RIETI Discussion Paper Series 03-E-004

T-forms of Organization Revisited and A Trans-disciplinary Framework for Institutional Analysis

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Abstract

In the first part of this paper, the idea of T-form of organization, as opposed to A-form and J-form, due to O.E.Williamson is revisited. According to him, T denotes temporary, transitional, or timeliness. The paper identifies the clustering of entrepreneurial firms as observed in Silicon Valley as an instance of T-form and examines conditions under which it can be informationally more efficient than the integrated A-form (functional hierarchy) or J-form (information-sharing). It also formulates an essential aspect of the Silicon Valley phenomena as a tournament game among entrepreneurial firm judged by the venture capitalist and explores conditions under which option value and externalities created by the tournament can exceed the cost of multiple financing of firms competing in developmental design. The second part of the paper suggests a game-theoretic approach to broaden the Williamsonian framework for comparative institutional analysis. Specifically it suggests analytical ways to integrate economic, political and sociological approaches to institutions, using linked games and strategic complementarity analysis.

Keywords: T-form, Silicon Valley model, Comparative institutional analysis, linked games, institutional complementarity

This paper was presented at the conference celebrating the 70th birthday of Professor Oliver E. Williamson held at University of California, Berkeley, on October 26, 2002.

In commenting on my earlier work [1990] on the comparison of A-form vs. J-form of organization, Williamson [1995] suggested there is "a third form of organization, the *T*-form, where *T* denotes temporary, or transitional." He added, "*T* also denotes timeliness, which plays a huge role in the success or failure of firms that are operating in newly developing markets where technology and rivalry are undergoing rapid change. ... Also, what may be thought of as disequilibrium forms of organization can be important in real-time responsiveness respects." Leaving aside for a while the question of whether the nature of the T-forms may be captured as a disequilibrium phenomena or not, Williamson's call for further inquiries into these alternative forms of organization has proved to be truly significant and timely in light of recent developments in industrial organization.

In the article referred to above, Williamson pointed to joint ventures and alliances as cases of *T*-forms of organization. He characterized them as follows: "Each party being unable, by itself, to assemble and deploy the requisite resources in a timely way, the requisite resources are instead assembled by pooling. Thus constructed, both successful and unsuccessful joint ventures will commonly be terminated when contracts expire. Successful joint ventures will be terminated because the combined effort has permitted each to remain viable and learn enough and/or buy time to go it alone. Unsuccessful joint ventures will be terminated because the opportunity to participate will have passed them by." In contrast to these forms in which the requisite resources are temporarily pooled, there can be another class of T-forms in which the requisite resources are temporarily deployed by many independent entrepreneurs in the beginning, with the outcomes of their uses to be selectively combined ex post to generate a large innovative product system in timeliness. The workings of the so-called Silicon Valley clustering may be looked at from this perspective. Mobilizing contractual and option-value theories, we may identify several technological and institutional conditions under which this type of T-form can perform better in terms of generating a large, complex innovation system more efficiently vis-à-vis the traditional hierarchies of A-form or J-form. The exercise I will present below in this regard is essentially of "equilibrium" nature in terms of analytical setting. Also, the analysis indicates the possibility of a new framework for trans-disciplinary approaches to institutional arrangements, complementary to the Williamsonian comparative institutional approach.

