliances with equity investment). Finally, the value of the investment as a hostage is increased by the fact that since many biotechnology firms are unlisted startups, the possibility for the financier to dispose of the shares is severely constrained by their illiquidity, if not by explicit contractual covenants. Pisano (1989) also argued that equity participation is a form of hostage taking in biotechnology alliances.

[19] The reader may consider this as a matter of course in the case of formal contracts, which are stipulated precisely to secure legal protection in case things go sour. However, as a matter of facts, the parties often waive their right to bring issues to courts, and quite often opt for leaner means of dispute resolution, like mediation or arbitration. Ryall and Sampson (2003) found that this is a common practice also in the case of ICT alliance contracts.

[20] Suchman (1994) had based his content analysis of venture capital contracts on about 400 items. Too high a number of items imposes very severe data requirements on multivariate analyses of interdependence.

The first problem in the construction of an empirically based taxonomy is the selection of the variables to be observed. The previous section has dealt with precisely with that issue. In principle, cluster groupings could be constructed directly from the original variables. However, our desire that the taxonomy be based on a rich description of the contractual features and, conversely, the limited size of our database, prevented the adoption of this research design and advised the use of data reduction techniques first.

Earlier studies have used factor analysis applied to matrixes of tetrachoric and polychoric correlations (Pearson 1901), multidimensional scaling (MDS – Kruskal and Wish, 1978) and multiple correspondence analysis (Benzecri, 1973). One problem with the first methodology is that the model assumptions are not always appropriate – for example, if the latent traits are truly discrete. Unfortunately this obtains very often with the measurement of the presence of certain provisions in a contract: there is no such thing as the intensity, say, of a non-compete clause in a contract. As to MDS, its normal application is to determine the perceived relative image of a set of objects (Hair et al., 1998). Researchers in a variety of fields ranging from psychology to marketing find it convenient as it does not require the specification of variables to be used in comparing objects. However, quite opposite to these conditions, our research has determined inductively the variables that we intend to use for the comparison, while it does not have any obvious respondent whose perceptions we may be interested to map. Thus, the only way to apply MDS would be to construct synthetic indexes that summarize the similarity between objects – contracts – on each variable. Thus described this procedure already sounds like a quite convoluted way of comparing contracts: using a decompositional method for a compositional purpose. In addition, the simultaneous presence in our dataset of variables measured at the nominal ordinal and interval level would make the computation of a synthetic index of similarity not just practically complex but also theoretically problematic (Coppock and Mazlack, 2003).

These difficulties have been considerably alleviated by the fairly recent introduction of state-of-the-art computer programs implementing a special variety of principal component analysis that includes nonlinear optimal scaling transformation of the variables, that is, the optimal assignment of quantitative values to qualitative scales. Meulman et al. (2004), explain the essence of the optimal scaling process to the treatment of categorical data by referring to the linear regression model. In such model the researcher is interested in predicting a response variable from a number of predictors. "This objective is achieved by finding a particular linear combination of the predictor variables that correlates maximally with the response variable. Incorporating optimal scaling amounts to further maximization of this correlation, not only over the regression weights but also over admissible nonlinear functions of the predictor variables" (Meulman et al. 2004: 50).[21] One computer program that incorporates such features (the one that was used for the analyses in this study) is CATPCA (an acronym for Categorical Principal Components Analysis) that is available from SPSS 10.0 onward.

Multiple Correspondence Analysis (MCA) is another feasible procedure, quite similar to CATPCA, in the sense that it combines optimal scaling with principal components techniques. However, we preferred CATPCA over MCA since the latter assumes that all variables need to be scaled at the multiple nominal level, while the former allows for scaling of variables at single nominal, ordinal and numeric level.[22]

5.1. Categorical Principal Component Analysis

Principal components analysis requires the researcher to make a number of choices. One of these relates to the number of factors to be extracted from the larger set of variables. A

[21] "The optimal quantification for each scaled variable is obtained through an iterative method called alternating least squares in which, after the current quantifications are used to find a solution, the quantifications are updated using that solution. The updated quantifications are then used to find a new solution, which is used to update the quantifications, and so on, until some criterion is reached that signals the process to stop." (Meulman and Heiser, 2005: 1).

