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On "Comparative Institutional Analysis" of the Genesis of Institutions: A Critical View*

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Introduction

As pointed out by H. A. Simon, the "rationality" of human beings is not perfect. He termed the rationality of actual human beings "procedural rationality." Today, it is more often called "bounded rationality," but the two do not differ much in substance. What is significant is that as human beings engage in economic activities, they take various limits as a given. Shiozawa (1990) calls these limits: (1) limits of vision; (2) limits of rationality; and (3) limits of influences. Given these limits, human beings are unable to grasp the world perfectly, and their thinking and cognitive faculties are limited. To achieve our objectives, we must take various steps, learning by mistakes along the way. However, despite the limitations and bounds, we choose our actions and live our daily lives without making serious mistakes. Generally, our actions are not severely hindered by the above-mentioned limits and we live our daily lives as if not aware of the limits. This situation is made possible by patterned behaviors called institutions, customs and habits. (Institutions, customs and habits have different nuances, but hereinafter, the term "institutions" will be used to signify such patterned behaviors, except in special cases.)[1] Owing to such "institutions," we can avoid fretting over unlimited options on one hand, and on the other, we can continue to live our lives without encountering serious inconveniences[2].

"Institutions" have two major characteristics: (1) self-enforcement and (2) self-sustenance. In other words, people "willingly" (accepting it as a given) and "repeatedly" follow "institutions." "Comparative Institutional Analysis (CIA)" is an attempt that has been made by Masahiko Aoki and others to grasp those "institutions" in a uniform manner, as a Nash equilibrium of the game. In this article, by chiefly focusing on CIA, I will analyze how evolutionary game theory accounts for the genesis of "institutions" and examine its effectiveness.

I. "Institutions" as a Nash Equilibrium

Let us briefly look at what it means to grasp "institutions" as a Nash equilibrium. By identifying a "set of players," "strategy sets of players" and "pay-off func-

* On the developed argument about this subject, see Shimizu [2003].

tions of strategies," exogenous rules of the game ("game form" Hurwicz) are determined. Let us assume that in this "game form," each player has chosen, without any prior consultation, a strategy that maximizes his/her pay-off. The Nash equilibrium in this case is defined as a set of strategies that satisfies the following conditions in a non-cooperative strategic game with n players.

- s_i : player i's strategy.
- S_i : set of player i's strategies
- $s = (s_1, s_2, \dots s_i, \dots, s_n)$: set of strategy profile of n players.
- $s_{-i} = (s_1, s_2, \dots s_{i-1}, s_{i+1}, \dots, s_n)$: set of strategy profile of $n-1$ players, excluding players i's strategy.
- $u_i(s) = u_i(s_i, s_{-i})$: $u_i(s)$ is player i's payoff when strategy profile s is chosen.

We say strategy profile $s^* = (s_1^*, s_2^*, \dots, s_i^*, \dots, s_n^*) \in S$ is the Nash equilibrium if, for every player $i = 1, \dots, n$, and every $s_i \in S_i$, we have $u_i(s^*) \geqq u_i(s_i, s_{-i}^*)$; ie., choosing s^* is at least as good for player i as choosing any other strategies given what the other players choose s_{-i}^*.

Using the terms of game theory, in the Nash equilibrium, each strategy gives the maximum pay-off to each strategy (i.e., each strategy has become the "best response" to each strategy). If the situation becomes settled in this condition, the players will have no positive incentive to change their behaviors. Unless there is a change in the "game form" or other exogenous changes, the players will continue ("self-sustenance") to choose behaviors ("self-enforcement"). A simple strategic form game is exemplified below. The shaded strategies are the best response strategies and the combination of the best response strategies, namely A choosing strategy 1 and B choosing strategy 2 (1.2), constitutes the Nash equilibrium.

A\B	1	2
1	10, 4	1, 6
2	9, 9	0, 3

The choice of this strategy is not forced exogenously, but "We regard these rules as being endogenously created through the strategic interactions of agents, held in the minds of agents, and thus self-sustaining."[3] If this is called an "institution," then an institution is "a self-sustaining system of shared beliefs about a salient way in which the game is repeatedly played."[4]

How, then, are such institutions (Nash equilibrium) generated? "Comparative Institutional Analysis (CIA)" employs two approaches:

1) The classic approach: In this approach, the Nash equilibrium is chosen as a result of a repeated non-cooperative game[5]. Players are assumed to be super-rational in gathering information, forming predictions, deducing outcomes and choosing rules of behaviors. This approach is suitable to analyze the self-enforcement of contracts, governance, etc. Players follow "institutions" because they rationally predict the disadvantageous outcome of not following them.