Three-way Comparison

Imagine that an innovative technological product system can be generated by a new combination of modular component products (element technologies). For example, a laptop computer as a technological product system consists of component elements as a LC monitor, MPU, image-processing LSI, hard disk drive, OS, application software, audio and communication devices, etc. Suppose that the potential value of the system depends on the quality of design of each module as well as the compatibility and synergy effects between both modules. Modules must be designed in such a way that they fit with each other to form a coherent, high-performing, market-competitive, technological system. An improvement in the design of each module, as well as that in the design of systemic characteristics, is costly in terms of effort in information processing and design decision as well as the use of financial resources. How much human and financial costs will be actually spent and how much value will finally be created will depend on organizational architecture for design activities. We will make a three-way comparison between A-form, J-form and T-form of organizational architecture, each simply composed of a system designer and two (classes of) module designers. The system designer S designs systemic characteristics of a potential innovation system (e.g., the division of a system into modules and specification of interface rules between the two), while module designers, M1 and M2, are engaged in the design of respective module, m1 and m2. There are three types of environments for design tasks: the systemic environment relevant to the design of systemic characteristics, the engineering environment common to M1 and M2 and that idiosyncratic to each of them. There can be three forms of organizational architecture distinguished by the allocation of information processing tasks and associated decision rights as below.

$ *A-form or functional hierarchies*: In this form, S designs systemic characteristics by processing the systemic environment, within which framework M1 designs the module m1 by processing information regarding the engineering environment common to m1 and m2, as well as that idiosyncratic to m1. Then M2 designs the module m2, with design specifications made by S and M1 as given. In other words, M1 is subordinate to S in terms of information processing and design decision, and M2 to M1, in hierarchical order.

$ *J--form or horizontal hierarchies*: In this form, S designs systemic characteristics using information she obtains by herself (as well as a modicum of it fed by M1 and M2), regarding the systemic environment. Then she let the design result known to M1 and M2. M1 and M2 then process and pool information regarding the common engineering environment and utilize the shared knowledge, together with individual information regarding respective idiosyncratic engineering environment, in resolving the respective design problem.

$ *S-mediated T-form or information encapsulation*: Suppose that each module is competitively developed by multiple designers. Let us denote the number of designers of module m1 as k1 and that of m2 as k2 respectively. S designs systemic characteristics in a manner similar to her counterpart in the J-form. Within this framework of limited information sharing, each module designer individually processes information regarding the engineering environments, both common and idiosyncratic, completely independently of each other. In other words, information processing by individual module designers is hidden from each other except for the sharing of systemic characteristics and we refer to this characteristic as S-mediated *information encapsulation*. Only after design decision has been made by each module designer, its performance characteristic is known to S and she selects the best combination of module designs that will maximize the value of the system. Albeit oversimplified, we may regard this form as capturing some essential aspects of the relationship between venture capitalists and entrepreneurial firms, as well as that among entrepreneurial firms, in Silicon Valley. According to this interpretation, S is the venture capitalist and module designers are entrepreneurial firms.

In the T-form, the design of each module is competitively performed by multiple agents. The additional cost of this form relative to others is the cost caused by the multiple experiments of designs involving the use of human and financial resources and its unique benefit is the one generated by ex post selection of the best combination from multiple design outcomes when uncertainty involved in system design is very high. Its net benefit depends on various conditions of institutional and market environments of its own. Before discussing those conditions, however, let us assume first that k1=k2=1 and examine basic conditions determining the relative advantages of three forms on equal footing, although this assumption ignores the essential characteristics of “temporariness” and “timeliness” of T-form. Suppose that the information processing capacity of each agent (measured in terms of the ratio of the variance of an observed environmental parameter to that of relevant observation error) is the same across all the agents and across the forms. When the net value of the final system created by one form is expected to be greater than those created by the other forms under this condition, we say the former form is informationally more efficient than the other forms. It is known that:

Proposition 1 (Cremer). T-form with k1=k2=1 is informationally more efficient than A-form and J-form, if and only if the design variables of the modules are not complementary.

The intuition behind the above proposition is as follows. In designing a module each designer needs to coordinate with each other to make their designs mutually compatible and synergetic in attributes, while he or she needs to be concerned with individual optimization on each design for a given interface rule. Roughly speaking, we say that the design variables are attribute-complementary if the former requirement dominates the latter. In that case, module designs need to be coordinated so that the choice variables have to move in the same direction on the dimension of design attribute. Such a mechanism is internalized in the A-from and J-form since information regarding the common engineering environment used for design decisions is assimilated in those forms of organizational architecture. In contrast, in the S-mediated information encapsulation, the observations of the common engineering environments by module designers are mutually hidden, so that their decision choices are necessarily less correlated.

