# Contracting for the unknown and the logic of innovation

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# Contracting for the unknown and the logic of innovation

**Abstract**

This paper discusses the components of contracts adequate for governing innovation, and their microfoundations in the logic of innovative decision processes. Drawing on models of discovery and design processes, distinctive logical features of innovative decision making are specified and connected to features of contracts that can sustain innovation processes and do not fail under radical uncertainty. It is argued that if new knowledge is to be generated under uncertainty and risk, 'relational contracts', as usually intended, are not enough and a more robust type of contracting is needed and it is actually often used: formal constitutional contracts that associate resources, leave their uses rationally unspecified, but exhaustively specify the assignment of residual decision rights and other property rights, and the decision rules to be followed in governance. The argument is supported by an analysis of a large international database on the governance of multi-party projects in discovery-intensive and design-intensive industries.

**Keywords:** Contracts, Innovation, Design, Discovery

## Introduction

A widespread tenet in organization, management and economics is that strong uncertainty puts both rational behavior and contractual governance under strain. The roots of that thesis lie in the bounded rationality argument that, in the face of growing uncertainty, decision making increasingly deviates from the classic complete knowledge, utility maximizing approach. Actors proceed with limited knowledge, rely on simplifying heuristics and take decision-making shortcuts. In contract theory, especially where bounded rationality is admitted, as in the most important strands of transaction cost economics and property right theory, it is generally

contended that as uncertainty grows, limitations in foresight render contracts more and more incomplete, in the sense that an increasing variety of matters are left unspecified (Williamson, 1975; Hart, 1988). The mechanisms that intervene to take care of those unspecified matters are often thought to be mainly 'extra-contractual' (Macaulay, 1963) and mainly informal: for example, self-enforcing mechanisms based on common interest – what economists mean by 'relational contracts' (Backer *et al*., 2002); and social embeddedness in commonly accepted norms – a view of relational contracts that is common in management (Ring and Van de Ven, 1992; Poppo and Zenger, 2002).

Both the above traditions in decision making and contract theory face important anomalies though, especially when action projects aim at innovation - that, in fact, is not prominently considered in those works. For instance, how can the innovation rate be as high as it is, if decision-making under uncertainty is shaped by local search and 'simple heuristics' (Grandori, 2010a)? How does it come that different parties frequently enter into collaborative agreements for innovative ventures, often underpinned by rather 'simple' contracts (Al-Najjar, 1995)? Is it simply because poorly observable cultural, informal or social relations blend in to support governance (Gilson *et al*., 2010)? How can this type of relational agreements provide sufficient shelter for investing significant human, technical and financial capital in risky projects? These puzzling questions invite some rethinking of the cognitive and contractual foundations of innovation.

The rethinking proposed in this paper contends that when innovation is important, more ambitious responses to uncertainty are worthwhile, possible and even common. They can be identified by revisiting innovation studies in various fields, looking for answers to disconfirming questions such as: Is it really the case that the best that humans can do in the face of uncertainty

is to ‘avoid’ or reduce it? Is it really the case that there is no effective form of contracting ‘in the face of the unknown’? Is it really the case that ‘the management of innovation’ can only be flexible if it is largely informal?

The conceptual part of this paper addresses those questions, by identifying some key features of innovative decision processes; and enquiring into the features of agreements among different actors that may allow, and possibly support, the unfolding of those processes. The main idea is that between incomplete contracts among boundedly rational actors on one side and complete contingent contracts among omniscient actors on the other side, there is something else, and probably the most interesting things.

Consider for example what is and what is not specified in the following agreement for innovation, entered into in 2003 by Aspreva Pharmaceuticals S.A. of Switzerland, and the U.S. prescription drug unit of Hoffmann-La Roche (“Roche”), and intended to last until 2017. The object of the agreement was the development and commercialization of a certain drug, already approved for the prevention of organ rejection, as a treatment of possible additional indications. The contract incorporated the traditional “boilerplate” (i.e. standard) clauses, such as limitations on liability, indemnifications, and force majeure, to deal with those risks that are recurring across all contractual relationships. The most important and specific set of clauses regarded royalties, as they were the main form of payment. The agreement designed them so as to bring about a substantial sharing of risk. Beyond those basic standard ingredients, the interesting feature of such an agreement is that it specifies many things except what precisely will be done or delivered. The agreement dedicated no more than a couple of lines to detailing the object, which was in fact partially unknown at the outset. Instead, the agreement was very extensive (a hundred pages) on a few issues, illustrated in the next points.

- A sizeable section of the agreement regulated drug development and the subsequent commercialization activities. For this purpose, the agreement referred to the 'plans' attached to it, but recognizing that they were to be intended as a 'high-level outline'. Interestingly, these sections explicitly recognized the fallibility of judgment under uncertainty, and held that the parties would not be deemed to be in breach of the contract if they failed to meet the drug development goals of the collaboration.
- Rather than on the content of goals and results, the contract concentrated a lot on the ruling bodies and the decision making procedures. These procedures were relatively short as to the relational norms to be followed, such as that the parties promptly disclose information, provide reasonable assistance to each other, and use commercially reasonable effort. Instead, substantial space was dedicated to contractual terms that established an association among the entities and a joint governance body, and specified the parties' decision and exit rights, exemplified in the next points.
- The parties had right to access each other's patents and know-how for the purpose of the collaboration, and obligations not to perform any activity with the same technology and for the same purpose outside the focal collaboration. In the case of unilateral withdrawal of one party, the non-terminating party would continue to enjoy access to the technology for the purposes of the agreement. The association was also granted the right to access for the same purposes every invention that would occur during the term of the collaboration.
- The steering of the association was assigned to a Joint Committee, and to subcommittees that this would institute. The parties would have equal representation in the Joint Committee, and this organ would decide on a wide array of matters, in every case by

unanimous consent. This stipulation, coupled with a set of checks and balances, entailed that no material issue would be decided unilaterally.

- The parties waived the right to determine disputes through court litigation. As a result, far from minimizing the need for ex-post negotiation, the agreement institutionalized joint decision making and negotiation as the main mechanisms for making important decisions. In case of disagreement, the 'court of last resort' was indicated in a jointly appointed arbitrator.