[22] "With single-nominal quantification, you don't usually know the order of the categories but you want the analysis to impose one. If the order of the categories is known, you should try ordinal quantification. If the categories are unorderable, you might try multiple-nominal quantification" (Meulman and Heiser, 2005: 4).

number of rules of thumb are used in the social sciences (cfr Dunteman, 1989). Yet none of them is totally undisputed. In the last analysis it is important that the factors extracted are comprehensible, and comprehensibility tend to decay with the number of factors. A second important consideration in the choice of factors is to be given to the fact that the variance they explain is sufficiently high. While for uses of PCA like the validation of a scale of five or six items a researcher would try to extract variance in the neighborhood of 90%, in our setting where 27 items are involved we regard anything in excess of 50% are quite satisfactory. A floor on the variance explained sets an opposing requirement that factors are not too few. Since a 50% floor can be barely crossed by two-dimension CATPCA's we focused on three dimension solutions.

In preliminary runs of CATPCA, we observed that the transformation plot of the categorical variable 'Action selection mechanism' (#14) always resulted in a kinked curve where the quantified values of two categories were almost identical.[23] This showed that these categories did not differentiate between contracts, and suggested to rescale the variable in a two-component one. However, once recoded, the cases concentrated overwhelmingly in one of the two categories, so that we decided to drop the variable for insufficient variance. A second variable that had to be dropped is 'Allocation of continuous rewards' (#10). While CATPCA works even if the underlying data contain numerous missing values, when missing values are given a passive treatment (that is, objects with missing values on the selected variable do not contribute to the analysis) CATPCA cannot compute the variance explained. To circumvent this problem we had to opt for an active treatment, whereby all missing values are replaced with the same quantification of an extra category. Unfortunately, once that was effected, it turned out that both one of the original categories and the extra category of missing values

[23] Transformation plots display the original category number on the horizontal axes; the vertical axes give the optimal quantifications.

had high quantifications. This fact blurred the interpretation of the factor loading and suggested dropping the variable from the analysis.

We carried out CATPCA on the remaining 25 variables and proceeded on by deleting in a single shot all the variables that explained 30% or less of the variance of all the factors. Then we fine tuned the solution by deleting other low-loading variables, while keeping an eye also on cross loadings. This process resulted in the solution that is displayed in Table 3. For ease of interpretation the variables are sorted so that those with the highest loading on a certain factor are placed next to each other, and lines are drawn between sets of variables loading highly on different dimensions. This solution encompasses 13 of the original variables and explains 54.8% of total variance.

In CATPCA dimensions are to be interpreted in terms of the sign and dimensions of their loadings, which represent the correlation coefficients between the original variables and the factors. By looking at Table 3 we notice that d1 is highly correlated with longer contracts (# 1), with the assignment of monitoring rights (# 21), of bureaucratic control (# 19) and greater use of restraints (# 12). Although lower in absolute value than that of other dimensions, d1 also exhibits a positive and non-negligible correlation with a higher use of presentiation (# 4) and with open ended R&D activities (# 2). Thus, not surprisingly, contracts scoring high on d1 assign less frequently the right to extend the project or the alliance (# 17).[24] All this seems to describe a strategy centered on the use of formalization (# 1, 12, 4) and, in parallel, on the use of control (# 21, 17), that we shall label *bureaucratic intensity*. As setting up and operating a bureaucratic apparatus is costly, it is not entirely unexpected that its use better associates with ongoing, rather than with time-bounded activities (# 2).

As to d2, we must notice preliminarily that one of the variables that loads highly on it (# 5: 'Specification: task') had missing values, which had to be treated as an extra category, as

[24] This feature should not be emphasized, since the right to extend the project separates the three dimensions only by the intensity (not the sign) of its correlation.

explained above. By looking at the table of quantifications we notice that the categories having significant values are "High" (with negative sign) and the extra category (positive sign).[25] In turn most of the missing values owed to the variable being not applicable, inasmuch as the R&D firm was not requested to carry out pre-clinical R&D activities. In sum a high positive loading of variable 3 on d2 negates either a high specification of tasks or the fact that the R&D firm is requested to carry out a task at all in that particular area. The other loadings indicate that d2 correlates positively with open endedness of R&D activities (# 2), with sharing of project costs among the parties (# 8), and negatively with the use of contingency planning (# 4). Other non-negligible loadings indicate that d2 negatively associates with the use of explicit incentives in the form of milestone payments (# 9) and with the detailed specification of the human resources to be brought to the alliance (# 7). Overall, the sharing of the incidence of burdens (# 8), low-powered incentives to effort (# 9), a less conscious awareness of future contingencies (# 4), and an ongoing relationship (# 2) seem to be some of the describing feature of a 'community of fate'[26] and suggest the labeling of *associational intensity* for d2.

Finally, d3 is correlated positively with the use of contractual hostages (# 23) and explicit incentives (# 9) and negatively with the assignment of decision rights on specific matters (# 15) and with the specification of the quality of inputs (# 7) to be brought to the alliance. Such high reliance on incentives and the relative neglect of the process that leads to the desired outcome seems to be at the core of discrete transactions that are underpinned essentially by the self interest of the parties, as reflected in the promises exchanged (Macneil, 1974). These characteristics give good reason for labeling d3 as *market intensity*.