In order to focus on the role of attribute-complementarity between the design tasks, Proposition 1 was stated for the case where the precision of observation is equal across all forms of organizational architecture. However, even with the same level of information capacity of module designers, the precision of processed information can be inherently different across forms of organizational architecture. Recall that in the J-form, the module designers are collectively engaged in observation and communication of the common engineering environment, while in the S-mediated information encapsulation, it is observed separately. Suppose therefore that the precision of processing information regarding the respective idiosyncratic environment is sacrificed relatively more in the J-form because of the diverted attention to communications regarding the common engineering environment, although the precision regarding the common engineering environment may be improved because of the pooling of data in this regard between the module designers. If such difference exists, then in some cases the S-mediated information encapsulation may become informationally more efficient than the J-form even in the presence of a modicum of attribute-complementarities. In order to identify such cases, we say that the engineering environments of module designs are statistically correlated, when the variance of the common engineering environment is greater than those of the idiosyncratic engineering environment. Then we claim:

Proposition 2. If the engineering environments of the module design are statistically correlated, then S-mediated information encapsulation is informationally more efficient *ceteris paribus* than the J-form even in the presence of a modicum of attribute-complementarities.

The above two propositions are genetically relevant for the nature of an emergent industrial organization in the information industry. Baldwin and Clark (2000) documented and analyzed the way by which the complex IBM System/360 was designed and noted the following two important aspects of it: (1) partitioning of the entire system into relatively independent modules; and (2) reduction in attribute-complementarities among the modules through the centralized specification of interfaces among them. We submit that the unique mixture of information sharing about the systemic environment and information encapsulation in the S-mediated information encapsulation has a close relationship with those two aspects.

First, modularization partitions a complex product system into modules. A module is a unit of a system within which elements are strongly interrelated to one another, but across which they are relatively independent. In order to obtain this property of the system, the way in which partitioning is carried out cannot be arbitrary. Albeit in a different context, Cremer (1980) showed that the optimal way of partitioning an organization is one that minimizes the statistical correlations among the units. In the present context, the whole design problem should be divided into two design tasks in such a way that statistical correlation between the two is minimized. This means that the common engineering environment for each unit would become relatively unimportant as compared with idiosyncratic engineering environments. As Proposition 2 shows, S-mediated information encapsulation is viable in such environments. In this sense, good modularization, namely good architecture of a product system, is complementary to the unique informational arrangement of the S-mediated information encapsulation.

Second, all the modules created through the process of partitioning as mentioned above have to be compatible with one another and work together in a smooth manner. In order to assure such compatibility, the interfaces among modules have to be explicitly determined and fixed. In other words, the interfaces have to be standardized. Under well-defined interfaces, design activities in respective modules can be conducted independently in parallel, while they have to be done sequentially in A-form and jointly in the J-form. Standardization of interfaces means a reduction in attribute-complementarities is to be taken into consideration in the design of each module. Thus standardization of interfaces also complements S-mediated information encapsulation as a viable organizational arrangement.

So far we have assumed that k1=k2=1 so that we have ignored the essential characteristics of "timeliness" and "temporariness" of the T-form. However, if attribute complementarities between module designs are reduced through standardization of interfaces and/or otherwise, the potential value function becomes nearly separable in the values of modules, meaning that the improvement of the whole system can result from that of each modular product, rather than from the coordinated improvements of several modular products. This sets apart the technological basis for a product system to be formed evolutionarily by combining new modular designs in the best manner from many designs. Therefore we now turn to an examination of the T-form with k1, k2 ≥ 2, i.e., the situation where multiple entrepreneurial firms are present in each module design and the standardized interfaces are made publicly open to them.

The Tournament Effect and Option Value in the S-mediated T-form

Let us consider the following game played repeatedly in four dates.