What this contract formally specifies then, in quite an exhaustive manner, are the reciprocal rights and obligations of the parties, what they commit and own, how they are going to decide what to do. Such a contractual profile is rather common in innovation. As Lerner and Merges (1998) observed in a valuable footnote to their analysis of the content of a large sample of biotechnology alliance agreements, rather than trying to spell out "a myriad of possible world-states, and dictating outcomes under each of many scenarios" these contracts focus on "discrete aspects of the fundamental ownership right over the research results".

*Why* is such form of contracting common in innovation? Is the fact that the contract does not specify all possible contingencies and action a case in contract incompleteness and bounded rationality, as contract theorists maintain (Hart 1988)? Or, rather, can this type of contract find justification as a rational agreement, if the notion of contract and rationality are broadened with more serious consideration of innovation and discovery? Is the broad category of 'relational contracting' (Macneil, 1978) sufficient to make sense of them? Are there significant differences between contracts for innovation and the most usually analyzed types of relational contract, based on stable long-term relations and repeated transactions?

The first part of the paper addresses these questions theoretically. The empirical study presented in the second part of the paper extracts evidence, pertinent to respond to those research questions, from a large database on the governance of projects in discovery- and design-intensive industries (the KGP database[1]). The results of the analyses square well with the governance patterns for innovation predicted by the broadened approach to rationality and contracts prospected here.

**The generative logic of innovation and discovery**

It has been already observed that when the world becomes more difficult to understand and predict, a possible move, especially if innovation is to be generated, is to treat uncertainty as an opportunity rather than a threat (Kirzner, 1979), to invest in research and to stretch the mind, rather than reducing the costs of search and cognitive effort (Grandori, 1984, 2010a); to apply forms of 'rational imagination' and design to generate possible alternatives, rather than remaining trapped in local search and in received problem frames (Byrne, 2005; Shackle, 1979; Le Masson, Hatchuel and Weil, 2007; Roberts, 2013).

Outside economics and management – say, among philosophers of knowledge, logicians, engineers, designers, experts in the defense from natural hazards – no one seems to dispute that rational thinking in the face of the unknown is possible and indeed desirable; and this attitude has stimulated efforts to model how very complex open problems are solved through logically correct, methodologically rigorous procedures. Models of those processes are now available also in management fields that study innovation processes, including design theory, technological

[1] The database was constructed in 2007 within the international research program 'Knowledge, Governance and Projects': a partnership among universities and investigators studying innovation and the project economy in countries with significant project-intensive sectors - Germany, Italy, Denmark in the EU, and California in USA, of which the first author of this paper was the Principal Investigator.

innovation, entrepreneurship and strategic innovation. It is beyond the scope of this paper to give an account of all these procedures for effective innovative decision making. What we need and set out to do here is to identify some core common features of those methods for effective reasoning under uncertainty that have direct implications for contracting. These features can be summarized as follows.

- The core ingredient of any logic of discovery is hypothesis formulation and testing (Popper, 1935; Simon, 1976). This holds for any science with an empirical basis, but also and more generally for any rigorous discovery and learning process in business and life (Campbell, 1991; Popper, 1989). Furthermore, this fundamental logics also governs processes where what is to be discovered are solutions that can be designed, and not something given and hidden in nature. For example, in strategy formulation, possible actions, possible scenarios, the diagnosis of trends or states of the world, conjectures about the possible moves of competitors etc, all have the logical status of hypotheses (Liedtka, 2000). In design theory, the core task is to validate propositions of the type "There exists some object X, for which a group of properties $p_1$,$p_2$, $p_k$ hold in K" , where K is the body of existing knowledge, or knowledge space (Le Masson, Hatchuel and Weil, 2007).
- In innovative processes, problems are 'open' and not 'given'. They have to be defined, and 'redefined' in the very process of being solved (Pounds, 1969), through recursive processes (Hatchuel and Weil, 2003). The process of solving one problem may lead to solve another one (Campbell, 1960), and an ex-ante or prior problem definition may not even be needed, as when 'solutions' or 'means' meet or even generate problems worth solving (Cohen, March and Olsen, 1976; Von Hippel and Van Krogh, 2016).

- Generating hypotheses on the multiple functions and consequences that an artifact, resource, or action may have is crucial in innovation processes. "Design uses for one meter cotton thread" epitomizes a problem formulation for design purposes (LeMasson, Hatchuel and Weil, 2007); in other terms, the classic Simonian example of problem formulation -'find a needle sharp enough to sew with' – would become 'design possible uses for a needle'. In fact, in the crafting of entrepreneurial opportunities as well as in the discovery and design of innovative products, a heuristic named 'resources in search of uses' (Henderson *et al*., 1999; Grandori, 2010a), or 'effectuation' (Sarasvathy, 2008) has been repeatedly identified; meaning chiefly that the standard logic of solving a given problem (an end in search of means) can be usefully reversed for innovation purposes (means in search of ends, of problems to be solved). But even without the wider degrees of freedom provided by the possibility of designing alternatives, even when alternatives are not modifiable (e.g. when evaluating and choosing people or given technological equipment), basing their evaluation on multiple functions, and considering 'unintended consequences' is a core ingredient of innovative action selection (Villani *et al.,* 2008).
- As a result of all the above processes, in effective innovative decision making, knowledge 'expands' (Hatchuel 2001; Hatchuel and Weil 2007), 'problems shifts' (Lakatos 1976), and hypotheses on objectives and cause-effect relations are revised (Grandori 1984).

**The associational and constitutional texture of contracts for innovation**

If those are some core features of innovative rationality, we can now ask which features should a contract have in order to motivate and to allow the actors to engage in the 'expanding' and explorative decision processes that characterize discovery and design. If the logic of innovation

is characterized by the traits that were highlighted above, the expected traits of contracts for innovation, can be conjectured to comprise the following.