5.2. Cluster analysis

[25] The vector coordinates of "Low", "High" and "Missing" for variable #3 on d2 are respectively 0.05, -0.63, 1.48. Case frequencies of those categories are respectively 30, 35 and 14.
[26] We owe this expression to C. A. Heimer (1985).

The output of the CATPCA has been analyzed to reveal groupings of contracts in our sample that would otherwise be not apparent. As it is well known, cluster analysis requires several methodological choices on the part of the researcher (Ketchen and Shook, 1996). Two important ones are the choice of the clustering algorithm and, relatedly, the choice of the number of clusters. To-date neither of these problems has received a definite answer and these issues are still subject to ongoing research. Extant theories about contracting for technology do not suggest very detailed typologies. Additionally, given the limited size of our sample it was unlikely we would be able to predict with high statistical accuracy memberships of solutions involving a large number of clusters. Thus, *a priory* considerations and sample characteristics indicated we should focus on solutions involving up to three or four clusters and compare them. In turn, this decision implies that a trial-and error exploration through k-means clustering is feasible, and allows us to avoid two fundamental problems that are associated with the main available alternative: hierarchical clustering.[27] Partitioning methods like k-means have their own limitations, the most relevant of which is the fact that the number of clusters must be specified in advance.[28] Thus, following a solution advocated by many experts, we shall also compare the number of groupings suggested by a priori considerations with the number determined by one type of hierarchical clustering.[29]

The joint application of these criteria indicates that a three-cluster solution best suits our data.[30] As indicated by the final cluster centers in Table 4 in the Appendix, cluster 1 is defined by values of associational intensity and of market intensity respectively above and below the

[27] K-means clustering is known to suffer less from the impact of outliers and to have greater stability when cases are dropped. Moreover, since it reaches a solution through multiple passes through the data, k-means clustering optimizes within-cluster homogeneity and maximizes between cluster heterogeneity (Ketchen and Shook 1996: 445-446).

[28] Other limitations are the fact that k-means clustering may converge on local optima and that it is not suitable to discover clusters with non-convex shapes.

[29] We shall use TwoStep Cluster, one method implemented by SPSS that integrates hierarchical with distance-based clustering.

[30] A pseudo F test indicates that a 2 cluster k-means solution would be unsatisfactory, as just one dimension would account for the greatest separation between groupings. On that account both a 3-cluster and a 4-cluster one would be equally acceptable. However, we select the former as the TwoStep procedure also yields a 3 cluster solution.

sample average. Cluster 2 is described by high bureaucratic intensity and by low associational intensity. Finally, cluster 3 is characterized by above-average market intensity and by below-average bureaucratic control.[31] Thus the definition of each cluster involves high doses of one dimension and negates average, or above-average values of at least another one. Moreover, each dimension significantly associates with the definition of at least one cluster.

Cluster analysis is known to be very sensitive to the choice of the variables the analysis is conducted upon. In particular, the inclusion of irrelevant variables increases the chance that outliers will be created on these variables (Hair et al 1998: 482). On the other side, also the exclusion of relevant variables may result in suboptimal clustering (Dillon, Mulani and Frederick, 1989). In our case, basing on criteria of parsimony and interpretability we opted for a 3-variable solutions of CATPCA. However, we examined also what the impact on our cluster analysis would be if we based it on the output of a 4 dimensional CATPCA. When four dimensions are used as inputs to a 3-cluster k-means CA, the pseudo F-test highlights the fact that one variable contributes distinctively less than the other three to our cluster solution, though the number of cases in each cluster remains almost unchanged.[32] The coordinates of the final cluster centers along the first three dimensions differ only marginally from those obtained by clustering applied to three variables. A TwoStep procedure again generates a three cluster solution. However, in every grouping the fourth variable fails to reach critical value of significance in the pseudo t test assessing its difference from the average.[33] In sum, it

[31] One output of the TwoStep procedure is a t test of equality of a variable's distribution within a cluster versus the variable's overall distribution. With the exception of bureaucratic intensity in cluster 2, all dimensions are significantly different from average at a 95% confidence level, with their size and direction in line with the values indicated by the cluster centers. Additionally, bureaucratic intensity in cluster 1 and associational intensity in cluster 3 are also significantly below the average of their overall distribution.
[32] We obtain a 26, 38, 15 cluster distribution versus 28, 34, 17 in the main-case analysis.
[33] Data available from the author.