- The 1st date: The system designer S processes information regarding the systemic environment and determines the decomposition of a potential product system into two modules and interface rules that each module needs to satisfy. She decides the value of k1 and k2, i.e., how many module designers (entrepreneurs) are to be financed for each module design, on the basis of her ex ante knowledge about the probability distribution of the engineering environments and draws a contract with each module designer regarding the shares of its final value at the final date. The amount of initial financing to each module designer is not sufficient for the completion of design of any module, however.
- The 2nd date: Each module designer monitors the state of the engineering environment, both common and idiosyncratic, independently of the others (information encapsulation) and utilizes the information to make a "temporary" design of a module. The effort level of each designer is not observable by S, but the performance characteristics of the design can be transmitted to S.
- The 3rd date: The system designer selects only one temporary design for each module for additional financing needed for the completion of system design in order to maximize the expected value of the final system, under the condition that she can evaluate it with some imprecision and/or that the valuation market for the final system is uncertain. [Under the condition of absence of attribute complementarities, the expected value of a system may be represented as a linear function of potential values of component modules, each of which is strictly increasing in the level of effort

spent for its design.] The selected designer completes design within the date. At the end of the date all the environmental uncertainties are resolved.

- The 4th date: The system designer sells the product system composed of the selected modules to the market, of which uncertainty is resolved in the beginning of the date. The system designer and selected module designers share the sales value according to the contract. Unsuccessful designers receive nothing. The game ends.

In this game, the basic nature of T-forms pointed out by Williamson, i.e., temporariness and timeliness, is captured. The financing of module design is temporary only for one date except for the selected winners. The refinancing is made in the 3rd date in a timely manner only to those who have exhibited the highest potential values for their temporary designs. However, we assume that there are random elements in the selection of winners by S in the 3rd date because of her limited capacity in judging the potential values of each temporary design or the uncertainty of market conditions for the final product. There can be two types of unique values created under this T-form of organizational architecture: option values and externalities generated by a tournament-like competition among module designers (entrepreneurs). Let us examine first each of these separately.

For simplicity's sake, let us imagine for a while that in each module design the level of effort is constant and observable and that the engineering uncertainty can be resolved at the end of the 3 rd date so that the best design can be identified then. This is the situation assumed in Baldwin and Clark [2000]. Namely they regard the result of modular designs as "real options." They suggest that the greater the number of parallel experiments (k1 and k2), the greater the value of real options, which they call the "value of substitution." Equating the marginal diminishing value of experiments with the constant marginal cost of single experiment determines the optimal number of experiments. Applying the option value theory in a straightforward manner, it holds that the greater the uncertainty involved in modular design, the greater the optimal number of experiment (Baldwin and Clark).

In reality, on one hand, the cost of experiment is not constant, as the level of design effort can be controlled by the module designer. On the other hand, the value of module design will depend on the precision of information processing activity, i.e., effort level of the module designer. However, as the level of design effort cannot be observed by the system designer, the level of effort will be undersupplied in case of k1=k2=1, because the utility-maximizing module designer will equate the marginal cost of effort with its marginal value times his expected share in it which is less than one. Will the situation be altered when k1, k2 ≥ 2, i.e., when tournament-like competition is managed by the system designer who evaluates the potential value of each module design with some imprecision? Yes, it will, albeit in a second best manner, because the marginal value of extra effort by the module designer is now composed of the expected marginal value of his effort when he wins the tournament *plus* the expected total value when he wins times the marginal increase in the expected probability of winning the tournament *plus* the marginal expected value associated with the market uncertainty/system designer's observation error which he cannot control, with all three values multiplied by his share in the final value (Aoki and Takizawa 2002). In other words, the tournament-like competition managed by the system designer can create kinds of externalities. Under the uncertainty involved in the market of the final system and the system designer's error in identifying the best module designs, the last two terms (external effects) are strictly decreasing in the variance of VC's observation error and/or the market uncertainty, and strictly increasing in the uncertainty involved in module design. The first term is strictly decreasing in the number of module designers (k1,k2 ≥ 2) as it reduces the probability of winning for each module designer. Thus, incentive consideration tends to reduce the desired number of module designers in each module, whereas the option value increases in the number of module designers. Striking a balance, we can say that incentive consideration can limit the effectiveness of the substitution operator. In the integration of the option value approach (Baldwin and Clark) and the tournament game approach (Aoki 2001), the following holds:

Proposition 3. (Aoki and Takizawa) If the total value of a final system is expected to be very high, and if the system designer's judgment in the selection of tournament winners is believed to be precise by the module designers, then there exists k1, k2 ≥ 2 for which the total value of a final system net of multiple effort and financial costs is expected to be higher than in the case of k1=k2=1. Conversely, if module designers' confidence in the system designer's competence is low, the system designer cannot adequately elicit the module designers' efforts that can compensate the costs of multiple financing.

Proposition 4 (Aoki and Takizawa). The optimal number of module designers in the T-form of organizational architecture (k1, k2 ≥ 2) is strictly increasing in the uncertainties involved in module designs and valuation of final product system.

Complementary Institutional Environments of SV-clustering

The T-form in the previous section is formulated at a very abstract level. However, it may be considered that the model captures some essential aspects of the so-called Silicon Valley phenomena at a generic level (e.g., see Aoki 2001, ch.14 for justification). In this interpretation, the module designers may be identified with entrepreneurs competing in a niche market that may constitute a module of an innovative technological system. The system designer may be considered as the generic venture capitalist that makes initial financing to multiple entrepreneurs and successively makes selections from among them for refinancing (I will present another, more subtle interpretation shortly). The realization of value of a final product by a successful module designer may then be interpreted as the sale of a successful entrepreneurial firm in the IPO market or its acquisition by an established firm. Let us refer to the formulated T-form in these interpretations as the *SV-clustering,* implying a model of the clustering of entrepreneurial firms of Silicon Valley type. Applying a Williamsonian framework (a layer schema in [1993]) dealing with interactions between the institution of governance and institutional environments to this T-form, we may derive a few interesting remarks. Later I submit a complementary conceptual and analytical framework for endogenizing some of institutional environments.

First, let us take the proposition that the confidence of competing entrepreneurs in the competence of venture capitalists is complementary to the SV-clustering. It is analogous to the situation that, unless the referee is believed to be fair and able, the players of sports game may not be motivated to play earnestly. However, the availability of such referee cannot be taken for granted. He needs to be well versed in the rules of the game and have been trained in judgmental skills. Also he himself needs to be motivated to be unbiased and neutral. Professional reputation may be one possible source for such motive in a sports game. One of the major reasons why the clustering of Silicon Valley type has not emerged so easily in Continental Europe and Japan until recently in spite of promotional public policy may be sought in the shortage of supply of credible venture capitalists. In these regions venture capital firms were first set up more often by financial institutions. On one hand, their managers were not necessarily equipped with technological expertise necessary for drawing future prospects of technological development ("the design of systemic characteristics") as well as making proper judgment on staged-financing based on tacit knowledge. On the other hand, the evolution of the Silicon Valley clustering was greatly aided by the ample supply of knowledgeable, skillful, and imaginative venture capitalists. A great majority were those that had quit large established organizations such as IBM, Bell Lab., Xerox with the background of management of technological development. Talents of this type are still largely harbored by established firms in Continental Europe and Japan. However, even in these regions there have recently been emerging clear signs of change. This suggests that the clustering of entrepreneurial firms of the Silicon Valley type needs to co-evolve with the "creative decomposition" of old forms of organizational architecture (the A-form and J-form) in the industry fitting T-forms, as well as the associated development of markets for human resources for technological management in the industry.