First, in order to provide room for the discovery of actions and objects what can be specified ex-ante is not a 'description' of such actions or objects. For example, if an 'unknown object' is to be designed, that very object cannot be described before the design process ; rather it possible to hypothesize 'only certain desirable properties, without the ability to give a constructive definition of the object and without being able to guarantee its existence on the basis of pre-existing knowledge." (Le Masson *et al*., 2017: 129). Furthermore, as illustrated above, innovation may also start not from problems to be solved or properties that a sought object should have, but from more open, 'resources in search of uses' questions like 'which possible objects may be realized with a set of resources', and 'which properties may those objects have' and 'which problems may they solve'. In those cases, in order to provide room for the discovery of consequences, the result parameters should let be free to adjust (the possible 'tunnel effect' created by too narrow and specific targets in innovative activities has in fact been early detected in goal setting theory) (Locke, 1996). As in the Aspreva-La Roche agreement described in the Introduction, the 'plan' or 'project' is defined as a general guideline and a broad domain of activity, rather than as a detailed specification of a given problem to be solved, or type of activity to be performed or type of consequences to be reached.

What can the parties contract on, if outcomes, objectives and activities can be pre-defined only as hypotheses to be tested and revised? A fundamental shift in the matter of contracting is a possible response: agreeing on pooling and committing resources; rather than agreeing on actions or trans-actions (exchanges) is in itself a response to uncertainty (Grandori, 2010b). Parties can promise to commit resources, and bet on their potential rather than on specific actions,

transactions or projects. Examples range from R&D agreements, as the Aspreva-La Roche contract, to 'entrepreneurs/investors' contracts for innovation, where 'betting on the jockey' (the resources) rather than 'the horse' (the project) is a very common decision strategy (Kaplan *et al*., 2009). Early stage investors regularly and explicitly admit they know that the business plan presented is not likely to be the one that will be realized; and that the thing they value the most is the potential of human and technological resources to generate revised, adapted and novel projects (Grandori and Gaillard, 2011)

If parties commit resources without specifying their uses, it is critical that the contract specifies two other matters: which rights the parties have on the committed resources, and who decides on their use. That's why contracts for innovation, as in the Aspreva-La Roche case, are so focused on asset commitments, rights of ownership on those assets, residual rewards, decision and control rights, and separation procedures. As an expert lawyer assisting contract writing in innovative activities in Silicon Valley said in one of our interviews: 'When we come to the contract, there are many matters to specify - from sought outputs, to milestones, to warranties and indemnities, to decision and control rights, to exit procedures - but one thing is particularly important and completely specified: who owns what."

In addition, if we wish to understand the texture of contracts under uncertainty, we should also consider that designing incentives and preventing conflicts are not the sole functions that contracts have in any relation of some complexity. Contracts are also tools for coordinating activities (Grandori, 1997; Gulati *et al.,* 2005); hence their articulation is likely to be sensitive to the complexity and size of the activities to be coordinated. In fact, as documented in longitudinal studies of contract evolution (Mayer and Argyres, 2004), the process of learning from the errors and the problems encountered is likely to enrich the contract in all its components, including the

operational parts of agreements describing activities, as well as the procedures and mechanisms to be used in communication and the coordination of joint work.

In conclusion, the recourse to informal agreements and social norms, so dear to much literature on 'relational contracting', does not seem to be the whole story. Moreover, it is doubtful that it can cope with the substantial level of uncertainty and complexity that are characteristic of most innovation processes, both for reasons of conflict resolution and of activity coordination.

In particular, if 'relational contracts' (RC) are intended as informal, i.e. as handshake agreements, they are weak in conflict resolution respects. They are flexible only because no formal commitment is taken. Hence, they are flexible at the expense of protection and enforceability (Shreyogg and Sydow, 2010), except for the restrictive case of self-enforceable agreements. And it is unlikely that self-enforceability obtains when innovative activities are involved (i.e., it is unlikely that the parties can clearly know ex-ante that the returns from collaboration outweigh those from opportunistic behavior). Hence, an exposure to considerable risk and opportunism is likely to follow. In fact, business companies rarely embark in projects entailing risks of this sort purely on the basis of trust, especially if the stakes are high; and even more so if the partner is 'new', as it may and should occur in innovation. Indeed, various influential students of inter-organizational contracting for innovation are increasingly skeptical that relational-as-informal contracting is up to the challenges posed by innovation and design (see, for example, Sabel and Zeitlin, 2004).

In their meaning of contracts embedded in socially enforceable norms, RC are more protective, thanks to social control, but at the expenses of flexibility. In fact, the establishment of social norms requires significant stability of partners and activities. However, social norms are quite difficult to change, due to the effects of interiorization, socialization, institutionalization and

group pressure (Ouchi and Wilkins, 1983). If norms of conduct are limited to general principles they might be flexible in the sense of not constraining behavior excessively (i.e., they would leave room for adaptation), but that could be at the expense of clarity. For example, establishing and verifying what constitutes "best effort", "fair play" or "due diligence" in any given situation of some complexity is difficult not only for any court of law (Jennejohn, 2008), but even for the partners themselves (Grandori, 2006). In fact, when knowledge is differentiated and the parties change frequently over time (or are unfamiliar due to lack of long-standing relations), as it does and should occur in innovative projects, the cognitive bases for social control are weak.

In sum, although informal agreements and social norms can be used in combination with formal contracting (Poppo and Zenger, 2002), both in repeated and stable exchange contracts (Brusco, 1982) and in complex and innovative contracting (Gilson *et al.,* 2010), they are unlikely to solve the main problems and hazards of contracting in the unknown. Our hypotheses stem from the suspicion that, together with the usually detected addition of social and informal governance, in effective governance of innovation other modifications occur in the structure of the formal contract, and that these have so far gone undetected for lack of pertinent theoretical lenses.

A useful observation for moving in that direction is that the term 'relational contracting' has been used in yet another meaning, which has nothing to do with formalization. Rather, it has to do with the matter that is regulated: the relation among the parties, rather than the content of the actions and transactions that the parties must perform (Grandori, 2006). It is thanks to that basic shift that relational contracts in this sense have better properties than classic transactional contracts in the governance of uncertainty. Hence, in order to distinguish them from relational-as- informal contracts (and to clarify their different cognitive underpinnings), it would be more precise and clear not to call them 'relational' but, paraphrasing Simon (1976), 'procedural'

contracts, in opposition to the traditional 'substantive' contracts. However, not all procedural contracts have the same properties. For example, a classic authority relation can be (and has been) seen as a relational contract in the sense that it substitutes a contract on what to do with a contract on who is going to decide what is to be done (Simon, 1951). Thanks to that property, the contracts and relations of authority can govern a higher degree of uncertainty – stemming from variability of conditions – than a market contract. Nevertheless, when uncertainty stems from knowledge rather than variability problems, as in innovation, then centralized decision making, hence also a contract incorporating it, is also expected to fail (Burns and Stalker, 1961; Perrow, 1967; Nickerson and Zenger, 2004; Grandori, 2009).