2) The evolutionary approach: The Nash equilibrium (in this case, evolutionary stable strategies: ESS) is chosen as players with "bounded rationality" are engaged in an evolutionary game. This approach is suitable for analyzing spontaneous "institutions" such as habits and customs. Here, rules are "considered as a given."

Aoki, while recognizing the effectiveness of the classic approach concerning the genesis of "institutions," claims that it is insufficient for constructing a general theory of "institutions." This is because "there is nothing that the notion of subgame perfect equilibrium can reveal about why a certain institutions evolves in one place and another evolves elsewhere"[6] And it is evolutionary game theory, the support pillar of the general theory, which explains the diversity of "institutions."

II. From Classic Approach to Evolutionary Approach

Evolutionary game theory has, following its success in biology, been increasingly applied in recent years to broad areas not only of economics, but also of philology, psychology, politics and many other disciplines[7]. As such, I will examine the characteristics of this game theory in the context in which it was originally used, i.e. biology. First, I will set up a pay-off table, and then demonstrate that the meaning of the game will be completely different depending on whether one adopts the classic or evolutionary approach.

II-1. Explanation of the Hawk-Dove Game by the Classic Approach

Let us assume the following non-cooperative strategic game:

A\B	Hawk	Dove
Hawk	−2, −2	2, 0
Dove	0, 2	1, 1

Here, "Hawk (H) strategy" is a strategy of fighting to obtain a pie, while "Dove (D) strategy" is a strategy of first intimidating the opponent to obtain the pie and running off if the opponent fights back. The strategy sets of players A and B are illustrated as (A's strategy, B's strategy). Here, the pay-off of (H, H) is (−2, −2), meaning that the cost for the fight is larger than the pie obtained through the fight, whereas the pay-off of (D, D) is (1, 1), signifying that the pie is shared in peace. In ordinary game theory, individuals A and B, as rational players, will choose a strategy to maximize their own pay-off, each knowing that the other is also rational[8]. The Nash equilibrium of this game comprises two pure strategy equilibriums — (H, D) and (D, H) — and one mixed strategy equilibrium [(1/3, 2/3)(1/3, 2/3)][9]. In this situation, it is not known which of the three Nash equilibriums will be chosen.

The game assumes a situation in which each of the rational players can read the opponent's strategy. Furthermore, it is a "complete information game," in which players know the "rules of the game." It is true that in the real world there are few such complete information games (the Japanese game of go and chess as examples). In reality, players are neither fully aware of the "rules of the game," nor can they rationally read the response of the other by randomization[10]. However, I would like to focus here not on the dereism of conventional game theory, but on the broadened perspective when the same pay-off table is replaced by context of the evolutionary game.

II-2. Explanation of the Hawk-Dove Game Using an Evolutionary Approach

In the context of the classic approach, the Nash equilibrium consists of the rational behaviors of the players. Evolutionary game theory attempts to re-interpret the Nash equilibrium as a population equilibrium and also to provide it with a dynamic foundation. A situation is assumed where games are repeatedly played over an extended period by the random matching of individuals within an infinite population. Players do not need to have complete knowledge about the rules of the game, as they play it primarily on the basis of a strategy coded in genes. Here, pay-off indicates fitness (survival rate $\times$ reproduction rate). Therefore, the relative frequency of individuals with a gene that codes for a strategy that leads to a larger pay-off will eventually increase through repeated alterations of generations (the process of "natural selection").

Following this thought, out of the three Nash equilibriums which are placed on the same level in the conventional game theory, only the mixed strategy [(1/3, 2/3), (1/3, 2/3)] is identified as an ESS (Evolutionary Stable Strategy). Here, ESS is a strategy that satisfies the following conditions:

If strategy I is an ESS, I satisfies two conditions (E(I, J) is the expected utility for a player using strategy I when the other player uses strategy J).

- ESS 1 : equilibrium condition. $E(I, I) \geqq E(J, I)\ \forall J (I \neq J)$: I is the best response to I, otherwise players will abandon its use
- ESS 2 : stability condition : if E(I, I) is equal to E(J, I), $E(I, J) > E(J, J)$. If J is the best response to I, I is the best response to J (J might be invaded by I under this condition).

In other words, strategy I, which satisfies these two conditions, prevails (for the time being) over all the strategies created by changes of genetic coding through "mutation." Although it can easily be verified that the mixed strategy [(1/3, 2/3), (1/3, 2/3)] satisfies the conditions of ESS 1 & 2[11], here I will describe the process through which this strategy is chosen.

Selection process

We can assume that there is some proportion $p(0 < p < 1)$ of the population using a hawk strategy and some proportion playing a dove strategy $(1-p)$. In this case, the expected return from being a hawk is $E(H) = p(-2) + (1-p)\ 2 = 2-4p$ and that of being a dove is $E(D) = p(0) + (1-p)\ 1 = 1-p$. Thus E(H) exceeds E(D) when $p < 1/3$ and so it will encourage people to change to more hawk-like behaviour (p will rise). Conversely, when $p > 1/3$, p will fall, because E(D) is greater than E(H). When $p = 1/3 (E(H) = E(D))$, people will be indifferent to choosing a hawk strategy or dove strategy.