A similar argument may be easily seen to follow from the proposition that a reduction in the uncertainty involved in the valuation of a final product system will enhance the viability of the T-form. The well-developed, reliable markets for corporate assets and/or IPO markets have formed institutional environments for providing enormous incentives for entrepreneurs to compete, even in excessive degree in recent past. Conversely, many of recently emerged leading companies in the communications and information industry, as exemplified by Cisco Systems, Microsoft and so on, have attained their dominant positions in respective niche markets largely by the acquisition of carefully selected new technologies developed by small entrepreneurial companies. Thus, the corporate asset markers and new organizational architecture emerging from A&D (acquisition and development), on one hand, and the SV clustering of entrepreneurial start-up firms, on the other, may be considered as institutionally complementary.

Finally, let us reinterpret the role of the system designer as a mechanism rather than a concrete human entity. Above, I suggested a simple interpretation to identify her with the generic venture capitalist. However, in the actual working of the Silicon Valley clustering, the system designing role, especially that of drawing possible prospects for the future evolution of a new technological system, is dispersedly and informally performed by many actors. They may include not only venture capitalists, but also angels, leading firms in niche markets, standard-setting industrial associations, consulting firms, law firms, university professors, and so on. Further, at the early stage of development of a potential technological system, communications are often informal, because knowledge exchanged is still at a formative stage, often remains tacit and communicable only on the face-to-face basis. Standard-setting is often evolutive. Knowledge exchanged in this situation is therefore not proprietary. Yet there are intensive interactions and communications among those agents and entrepreneurs in Silicon Valley, making the clustering in lieu of visible or invisible hands one of distinguish features of the region. Indeed, the sharing of generic knowledge relevant to new directions of technology on one hand and the encapsulation of information processing relevant to potentially proprietary on the other appear to be inseparable dualistic characteristics of the SV-clustering. However, if the generic knowledge is potentially capable of generating proprietary knowledge, why do no the agents hesitate to exchange it without explicit pecuniary compensation? If they benefit from an access to such knowledge, why do they not try to free ride on the supply of knowledge by others while holding his or her knowledge in secrecy? Further, there may be differentials among agents in their ability to generate and disseminate potentially useful knowledge. Why are able agents willing to part his or her knowledge to others without necessarily being reciprocated in communications as such? Apparently what is operating here is something reminiscent of "social embeddedness" (Granovetter) of communications in the professional community. Namely they are able to gain higher status and esteem within the community by making best efforts in disseminating their superior knowledge. The opportunity costs of cooperation incurred by them are compensated for by a greater amount of intangible social capital allotment to them such as social esteem, professional reputation (Aoki [2001], chapters 2.2, 8.1). There is a substantial similarity with ways by which communications are exchanged in the academic community.

We have seen that the SV-clustering is complemented by institutional environments of a particular type, such as markets of specific intermediary skills (venture capitalist skills) and corporate assets, as well as embedded in the professional community. We have already hinted that they are not just exogenous environments for the SV-clustering, but rather mutually reinforcing or linked with the SV-clustering. For looking into such reciprocal/linked relationships further, we need to expand the conceptual and analytical framework a little further.

A Trans-disciplinary Framework for Endogenizing Institutional Linkages

One of great contributions of Williamson can be found in his attempts to broaden the analytical horizon of comparative institutional analysis and incorporate useful insights from other disciplines than economics, covering political science, law, sociology, and cognitive science. The current generation of economists has been learning a lot in contents and methodology of the comprehensive framework of Williamsonian perspective of New Institutional Economics. A distinctive feature of his analytical frame is to pinpoint to the transaction as the unit of analysis and go on to examine how different *institutions of governance* (market, hierarchy, hybrid, and bureaus) can/cannot economize costs of transaction with various attributes. The *institutional environment* (political and legal institutions, laws, customs, and norms) is treated as the locus of shift parameters that induces changes in the comparative costs of governance. It is in such treatment that insights of disciplines other than economics are incorporated into the frame, while the comparative analysis of the institutions of governance is conducted basically in the spirit of efficiency criteria of economics, although the domain of analysis is expanded to include such non-market governance structures as hierarchies and bureaus. This is certainly a tractable and operational approach, under which many important testable propositions have been generated. .