Hence, the core question is: what kind of contract, in the course of focusing on the relation among parties, can also protect them from hazards, pool differentiated competences, and provide enough leeway for discovery, when activities are still largely unknown?

On the basis of the above discussion, we submit that rational contracting for the unknown should be characterized by each and all the following main features.

*Contracts for innovation are 'procedural' (rather than 'substantive')*

A substantial part of the contractual provisions in any agreement of some complexity are 'procedural' stipulations on 'how to decide what to do' rather than 'substantive' stipulations on what to do. In other words, parties can contract on the procedures for action selection and on the fair division procedures over (unknown) effects and consequences, deriving from the joint (not fully described) project. The higher the uncertainty, the more the procedural component can be expected to expand, relative to the substantive, action-specific component.

*Contracts for innovation are 'associational' (rather than 'transactional')*

What can be also contracted on, that is reasonably known and clear, are the commitments of, and rights on, the resources that are supposed to generate a project of interest. The rationale of such an associational, resource pooling feature of contracts for innovation is to take a step backward in the causal chain, to consider the factors or resources generating actions and consequences, and to contract on those factors, over rights and obligations over resources (in search of use) rather than over uses. For example, in the Aspreva-Roche case the core of the contract is the promise to commit resources to research, production and commercialization of still unknown products to be developed jointly. The contractual specification effort focuses on defining rights over the resources committed and over the outcomes, so that actions and transactions can be discovered along the way. In fact, the typical agreements that lie behind inter-firm alliances, joint ventures, consortia, etc. for innovation all rely on some form of associational contract (Grandori and Furlotti, 2006).

*Contracts for innovation are 'constitutional' (rather than 'operational')*

A necessary complementary ingredient for governing an association is to specify who will decide over the life of the association itself, over the stream of actions to be taken, and how. Contracts of association establish a sort of 'condominium' (Goldberg, 2013), endowed with "a sort of constitution regulating the on-going relationship" (Goldberg, 1976): we can "think of written parts of contractual relations as constitutions establishing legislative and administrative processes for the relation" (Macneil, 1978). Indeed, as in any condominium, a necessary complement of an agreement to associate is an agreement on who will decide and according to which procedures. The contracts (or the types of clauses within them) that associate partners, establish decision procedures (including separation) and apportion control and reward rights, can be called 'constitutional'. The branch of economics broadly identified as 'constitutional political

economy' (Brennan and Buchanan, 1985; Vanberg, 1994) borrowed the term 'constitutional' from the juridical tradition. Because of these foundational features, constitutional governance can especially be distinguished from and contrasted to 'operational' governance (Ostrom, 1990), which being more specific and applied in content, is the organizational governance equivalent of what ordinary law is within legal systems.

Constitutional governance is usually operationalized as a set of (fundamental) rules. However, constitutions do more than that. They are agreements or contracts (*cum trahere* means pulling together, after all) constituting actors and systems: "A constitution both recognises and reinforces the place of individual *constituents* within the institution, and also *constitutes* them as a group or collective" (Bottomley, 1997).

Constitutional orders can also comprise unwritten, socially accepted, interiorized components (Sabel, 1993). However, we all know how important it is for legal certainty to have a 'chart' of written, explicit and enforceable constitutional provisions; and this is especially important in innovation as change and uncertainty are sources of hazards (Grandori and Furlotti, 2009).

*Constitutional governance for innovation is 'poliarchic' (rather than 'hierarchic')*

Constitutions may vary in their degree of centralization. At one extreme, a contract on decision rights may assign them all to a central actor, who is then entitled to choose the best actions as a function of circumstances. In spite of being able to cope with some uncertainty, though, such an agreement is effective for the system of action, and acceptable by the recipients of decisions, only under restrictive conditions, that are not those that typically characterize innovation. In fact, first and foremost, it is necessary that such a central actor holds the relevant knowledge for diagnosing circumstances and for selecting superior actions (Ostrom, 1990), and that the other agents are quasi-indifferent to the actions that can be prescribed to them (Simon,

1951). This is rarely the case in innovation. To generate novelty, most often it is necessary to 'recombine' knowledge and competences, and these are likely to be held by different actors (Galunic and Rodan, 1998). These actors in turn, are rarely 'quasi-indifferent' on the use of their resources, and, even more importantly, they are more knowledgeable about the best possible uses (Grandori, 2016). Indeed, organizational research has established long ago that hierarchy is likely to 'fail' as a coordination mechanism in the governance of innovation (Burns and Stalker, 1961). Therefore, centralized governance, even when based on a relational contract on decision rights as in authority relations, should not be expected to be an appropriate ingredient of contracts for innovation. The alternative is a decentralized, multi-lateral allocation of decision rights, representative of all the constituencies (Ostrom, 1990; Bottomley, 1997); and it is this 'poliarchic' rather than 'hierarchic' type of constitutional governance that can be argued to fit with highly uncertain, knowledge-intensive, innovative activities (Grandori, 2009).

**A study on project governance in design- and discovery-intensive industries**

Here we present original quantitative analyses of the KGP database pertinent to the above argument: 440 multi-party projects, in project intensive industries, in countries where all these sectors are well represented and accessible. The countries were Germany, Italy, Denmark and California (Silicon Valley) (see the Appendix for all the database characteristics).

Projects were the units of analysis (one project-one questionnaire). Projects are constituted by definition for performing non-routine activities, and are typically based on the pooling of different competences, but they can differ in terms of design intensity and discovery intensity. The projects of the KGP database belong to three clusters of sectors that capture those

differences: creative industries, high technology and science-based sectors, and machinery and construction sectors.