appears that dropping from CATPCA the next factor with lower eigenvalue does not deprives the subsequent cluster analysis of valuable information.[34]

An additional concern with cluster analysis relates specifically to the k-means procedure, which can yield different final clusters depending on different initial partitions of the dataset. To tackle this concern we have run the clustering procedure 10 times, each time after sorting the cases in a different way. Indeed this results into slightly different assignments of cases to clusters and into different values for the cluster centers. While visual inspection may be sufficiently reassuring of sufficient reliability, we have also subjected our data to quantitative analysis. This problem resembles an assessment of inter-rater agreement between n-judges. In our case the 'judges' are the 10 different cluster analyses while the 'subjects' are the cluster centers and the number of cases in each cluster. We conducted the reliability analysis on the cluster centers separately from that on the number of cases in each cluster. The former yields a Cronbach alpha of 0.973, the latter one of 0.908. We consider this as evidence that that our results are sufficiently robust to different initial partitioning of the dataset.

6. DISCUSSION

This study adds flesh to Stinchcombe's (1985) contention that contracts are an organizational phenomenon, that is, social structures that can contain the same basic elements as unified governance forms. It also expands a line of reasoning first developed by Victor Goldberg (1976: 428) that contracts can be "constitutions". Continuity with Goldberg's lies in the acknowledgement that in certain contexts contracts shift from a detailed specification of the terms of the agreement to more complex, generally procedural, governance structures. Expansion lies in the recognition that the complexity of the contractual apparatus may exceed

[34] We have also tried to assess whether our solution is sensitive to outliers. For this purpose, we have plotted the distance of cases from their classification cluster center in a box & whiskers plot. Only one case, in cluster 2, lies more than 1.5 times the interquartile range away from the median. Filtering out such case does not significantly affect the resulting clustering solution. Data available from the author.

what is required for a simple "adjustment" of the agreement over time and may be motivated by the need to support also the discovery of suitable actions, and the adaptation, if not the discovery, of the goals of the relationship.

However, this study was designed particularly to highlight different *configurations* of mechanisms; hence, what differentiates dissimilar governance forms, rather than what they have in common. Thus, lest we forget, it is useful to remind some mechanisms that are important in technology alliances and yet do not show up in the multivariate solutions due to their uniformity across contracts. Some form of sharing of continuous monetary rewards, usually in the form of royalties on net sales or on net margins, is common to the vast majority of pharmaceutical biotechnology contracts. Similarly, alliance agreements in this field adopt a standardized solution concerning the incidence of foreground intellectual property, that is, inventions developed after the inception of the alliance. As to decision-making, the vast majority of contracts does not allow for changes at the strategic level of decision, but allows for post-contractual selection of actions through centralized and decentralized authority. Moreover, in about 70% of cases contracts assign one or both parties one particular decision right, that to terminate the alliance without cause. Yet this clause explains very little of the contractual heterogeneity in our sample.

Other standardized contractual terms that do not even make the list of our initial 27 variables relate to dispute resolution through arbitration and the institution of a joint-steering committee of tied membership, which usually decides by unanimous consent.

Some contractual mechanisms were left out not on account of uniformity of adoption but because they show a low correlation with the main contractual dimensions. Among these we have all the dispute resolution mechanism listed in Table 2, which are adopted in 30% or less of cases. Another, such mechanism is equity investment in the partner's capital.

Our study finds results that corroborate the hypothesis advanced by Grandori (2005). It appears that one defining characteristic of technology alliances is the degree to which they establish a continuing association of resources "no matter what", which tends to vary inversely with the specification of tasks and with the planning of contingencies. We labeled this dimension "associational intensity". This result comes with some caveats that will be detailed in the conclusions.

Next we shall compare our findings concerning the contractual dimensions with those of prior studies. In Suchman's study dimension 1 was understood to measure the degree to which the contract delineates various rights and obligations of the parties and was reflected particularly in the protective covenants of the agreement.[35] That dimension has little or no correspondence with our dimensions. In our opinion this owes mainly to two reasons: first, to the fact that our research design does not emphasize the risk planning part of the contracts;[36] second, to the fact that the protection of interests through the assignment of specific rights is particularly salient in a setting like venture capital financing, which binds together for a long time two or more organizations with very different knowledge bases. On the contrary, dimension 2 bears a certain resemblance with our "associational intensity". The former, labeled the *intensity of the relationship*, was based essentially on several decision rights that have the purpose of preserving the involvement of the financier. Continuity of commitment it certainly a definitional feature of an association and it is what makes possible the establishment of a communitarian regime on the incidence of costs – one of the defining traits of our dimension.