Albeit still at a less mature stage, I have submitted an analytical framework for making use of trans-disciplinary insights into institutions in my recent work [2001]. This approach may be considered not as an alternative to the Williamson's, but rather as its evolution. It takes the game as the unit of analysis. The game is defined on the domain composed of the set of strategic players and the composite sets of (technologically and cognitively) feasible action choices as well as the outcome function that maps each feasible profile of action choices across the players into an outcome. As Field [198] reminded us some time ago, it is not possible for us to define a completely institution-free, history-independent game. So some institutional factors (such as historically given property rights to certain goods, laws, as well as organizational entities with certain characteristics) are bound to be implicit in the form of the outcome function (pay-off functions) as well as the specification of the domain. Specifically, we may identify six basic types of domains: collective resource use (commons), economic exchange, organizational exchange, social exchange and political exchange, as well as organizational fields [Aoki [2001], ch.1]. We try to distinguish them solely in terms of their generic technological properties as much as we can, in order to identify variations in institutions that may endogenously evolve in each domain or across domains. We identify institutions with essential aspects of an endogenous equilibrium outcome of the game. Specifically we identify institutions as *self-sustaining shared beliefs among relevant players about ways how the game is repeatedly being played* (Aoki [2001] chs. 1 and 7). They can be self-sustained, shared and relevant to strategic choices of the players because they are summary representations of a (moving) equilibrium. Corresponding to each domain, a variety of institutions such as property rights, contract enforcement, organizational governance, social norms, states, and organizational conventions may be identified.

One of the great advantages of the equilibrium approach proposed here is, among others, that it provides an analytically tractable and operational conceptualization of the interdependencies of institutions across domains, as well as institutional linkages of different domains. For one thing, applying a technique developed by Topkis (1978) and Milgrom and Roberts (1990), we can analyze how an equilibrium constellation of strategic choices of players in one domain can become strategically complementary to, or conditional on, the equilibrium choices of other (and/or the same) players in other domain(s). In this way, we may understand the conditional robustness of an overall institutional arrangement (constellation of institutions across domains) of the economy as well as the multiplicity of such arrangements. We have already hinted that there may be such institutional interdependencies between the SV-clustering on one hand and competitive markets for corporate assets and particular intermediary skills (venture capitalist skills) on the other. However, in another place, we may find interdependencies between the organizational convention of the J-form and imperfectly competitive markets for engineers (Aoki [2001], ch.11.3).

In the rule-of-the-game approach of institutions by D. North, organizations are not regarded as institutions because they are players of the game but not rules. However, as the preceding discussion implies, we may treat conventions of organizational forms as institutions (equilibrium in the "organizational field"(Hannan and Carrol)). If we focus on the nano-structure of transaction with institutional environments of law, customs and the like as given, as Willimason does, markets and hierarchies can be substitutes, the selection from which may be determined by their relative transaction cost economizing function. However, if we treat organizational conventions as institutions and various types of market governance (trust and reputations, merchants' norms, third-party contract enforcement, "digital enforcement" and so on) as institutions arising in the commodity exchange domains, there may be complementary relationships between a certain combination of institutions from both.

One potentially fertile field of trans-disciplinary research on institutions may be found in the analysis of complementarities between forms of the state in the polity and institutions in other domains. To do this, we may start by making a distinction between the government as a player in the domain of political exchange, on the one hand, and a state as a stable order (equilibrium outcome) of relationships between the government and private agents, on the other. The word *state* derives from the Latin *stare* (to stand), and more specifically *status*. *Status* applies to something that is established, recognized as fixed or permanent in a particular position, as do its derivative the English words, static and stable. As such the state may be thought of as being amenable to "equilibrium" analysis, yielding possibly many varieties. We conceptualize a variety of states as stable multiple equilibria of a generic political exchange game in the polity domain by which a government and the private agents settle on a certain order between them.