*Creative industries projects* included ventures in advertising, architecture, design, film and video production, interactive leisure software, music, television and radio. Examples are a project for the production of television content, which involved one film producer, a TV broadcasting company and a film funding agency; or a project for live marketing events, that involved a live marketing agency, a company responsible for technical project management (light-show, sound, visual media) and a company in charge of artistic content. Creative industries are by definition design-intensive and are typically characterized by high uncertainty, due to both the volatility of tastes and demand, and the poor predictability and measurability of outputs (Caves, 2000).

*High-technology and science-based projects* are by definition discovery-intensive and research-intensive, and characterized by uncertainty in terms of expected output and the need to generate new knowledge in the process (Eisenhardt and Tabrizi, 1995; Fleming, 2001). Those in our sample were drawn from the semiconductors, software, biotechnology and telecommunication industries. Among the cases surveyed, for example, is a project between a large telecom operator, a provider of telecom equipment and a provider of software middleware, or collaborations between a designer of graphic chips and a chip manufacturer.

*Machinery and construction projects* included industrial collaborations set up for the production of machine tools and the construction of industrial plants. Among the projects surveyed there were things such as the creation of an automated metallurgical plant, which brought together a rolling mill equipment developer, a supplier of power control systems, and a producer of furnaces for the steel industry; and the construction of a pipeline, which involved the

collaboration between an engineering contractor and steel tube producers. In projects of this cluster, variance may arise in the process, but the output is generally defined *ex-ante* and the techniques for implementing it are relatively known (Shenhar, 2001). Hence, the machinery and construction industries are used here for comparative purposes as a sector characterized by relatively better-known activities and technologies.

The questionnaire included questions on the degree of innovativeness at the project level as well. The responses, as per the figures provided in Appendix, not only corroborate our expectations concerning the ranking by discovery intensity of the three sectors, but also indicate that a substantial number of our projects can be described as innovative. While the indicator is well-behaved in this respects, in terms of implications for contracting and governance, the differences in innovativeness at the project-level are likely to be augmented by and combined with sectoral uncertainty factors that are different across sectors, based on the different types of knowledge that are used therein (science-based, creative/cultural, applied technology). In addition, the output of innovative projects, especially the knowledge produced, spills widely beyond the borders of the focal projects (Elmquist and Le Masson, 2009), hence measuring innovativeness only at a project level may underestimate it. Therefore we used sectors as an independent variable.

As to governance, the questionnaires included questions on the extent to which various matters were specified in the contracts that regulated the collaboration among project partners. These matters were identified based on an initial list of around 20 items constructed through direct consultation with legal experts, content analysis of actual contracts and a review of empirical literature on contracts. Thereafter, conceptually similar aspects were grouped into a single class (for example, ownership of inputs and ownership of outputs are clustered into rights of

ownership; decision rights of various kinds were grouped etc.). Seven matters resulted: rights of ownership; decision and control rights; task descriptions; duration; separation procedures; warranties and indemnities; prices, fees and royalties.

Given the common argument that governance in the face of the unknown becomes more informal, the same question was repeated, asking the extent to which informal mechanisms - namely, informal agreements among parties or industry norms and customs - were used to govern the project on the same seven matters.

The analysis of the data presented here shows that: a) the extent to which the seven matters are regulated by contracts is higher than the extent to which they are regulated by informal agreements and norms (Table 1) for all projects; b) contractual clauses do cluster around two factors: a 'constitutional component' that includes rights of ownership, decision rights and separation procedures, and an 'operational component' that includes price, task descriptions, and the duration of collaboration (Table 2) [2]; and c) the 'constitutional component' of contracts is specified to a greater extent for projects in the more discovery- and design-intensive high-tech and creative sectors than in the machinery and construction sectors, net of various controls (Table 3). The three steps of the analysis and their results are reported in Table 1, 2 and 3 respectively.

*(Insert Tables 1, 2 & 3 about here)*

Table 3 is to be read as follows. If a project is in the high-tech or creative sector cluster, *ceteris paribus,* the constitutional component in the contract is significantly more specified than

[2] The loading of the 'warranties and indemnities' matter was almost the same on both factors. Due to this ambiguity, we dropped the item from subsequent analyses.

in projects in the Machinery and construction cluster, taken as a baseline of comparison. The richness of the constitutional component of contracts is not significantly explained by any other control variable, in particular project size and country of origin (columns 2). Rather, these other variables, which are not related to uncertainty, do affect the overall incidence of formal, contractual governance relative to informal governance (columns 6 and 8). Hence the results can be read as showing that the response to uncertainty is mainly a constitutionalization of governance, while the degree of formalization (i.e., the expression of governance by written contractual documents, rather than by informal means) responds to other factors. The effects of these other factors on formalization are unsurprising. Indeed, as mentioned in the hypotheses development part, contracts have also coordination functions and the number of activities to be coordinated is generally be expected to be positively related to the formalization of coordination mechanisms in organization theory. Furthermore, as known from societal effects studies, organization in some countries is *ceteris paribus* more formalized than in others, Germany amongst these, which our study is taken as the baseline country of comparison. In fact, the overall degree of contractual articulation and specification is negatively affected by the project being based in countries other than Germany (significantly so for the other countries that, being situated in Europe, and having similar civil law legal systems are more comparable with Germany). What is novel and surprising with respect to the classic tenets of organizational and contract theory, but consistent with our argument, is that knowledge-based uncertainty factors do not affect the degree of formalization, but the degree of constitutionalization of governance. Second, and interestingly, the effects of other factors commonly assumed to affect the intensity and articulation of contractual governance - such as the irreplaceability of partners and their prior ties[3] - is muted (never significant in our sample).