Some similarity can be established also between our dimensions and those in Brousseau (1995). In the latter study, factor 1, labeled "specificity" (in the sense of the extent to which

[35] "Preferred as opposed to common stock (…) specific dividend, merger, mandatory conversion and anti-dilution provisions (…) covenants that might weaken investors' preferential rights" (Suchman 1994: 210).
[36] Risk planning is identified by asking whether the contract may likely go through a successful conclusion without what is being planned in a particular section of the contract having to be carried out. An affirmative answer identifies risk planning. A negative answer identifies performance planning (Macneil 1975: 640).

the contract establishes a governance apparatus specialized to the particular relationship), is described by the intensity of use of centralized decision-making, monitoring, unilateral hostages and duration, with higher values of these mechanisms corresponding to higher degrees of specificity. These elements line up quite well with those defining the dimension we interpreted as "bureaucratic intensity". On the contrary, Brousseau's second factor – the degree of asymmetry – which measures the lopsidedness in the allocation of certain rights and obligations (hostages, monitoring, monetary rewards) does not find a parallel among our dimensions. Also in this case the design of our research (that was concerned more with the presence or absence of certain elements in the contracts than with the party to whom they were assigned) may be partially responsible for underplaying this factor. However, as illustrated by our previous remarks concerning decision-making structures and the assignment of intellectual property rights, biotechnology alliance contracts tend to exhibit a remarkably balanced allocation of rights and duties in several areas.

As to the clusters of contracts identified in our study, our results indicate that among pharmaceutical biotechnology alliances there are quite radically different governance models. Supposing that our dimension of bureaucratic intensity adequately represents the conceptual domain that Williamson (1991) meant by 'administrative' or 'hierarchical' intensity, our results indicate that a governance solution characterized by medium or low values of hierarchy is suitable in over 50% of the cases in our sample (clusters 1 and 3).

The governance configurations identified seem to be quite consistent with results established by organization theory for ongoing integrated structures. Market governance seems ill suited for organizations pursuing high involvement of members and continuity of association (cluster 1). Bureaucratic governance, particularly in the sense of standardization and formalization, does not match well with a low specification of commitments, a low planning of contingencies and, presumably, with the joint decision making that attend to associational

alliances (cluster 2). Finally, alliances with substantial reliance on incentives show also below-average dependence on instruments of conscious adaptations (cluster 3). These results indicate that in a stylized sense, 'hierarchy' is not just the opposite of 'market' but it is also at variance with governance by 'communities of fate'.

7. CONCLUSIONS

As it should be apparent for the foregoing review of literature, the field of the economic and organizational studies of contracting does not seem to have reached consensus about the fundamental dimensions of inter-firm agreements. As a result, "theory provides no unifying structure for the specification and testing of design hypotheses" (Masten and Saussier, 2002: 282). In a sense, the state of the field resembles that of the studies of work behavior at the beginning of the sixties, when factorial studies were still rare (Pugh et al. 1963). By analyzing *in extenso* a medium-sized sample of agreements, in terms of variables obtained from the literature on contracting, this paper attempts to redress this problem.

This study indicates that the intensity of 'hierarchy' is not the only dimension that discriminates among different inter-firm alliances. Further, it highlights that the 'type' of a governance structure is the resulting combination of a large number of contractual clauses often belonging to different substantive areas. This finding should inspire caution when analyzing contracts in a piecemeal way. Still more, our results indicate that the lopsidedness of rights allocation is not always a salient problem when contracting for technological information. If asymmetric allocation of rights is the efficient response to contractual incompleteness (see Hart, 1995) our results indicate that many technology agreements are, in a sense, "complete" yet, quite low on presentiation.

This study has also several limitations. First, by conscious design, this study has focused on the performance planning side of contracts to the neglect of the risk planning, that is, of

provisions like representations, warranties, indemnities and insurance. This was motivated both by the perception that in biotechnology agreements these sections are generally dealt with by means of ‘boilerplate’, standardized provisions, as well as by the practical necessity to reduce the mind boggling complexity of the task of analyzing contracts. Our guess is that in particular settings, like venture capital financing, risk planning is a non-negligible part of the contract and should be accounted for in the analysis. A second limitation is related to the size of the sample. As principal component analysis requires the ratio between cases and variables exceeds a certain minimum level, we have been prevented from basing our analysis on an even wider set of contractual attributes. Accordingly, some relevant contractual characteristics may not be reflected in our dimensions. The limited number of the original variables entails that each CATPCA dimension is predicated only on five or six contract terms. While this may be enough to identify dimensions, like ‘bureaucratic intensity’, that are already well rooted in the tradition of organization theory, a larger number of indicators would be desirable for constructs, like ‘associational intensity’, that have been recently proposed to the attention of the scientific community.