Thus a state is not merely a government organization or the rules that it makes (which could be broken or ignored), but an order that the government itself is subject to. It may comprise stable collective beliefs held by private agents, as well as by the government, regarding the possible outcomes of their (deviant) behavior (off-the-path-of-the-play) that may sustain a predictable pattern of behavior (on-the-path-of-the-play). In this sense, the state may be said to have an aspect of endogenous normative order. From this perspective we can identify several types of the state (such as liberal, representational-democratic, corporatist, developmental, administered-pluralism) and understand the nature of interdependencies between each of them and some particular form of institutions in other domains. For example, there may be complementary relationships between the corporatist state, on one hand, and codetermination as an institution of corporate governance and participatory hierarchies as a convention of organizational form, on the other (Aoki [2001], ch. 11.2).

Another possible type of institutional linkage is that the players may coordinate their own strategies across domains rather than taking an equilibrium profile of choices (an institution) in another domain as given – the situation called the linked games. By being able to do so, players' viable choices may be effectively enriched and the possibility of a new institution that is not feasible without such linkage may emerge. One particular class of this category is the aforementioned "social embeddedness" (Granovetter) in which the social-exchange domain "embeds" another type of domain and enables some strategy profile to be sustained in the latter, which would not be otherwise viable. The social exchange domain may be conceptualized as the one in which non-economic goods/bads (social symbols, languages) which would directly affect the pay-offs of recipient players, such as esteem, approval/disapproval, sympathy, accusation, and so on, are unilaterally delivered and/or traded with "unspecified obligations to reciprocate" (Blau, 1964/1988), and sometimes accompanied by gift-giving. Then, even if the cooperative standard of behavior, say in commons, does not appear self-enforceable in isolation because of the technological difficulty of excluding free-riders (the tragedy of commons), if the same players are engaged at the same time in a social exchange game which can produce a sufficiently large amount of social capital for them, members of the community may penalize the deviant in the commons game by ostracizing him in the social exchange game. Social capital refers to the present value sum of future benefits from non-economic goods/bads that individual players expect to derive from cooperative association with the community in the social exchange game. In order to derive returns from it, individuals must invest in it and maintain it through social exchange. The fear of denial of access to social capital by other community members makes it incentive compatible for each member to observe the cooperative standard in commons domain, while members' concerns with the disruptive impact of deviant behavior in the commons game make it in their common interests to impose social sanctions on the deviant in the social exchange domain. Although not explicitly formulated in game form, the "strategic" nature of social embeddedness was already referred to by the originator of the concept, Granovetter, who argued that values and norms may be perceived as exogenously given by individuals but actually they are endogenously shaped by them, "in part for their own strategic reasons" (p.57).

The linkage in the above example was between a commons domain and a social exchange domain. But the same idea can be extended to a linkage between another type of domain, such as economic, organizational, and even political, exchanges, on one hand, and a social exchange domain, on the other (Aoki [2001], chs. 2.2, 8.1, 10.1). Further there are also other types of linked games useful for understanding various forms of intermediaries, organizational architecture, contracts, and so on (Aoki [2001], chs. 8.2, 10.2). For example, the tournament game played on the S-mediated T-form may be considered as one investor linking multiple games ($k1,k2 \geq 2$) with one entrepreneur. By such linkage, externalities are created and in spite of duplication of investment costs, it may become profitable for the investor (i.e., venture capitalist) to finance risky development projects that may not be otherwise.

It is hoped that by relying on such game-theoretic tools as complementarity (super-modular) analysis and linked games, we can open up a new conceptual and analytical framework for transcending various domains of games in society traditionally dealt with by different social scientific disciplines. We owe a great deal to Willamson for having led us to this window of opportunity.

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