[3] These two variables were respectively measured as the number of alternative partners with whom the project at

These findings square well with those of a few other studies who performed analyses of contractual components. Luo (2002) has argued that the rigidity that may be engendered by contractual formalization can be avoided if contractual clauses are state-contingent and/or refer to general principles, procedures and guidelines. His empirical analysis of a set of international joint-venture contracts showed that the scale items measuring the degree of specification of action obligations, and those measuring the degree of specification of contingent and procedural provisions, load on two different factors. Crocker and Masten (1991) distinguished the contribution to flexibility of contractually-stated procedures for automatically recalculating the terms of exchange as information becomes available (called 'redetermination' procedures) from the flexibility that is gained by contractually-stated rights and obligations to ad-hoc joint decision-making (called 'renegotiation' procedures). The authors also correlated the presence of these procedures with the type of uncertainty faced. Their empirical investigation of buyer-supplier contracts in the natural gas industry found that the uncertainty that is engendered by price volatility did not increase the presence of renegotiation procedures, since such uncertainty can be managed by automatic redetermination procedures; while the task uncertainty stemming from long contract durations did.

The KGP database also sheds light on whether the nature of the constitutional provisions tend to constitute a hierarchic or a poliarchic order. To that purpose, Table 4 (column 3) reports the average allocation, across the 440 contracts in the database, of broadly-intended property rights (on assets, residual decision and control, and outputs) to the three main partners of each project.

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hand could have been carried out and the number of projects conducted in the past with the current partners. Convergent findings downplaying the role of asset specificity and prior joint activities have emerged in some other studies (Crocker and Masten, 1991; Reuer and Ariño, 2007) where these variables were measured through direct questions as in our study, rather than through ambiguous proxies such as investment size and the longevity of relations.

It also reports the contributions those partners made to the project, of various resources (columns 1 and 2). The patterns that emerge indicate that key resources are diffused, and that project governance is diffused as well, with property rights assignments broadly proportional to the resources and capabilities contributed by each actor. Overall, this supports the thesis that when key resources are diffused, a governance that mirrors a representative democracy is in order, and that it is instituted and formalized in the constitutional part of the contract.

**Summary and Conclusions**

This paper argued that the intensification of innovation and the increase of knowledge intensity in the modern economy requires forms of rationality and governance that are different from those usually considered in economics and management. Drawing on various strands of study on innovation processes, the key form of reasoning behind innovation has been qualified as generative, hypothesis-testing and knowledge-expanding. Key traits and ingredients of that form of innovative rationality are methods such as: treating all decision inputs as hypotheses to be generated and tested, letting problems to shift and actions to change, leveraging on the multifunctionality of actions and resources, and defining multiple objectives that can be flexibly adjusted to circumstances and opportunities. On that basis, the core question addressed has been to clarify which forms of governance, intended especially as forms of contracting, can permit and sustain those discovery processes, by providing adequate cognitive space as well as incentives to invest resources in its exploration.

Contracts with those capacities of governing innovation have been hypothesized to be characterized by four key features: contracts for innovation are procedural (rather than

substantive); associational (rather than transactional); constitutional (rather than operational); and poliarchic (rather than hierarchic).

The hypothesis that, as the discovery and design intensity of the governed activities increases, the constitutional component in contracts grows, and that the type of constitution is that of a multi-lateral representative association, has been also supported by an original specific quantitative analysis on a large questionnaire data base (the Knowledge, Governance and Projects database) on contracts governing projects in design- and discovery-intensive industries.

The elaborations on the KGP database conducted for this paper may illuminate some further aspects of interest in the management of innovation. In particular, the database includes both design-intensive creative projects and discovery-intensive science-based projects, allowing to explore whether the two different types of innovation processes might call for different governance configurations. Interestingly, they do not. The similarity of contractual profiles in the two contexts is consistent with the idea that the logic of discovery (likely to prevail in science-based projects) and the logic of design (likely to characterize projects in creative industries) are similar enough for being supported and governed by the same type of contractual arrangement.

Finally, the notion of constitutional contracting enriches the theoretical debate in both organization theory and organizational economics.

First, it suggests some revisions of the common tenets on formalization and contracts in organization theory. Constitutional contracts and agreements provide a 'flexible formalization' solution (Grandori, 2006) to the management of innovation, while flexibility and formalization are traditionally seen as conflicting dimensions (Schreyögg and Sydow, 2010; Volberda, 1998).

With respect to organizational economics, the analysis conducted in the paper contributes in several other ways. First and foremost, it has been argued and shown that formal contracts do not

'fail' altogether under the conditions of strong uncertainty that characterize innovation; and that they are not simply sustained by complementary informal agreements and norms. Rather, the formal and enforceable contract itself changes structure, by incorporating a stronger constitutional component, so that parties are free to discover new actions but are at the same time protected from hazards. Furthermore, it has been argued and shown that in innovative activities, such constitutional agreements should constitute partners and allocate property and decision rights in a poliarchic and representative way, rather than in a hierarchic way. On this ground, the argument is consistent with established propositions about the internal governance and organizational structures for innovation, such as that the governance of innovative firms is typically based on a multi-lateral agreement among investors of different types of capital (human, technical, financial) (Grandori and Gaillard, 2011) and on a 'democratization' of residual decision and reward rights (Rajan and Zingales, 2000); and that their internal organization is decentralized, 'intrapreneurial' and even democratic rather than hierarchic (e.g. Miles *et al*., 1997).

A more general conceptual implication therefore is that it would be helpful to abandon oppositions that, at a closer scrutiny, seem ill-founded: in particular, the opposition between contracts on one side (seen as mechanisms more pertinent to markets) and other governance mechanisms (seen as mechanisms more pertinent to organizations), such as authority relations and constitutions. Contracts can regulate transactions, but can also pool resources and constitute organizations; and even the foundation of a firm can be seen as a particularly intense, entity establishing, form of constitutional contracting (Grandori 2010b).