Some avenues for future research are implicit in the aforementioned limitations. Additionally, one future development may consist in developing and testing hypotheses on the antecedents of different contract types. Other studies should replicate the analysis in settings other than contracting for R&D, to explore the extent to which the dimensions identified are context-specific or characterize a wider class of alliances. Finally, still other studies may replicate the analysis beyond dyadic alliances and investigate which particular problems are posed by multiparty hybrid governance forms.

REFERENCES

Arruñada, B., L. Garicano, L. Vazquez. 2001. Contractual allocation of decision rights and incentives: The case of automobile distribution. *Journal of Law, Economics & Organization* **17**(1).

Bainbridge, S.M. 2002. ***Corporation Law and Economics***. Foundation Press, New York, 884.

Benzecri, J.P. 1973. ***L'analyse Des Données. Tome II-L'analyse Des Correspondances***. Dunod, Paris.

Boerner, C.S., J.T. Macher. 2005. *Transaction Cost Economics: An Assessment of Empirical Research in the Social Sciences.* Georgetown University, Robert E. McDonough School of Business Working paper.

Brousseau, E. 1995. Contracts as modular mechanisms: Some propositions for the study of "hybrid forms". *International Journal of the Economics of Business* 2(3) 409.

Coppock, S., L. Mazlack. 2003. Soft multi-modal data fusion. *FUZZ-IEEE Proceedings.*

Dillon, W.R., N. Mulani, D.G. Frederick. 1989. On the use of component scores in the presence of group structure. *Journal of Consumer Research* 16(1) 106.

Dunteman, G.H. 1989. ***Principal Component Analysis***. Sage Publications, Thousand Oaks, CA.

Friedman, L.M. 1965. ***Contract Law in America: A Social and Economic Case Study***. The University of Wisconsin Press, Madison and Milwakee, 280.

Furlotti, M. 2006. *Contracts as an Organizational Phenomenon: A Review of Empirical Research on Inter-Firm Contracts.* Paper presented at the 2006 Annual Meeting of the Academy of Management, Atlanta, Georgia - August 11-16, 2006.

Gilmore, G. 1995. ***The Death of Contract***. Ohio State University Press, Columbus.

Goldberg, V.P. 1976. Regulation and administered contracts. *The Bell Journal of Economics* 7(2) 426-448.

Grandori, A., M. Furlotti. 2006a. The bearable lightness of inter-firm strategic alliances: Resource-based and procedural contracting. Ariño, Africa and Reuer, Jeff, ed. ***Strategic Alliances: Governance and Contracts***. Palgrave, London.

Grandori, A., M. Furlotti. 2006b. ***Facio Ut Facias: Associational Contracting and Innovation***. Paper submitted to the international workshop "Internal Organization, Cooperative Relationships among Firms and Competitiveness", Lucca, 19-20 January 2007.

Grandori, A. 2005. ***Firm-Like Contracts: From Task Contingencies to Resource Commitments***. Milano: Bocconi University. Crora Working Paper n. 10.

Hair, J.F., R.E. Anderson, R.L. Tatham, W.C. Black. 1998. ***Multivariate Data Analysis***. Prentice Hall, New Jersey: Upper Saddle River.

Hart, O. 1995. ***Firms, Contracts, and Financial Structure***. Oxford University Press, Clarendon Press, Oxford and New York.

Heimer, C.A. 1989. ***Reactive Risk and Rational Action***. University of California Press, Berkeley and Los Angeles, 273.

Helm, R., M. Kloyer. 2004. Controlling contractual exchange risks in R&D interfirm cooperation: An empirical study. *Research Policy* 33(8) 1103-1122.

Ketchen Jr., D.J., C.L. Shook. 1996. The application of cluster analysis in strategic management research: An analysis and critique. *Strategic Manage. J.* 17(6) 441-458.

Kruskal, J.B., M. Wish. 1978. ***Multidimensional Scaling***. Sage Publications, Beverly Hills and London.

Lerner, J., R.P. Merges. 1998. The control of technology alliances: An empirical analysis of the biotechnology industry. *Journal of Industrial Economics* 46(2) 125-156.

Lundin, R.A., A. Söderholm. 1995. A theory of the temporary organization. *Scandinavian Journal of Management* 11(4) 437-455.

Macneil, I.R. 1978. Contracts: Adjustment of long-term economic relations under classical, neoclassical, and relational contract law. *North. Univ. Law Rev.* 72 854-905.

Macneil, I.R. 1974. The many futures of contracts. *South. Cal. Law Rev.* 47 691-816.