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## Appendix - The KGP database

The data derive from countries with a significant presence of project-intensive industries, namely, Germany, Italy, and Denmark in Europe and Silicon Valley California in the US. They were collected in 2007, within the international research program 'Knowledge, Governance and Projects', a research partnership among five universities in different European countries of which one of the authors of this paper was the principal investigator. The following prospect summarizes the main features of the database.

| ***Industry groupings*** | ***Sampling frame*** |
|---|---|
| **Creative**<br>Events (fairs, exhibitions, congresses; operation of art facilities)<br>Motion pictures<br>Business-to-business design<br>Games<br>Advertising<br>Publishing<br>Recorded music | *Denmark*: Registered enterprises within NACE/DB03 industry codes 221110, 365000, 744010, 744090, 921100, 923110, 923200<br>*Germany:* List obtained from various industry associations (Federal Association of German Galleries, the Association of Concert Agencies, etc.), industry rankings (e.g., Werben & Verkaufen ranking of major advertising companies) and prior academic research (e.g., DFG-Project "Production in Projects" - Bonn University) |
| **High-tech**<br>Semiconductors<br>Computer/Communication hardware<br>Innovation services<br>Biomedical<br>Electronic components<br>Software consultancy and supply | *Denmark*: Registered enterprises within NACE/DB03 industry codes 722100 and 722200<br>Germany: List from prior academic research project (DFG-Project "Production in Projects" - Bonn University)<br>*California*: List of firms from the Silicon Valley Venture Capitalists Association |
| **Machinery and construction**<br>Machinery and equipment<br>Mechanical engineering<br>Industrial plant construction | *Germany*: List of member firms of the German Engineering Federation<br>*Italy*: List of member firms of the following industry associations: ANIMP, OICE, UCIMU, APRI, AIAD, UCIMA, UCOMESA |

Conceptual reasoning and the insights of scholars familiar with these three industries suggest that projects in creative and high-tech industries are typically more discovery-intensive than those in the machinery sector, and various indicators and data also support this view. For example, the

2010 European Community Innovation Survey (CIS) of German firms reports the following figures for those industries in the CIS that most closely approximate the high-tech (HT), creative (C) and machinery sectors (M) of our study: [4]

- The percentage of enterprises in which a majority of employees hold a university degree is 42, 15, and 3 in HT, C and M respectively.
- The percentage of enterprises with innovation activities of sorts is 97, 89, and 88 in HT, C and M respectively.
- The turnover from novel products is 42, 47, and 37 percent of total sector turnover in HT, C and M respectively.
- The percentage of enterprises that engage in organizational and marketing innovation is 73, 80, and 66 percent of the total number of enterprises in HT, C and M respectively.
- The percentage of enterprises engaging in technological innovation and in continuous R&D efforts (data available and appropriate for high-tech and machinery sectors only) are respectively 94 in HT and 84 in M, and 69 in HT and 41 in M.

This assessment is also supported by project-level figures from our sample:

| Industry | % Projects that develop novel products/services* |
|---|---|
| HighTech | 44.34 |
| Creative | 39.00 |
| Engineering & Construction | 35.04 |

* Novel to the partners, the industry or the world as opposed to the product/service being a variation or a new generation of an existing product/service. Sample averages. N= 440.

These figures not only corroborate our expectations concerning the ranking by discovery intensity of the three sectors, but also indicate that a substantial number of our projects can be described as innovative. However, when added to the model, the project-level indicator does not affect the other coefficients and has no significant effect of its own, probably, as discussed in the text, for their combination with wider industry uncertainty. Since its inclusion also reduces the model fit, we opted for a more parsimonious model specification (data available from the authors)'

[4] Details about the data, the method and the results of these analyses are available from the authors.

Although our data were collected through a questionnaire survey, it is important to notice that five of the explanatory variables in the dependence analyses we perform (the sector dummies, and the country dummies) are not self-reported, but are known from the sampling framework. Therefore, percept-percept inflation is not an issue with them. To address the possibility that common methods bias may influence the estimates of the remaining parameters, we used Harman's (Harman, 1967) single-factor test to assess whether a significant amount of common variance exists in the data (Podsakoff *et al.,* 2003). All questionnaire items of contractual and informal governance variables, along with the items of the control variables were entered in a factor analysis. Using the eigenvalue-greater-than-one criterion revealed five factors, the first of which explained only 24.0 percent of the variance in the data, indicating that the findings cannot be attributed to common methods bias.