Macneil, I.R. 1975. A primer on contract planning. *South. Cal. Law Rev.* 48 627-704.

Masten, S.E. 2000. The regulation of contracts: Contractual choice. B. Bouckaert, G. De Geest, eds. ***Encyclopedia of Law and Economics. Volume 3. the Regulation of Contracts***. Elgar; distributed by American International Distribution Corporation, Williston, Vt, Cheltenham, U.K. and Northampton, Mass., 25-45.

Masten, S.E., S. Saussier. 2002. Econometrics of contracts: An assessment of developments in the empirical literature of contracting. E. Brousseau, J.M. Glachant, eds. ***Economics of Contracts: Theories and Applications***. Cambridge University Press, Cambridge.

Ménard, C. 2004. The economics of hybrid organizations. *Journal of Institutional and Theoretical Economics* 160(3) 345-76.

Meulman, J.J., W.J. Heiser. 2005. ***SPSS Categories® 14.0***. SPSS Inc., Chicago.

Meulman, J.J., Van der Kooij, A. J., W.J. Heiser. 2004. Principal components analysis with nonlinear optimal scaling transformations for ordinal and nominal data. D.W. Kaplan, ed. ***The Sage Handbook of Quantitative Methodology for the Social Sciences***. SAGE Publications, Newbury Park, CA.

Meyer, A.D., A.S. Tsui, C.R. Hinings. 1993. Configurational approaches to organizational analysis. *Academy of Management Journal* 36(6) 1175.

Oxley, J.E. 1997. Appropriability hazards and governance in strategic alliances: A transaction cost approach. *Journal of Law Economics & Organization* 13(2) 387-409.

Pearson, K. 1901. ***Mathematical contributions to the theory of evolution. VII. on the correlation of characters not quantitatively measurable***. Philosophical transactions of the Royal Society of London, series A. 1-66.

Pisano, Gary P. 1989. Using equity participation to support exchange: Evidence from the biotechnology industry. *Journal of Law, Economics & Organization*, 5(1): 109.

Powell, W.W. 1996. Inter-organizational collaborations in the biotechnology industry. *Journal of Institutional and Theoretical Economics* 152 197-215.

Rindfleisch, A., J.B. Heide. 1997. Transaction cost analysis: Past, present, and future applications. *J. Market.* 61(4) 30.

Ryall, M.D., R.C. Sampson. 2003. ***Do Prior Alliances Influence Contract Structure? Evidence from Technology Alliance Contracts***. Simon School of Business Working Paper No. FR 03-11.

Shelanski, H.A., P.G. Klein. 1995. Empirical research in transaction cost economics: A review and assessment. *Journal of Law, Economics & Organization* 11(2) 335.

Simon, H.A. 1976. From substantive to procedural rationality. In S.J. Latsis (Ed.), *Method and appraisal in Economics*. Cambridge: Cambridge University Press.

Sobrero, M., S. Schrader. 1998. Structuring inter-firm relationships: A meta-analytic approach. *Organization Studies (Walter de Gruyter GmbH & Co. KG.)* 19(4) 585-615.

Stinchcombe, A. 1985. Contracts as hierarchical documents. A. Stinchcombe, C. Heimer, eds. ***Organization Theory and Project Management***. Norwegian University Press, Oslo.

Suchman, M.C. 1994. ***On Advice of Counsel: Law Firms and Venture Capital Funds as Information Intermediaries in the Structuration of Silicon Valley***. Doctoral Dissertation. Stanford University.

Vanberg, V.J. 1994. Organizations as constitutional systems. V.J. Vanberg, ed. ***Rules and Choice in Economics***. Routledge, London and New York.

Whittington, R., A. Pettigrew, S. Peck, E. Fenton, M. Conyon. 1999. Change and complementarities in the new competitive landscape: A European panel study, 1992-1996. *Organization Science* 10(5) 583.

Williamson, O.E. 1991. Comparative economic organization: The analysis of discrete structural alternatives. *Adm. Sci. Q.* 36(2) 269-296.

Williamson, O.E. 1985. ***The Economic Institutions of Capitalism***. The Free Press, New York.

Williamson, O.E. 2003. Examining economic organization through the lens of contract. *Industrial & Corporate Change* 12(4) 917.

Williamson, O.E. 1975. ***Markets and Hierarchies: Analysis and Antitrust Implications – A Study in the Economics of Internal Organization***. Free Press, New York.

Williamson, O.E. 1979. Transaction-cost economics: The governance of contractual relations. *Journal of Law & Economics* 22(2) 233-261.

Appendix

Table 1: Coding scheme

Level	Matter	Area
Contractual		
		Documents
		Duration
		Presentiation
Intra-contractual		
	Substantive	
		Monetary Rewards - Project
		Property rights
		Commitments (Task, Resources)
	Procedural	
		Decision making
		Selection of Actions
		Control Rights
		Restraints
		Enforcement
		Hostages
		Punishments
		Monitoring
		Coordination
		Dispute Resolution

Table 2: Value labels and descriptive statistics

	Variable	*Values*	*Valid cases*	*Min*	*Max*	*Mean*	*Std. Dev.*
Contract-level characteristics							
1	Contract length (pages)		79	19	223	83.2	46.80
2	Project duration	1='Close ended', 2='Open ended'	79	1	2	1.4	0.50
Presentiation							
3	Contingent compensations	1='Contingent terms', 2='No contingent terms'	76	1	2	1.6	0.50
4	Cost allocation of 3rd party licenses	1='No', 2='Yes'	79	1	2	1.6	0.50
Specification of commitments							
5	Specification: task	1='Low', 2='High'	65	1	2	1.5	0.50
6	Specification: # of personnel	1='No', 2='Yes'	79	1	2	1.3	0.48
7	Specification: skills	1='No', 2='Yes'	79	1	2	1.4	0.48
Monetary rewards							
8	Project costs regime	1='Reimbursement', 2='Sharing'	79	1	2	1.4	0.48
9	Milestone payments	1='No', 2='Yes'	79	1	2	1.7	0.46
10	Allocation of continuous rewards	1='Revenues', 2='Profits and margins'	70	1	2	1.2	0.43
Restraints							
11	Non-compete restraint (on R&D firm)	1='No', 2='Yes'	79	1	2	1.6	0.50
12	Non-compete restraint (on client)	1='No', 2='Yes'	79	1	2	1.4	0.50
13	Other restraints (on R&D firm)	1='No', 2='Yes'	79	1	2	1.6	0.49
Decision making							
14	Action selection mechanism	1='Routines', 2='Centralized authority', 3='Decentralized authority'	79	1	3	2.1	0.56
15	Right to delay publications	1='No', 2='Yes'	79	1	2	1.6	0.48
16	Right to expand alliance	1='No', 2='Yes'	79	1	3	1.8	0.89
17	Right to extend alliance	1='No', 2='Yes'	79	1	2	1.6	0.50
18	Right to terminate alliance without cause	1='No', 2='Yes'	79	1	2	1.7	0.45
Coordination							
19	Budgets	1='No', 2='Yes'	79	1	2	1.5	0.50
20	Liaison roles	1='No', 2='Yes'	79	1	2	1.3	0.47
Monitoring							
21	Auditing rights	1='No', 2='Yes'	79	1	2	1.4	0.50
22	Inspection rights (of scientific records)	1='No', 2='Yes'	79	1	2	1.3	0.46
Hostages							
23	Upfront payments/ firm orders	1='No', 2='Yes'	79	1	2	1.6	0.50
24	Equity investment	1='No', 2='Yes'	79	1	2	1.5	0.50
Dispute resolution							
25	Unilateral decision rights	1='No', 2='Yes'	79	1	2	1.3	0.47
26	Authority to outsiders	1='No', 2='Yes'	73	1	2	1.2	0.43
27	Litigation	1='No', 2='Yes'	78	1	2	1.3	0.47

Table 3: Factor loadings

		Dimension		
Variable		*d1*	*d2*	*d3*
1	Contract length (pages)	0.82	0.04	0.08
21	Auditing rights	0.65	-0.32	-0.15
19	Budgets	0.63	-0.06	-0.06
17	Right to extend project/alliance	-0.57	-0.32	-0.26
12	Non-compete restraint (on client)	0.50	-0.03	-0.29
5	Specification: task	-0.03	0.75	0.08
2	Project duration	0.47	0.67	0.11
8	Project costs regime	0.30	0.64	-0.32
4	Cost allocation of 3rd party licenses	0.40	-0.63	0.04
23	Upfront payments/ firm orders	0.24	-0.18	0.73
9	Milestone payments	0.10	-0.48	0.68
15	Right to delay publications	0.29	-0.37	-0.53
7	Specification: skills	-0.04	-0.41	-0.52

Table 4: Final cluster centers

	Cluster		
	1	2	3
Bureau Object scores dimension 1	0	1	-1
Association Object scores dimension 2	1	-1	0
Market Object scores dimension 3	-1	0	1

Table 5: Cluster distribution

		N	% of Valid Cases
Cluster	1	17	22%
	2	34	43%
	3	28	35%
Valid		79	100%
Missing		0	