**Table 1. Intensity of regulation through contracts and informal mechanisms by matter**

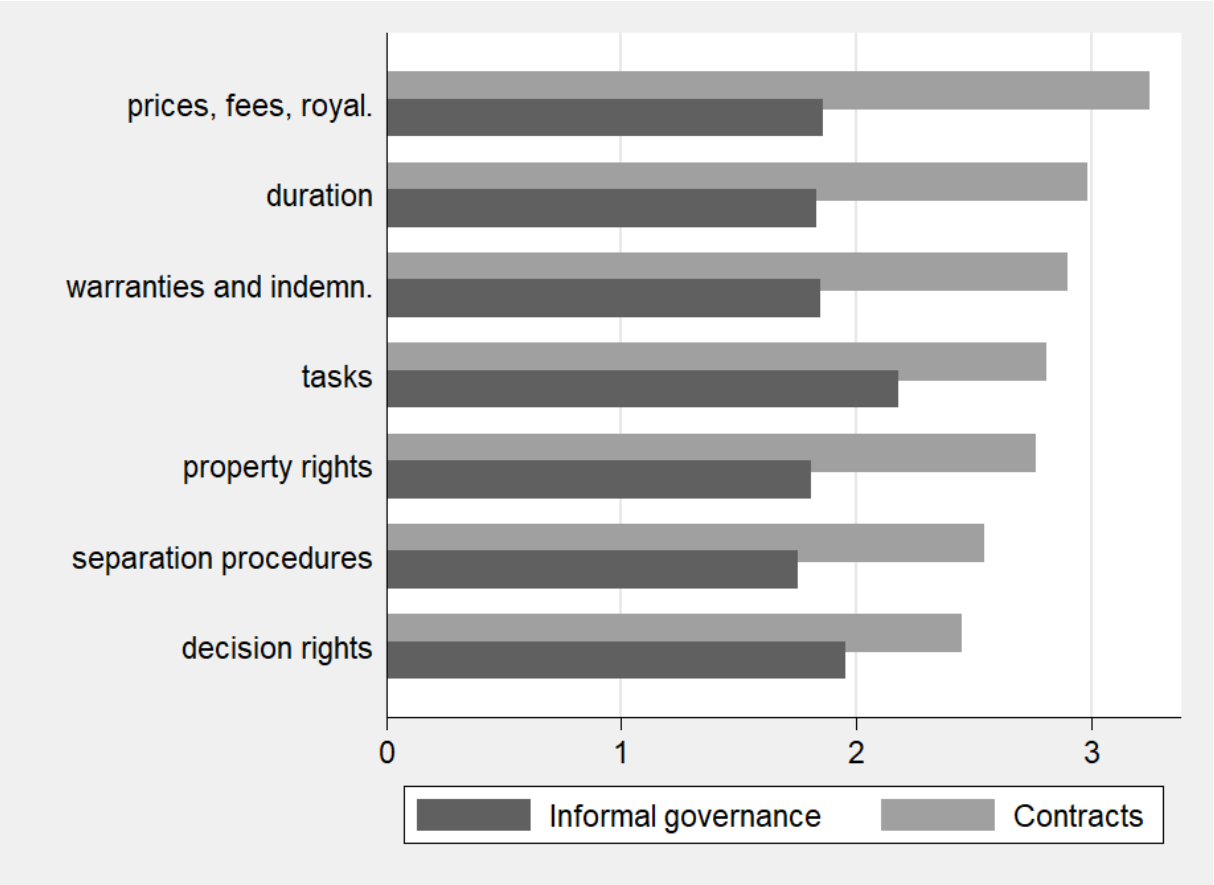


**Table 2. Factor analysis of contractual clauses**

| Matters | Operational governance (Factor 1) | Constitutional governance (Factor 2) | Uniqueness |
|---|---|---|---|
| Rights of ownership | -0.14 | **0.90** | 0.27 |
| Decision and control rights | 0.10 | **0.76** | 0.35 |
| Separation procedures | 0.37 | **0.55** | 0.39 |
| Tasks | **0.82** | -0.03 | 0.34 |
| Duration | **0.90** | -0.09 | 0.24 |
| Prices, fees and royalties | **0.66** | 0.16 | 0.46 |
| | | | |
| Eigenvalue | 2.91 | 1.04 | |
| Variance explained (%) | 0.48 | 0.17 | |
| Cumulative (%) | 0.48 | 0.66 | |

**Table 3. The constitutionalization of governance in design- and discovery-intensive sectors**

| | Contractual governance | | | | Ratio Contractual/Informal governance | | | |
|---|---|---|---|---|---|---|---|---|
| | Constitutional | | Operational | | Constitutional | | Operational | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Creative | | 0.479*** | | -0.091 | | 0.418** | | 0.141 |
| | | (0.125) | | (0.111) | | (0.144) | | (0.141) |
| High tech | | 0.430** | | -0.109 | | 0.446** | | 0.238 |
| | | (0.136) | | (0.119) | | (0.154) | | (0.170) |
| Irreplaceability | 0.014 | -0.009 | 0.002 | 0.008 | 0.009 | -0.015 | 0.012 | -0.001 |
| | (0.053) | (0.052) | (0.047) | (0.049) | (0.058) | (0.056) | (0.059) | (0.060) |
| Prior joint projects | -0.042 | -0.051 | -0.042 | -0.040 | 0.001 | -0.007 | 0.006 | 0.002 |
| | (0.041) | (0.040) | (0.030) | (0.030) | (0.045) | (0.044) | (0.046) | (0.046) |
| Project size | 0.182*** | 0.232*** | 0.163*** | 0.153*** | 0.249*** | 0.293*** | 0.219*** | 0.235*** |
| | (0.041) | (0.043) | (0.035) | (0.038) | (0.050) | (0.050) | (0.049) | (0.050) |
| Project duration | -0.090 | -0.045 | -0.060 | -0.066 | -0.030 | 0.003 | -0.061 | -0.056 |
| | (0.099) | (0.098) | (0.104) | (0.105) | (0.093) | (0.094) | (0.107) | (0.107) |
| Denmark | -0.172 | -0.329** | -0.294** | -0.256* | -0.123 | -0.281* | -0.010 | -0.090 |
| | (0.119) | (0.121) | (0.110) | (0.116) | (0.124) | (0.127) | (0.130) | (0.139) |
| Italy | -0.377*** | -0.246* | -0.164+ | -0.190* | -0.197 | -0.081 | 0.074 | 0.115 |
| | (0.113) | (0.120) | (0.086) | (0.089) | (0.125) | (0.133) | (0.130) | (0.138) |
| Silicon Valley | 0.134 | -0.050 | -0.208 | -0.148 | -0.032 | -0.258 | -0.028 | -0.185 |
| | (0.129) | (0.176) | (0.146) | (0.181) | (0.145) | (0.193) | (0.175) | (0.230) |
| Constant | 1.714*** | 1.229*** | 2.266*** | 2.353*** | 0.301 | -0.109 | 0.639+ | 0.518 |
| | (0.308) | (0.332) | (0.286) | (0.309) | (0.344) | (0.367) | (0.336) | (0.373) |
| Observations | 440 | 440 | 440 | 440 | 440 | 440 | 440 | 440 |
| R-squared | 0.082 | 0.117 | 0.104 | 0.106 | 0.101 | 0.126 | 0.068 | 0.073 |
| F | 5.887*** | 7.876*** | 7.974*** | 6.269*** | 5.853*** | 6.332*** | 4.116*** | 3.571*** |

Notes: + 0.10; * 0.05; ** 0.01; *** 0.001 (two-sided tests). Specification: OLS. Robust standard errors in parentheses. Dependent variables for the models: (1) and (2): degree of specification of constitutional matters in contracts; (3) and (4): degree of specification of operational matters in contracts; (5) and (6) extent to which constitutional matters are regulated through contractual specifications relative to informal agreements and norm specifications; (7) and (8): extent to which operational matters are regulated through contractual specifications relative to informal agreements and norm specifications.

**Table 4**. **Representative multi-lateral governance: resources committed to the project and property rights held by key partners**

| (*Average %*) | Resource contributions | | Property Rights Assigned |
|---|---|---|---|
| | Technological and Financial | Human and Social | |
| | (1) | (2) | (3) |
| Partner 1 | 47.7 | 55 | 56.1 |
| Partner 2 | 31.5 | 27.3 | 26.8 |
| Partner 3 | 20.7 | 17.5 | 13.3 |
| TOTAL | 99.9 | 99.8 | 96.2 |

Notes: Cell content: sample means (percentage). N= 440.