Within the population that employs strategy H alone (i.e., in the case of $p = 1$), if an individual that employs strategy D is born by mutation, individuals adopting strategy H will be culled and those adopting strategy D will increase. Within a population that only employs strategy D (i.e., in case of p=0), if a mutant that employs strategy H is born by mutation, individuals adopting strategy D will be culled and those adopting strategy H will increase. The population will "evolve" until it stabilizes at an equilibrium when the proportion of individuals using H and D within the mother population becomes 1: 2. This dynamic process, in which the component ratio of the behavior pattern of future generations is determined in proportion to the fitness degree of the present behavior pattern, is usually called "replicater dynamics." In this process, as can be understood instinctively from the above explanation, an ESS is characterized not only by a "dynamic equilibrium," in which a once-settled condition is repeated (the reverse is not true, as can be seen from the fact that a strategy D-only population is dynamically stable but not evolutionarily stable.)[12], but also by "asymptotical stability," in which any deviation from the condition will be corrected, bringing back the original condition. It has been verified that an ESS generally becomes asymptotically stable in the dynamic process.

Here, the meaning of the mixed strategy [(1/3, 2/3), (1/3, 2/3)] differs between conventional game theory and evolutionary game theory. It is not that each player provides a probability to each strategy, but that individuals that play each strategy exist in the population to an extent that responds to the probability. For example, in a conventional non-cooperative game, strategy H=1/3 means that A or B chooses strategy H once every three times, whereas in the evolutionary game, it is interpreted as meaning that 1/3 of the population chooses strategy H.[13]

Let me give some further explanation of the characteristics of evolutionary game theory. The basic set-up of evolutionary game theory is very often a symmetrical two-player game. This symmetrical condition, if illustrated by the pay-off table, is that if both players follow the same strategy, they obtain the same amount of pay-off (the same pay-off for both players is shown by a declining diagonal line in the pay-off table), whereas their pay-off will be unequal when they use different strategies. This is the case when the pay-off table of the two players forms a transposed matrix. The "symmetry" indicates that the pay-off of the players depends only on the strategy chosen, and bears no relationship with the positions. If the game is repeated by random matching within a population and the pay-off shows biological fitness, this setting does not seem to be unreasonable. It is demonstrated that in the evolutionary game based on the 2×2 symmetric pay-off table (the form with two pure strategies), there is necessarily an ESS (This is not necessarily true with the form of three pure strategies)[14].

II-3. Analysis of the Genesis of "Institutions" Using the Evolutionary Approach

In analyzing the genesis of "institutions," CIA directly applies the convergence of the equilibrium on ESS in the evolutionary game. Players with "bounded rationality" choose a strategy at random matching, learn from their experiences the strategy with higher pay-off, and this becomes stabilized. The set of stabilized strategies is called "institutions," and they are self-enforcing and self-sustaining as they are ESS. In this case, there is a need for strategic force to act upon the selection so that the relative frequency of players using a strategy that obtains a higher pay-off increases within the population. This is considered to be an economic selection through competition[15]. Now let me introduce the actual institutional analysis by CIA in an extremely simplified format[16].

A\B	contextual skills	functional skills
contextual skills	6, 6	1, 1
functional skills	1, 1	4, 4

We assume that a worker is faced with a certain skill choice. "Contextual skills" mean broad and malleable skills that can be acquired by OJT, while "functional skills" are segmented skills that require more specialized knowledge. Let us assume that if workers with the same skill encounter one another, they can achieve higher productivity, and therefore earn higher compensation. Each worker repeats random matchings and tries to learn the skills that provide the higher pay-off. Here, there are three Nash equilibriums: (contextual skills, contextual skills), (functional skills, functional skills), and [(3/8, 5/8), (3/8, 5/8)]. The first two are ESS, and the mixed strategy is a strategy to be eroded. Which of the equilibriums (contextual skills, contextual skills), (functional skills, functional skills) will be formed in a certain community cannot be determined *a priori*; the decision depends upon the initial condition of population distribution in the community (In this case, the number choosing contextual skills exceeds 3/8 of the population, then contextual skills universalize, and vice versa.) This dependence is called "historical path dependence." This is an extremely simplified discussion of CIA; CIA uses such a discussion to explain how contextual skills (learning) are "institutionalized" in Japan, while in Anglo-American countries functional skills (learning) are "institutionalized."

II-4. Can the Evolutionary Approach Explain the Genesis of "Institutions"?

Based on the above discussion, I try to examine the question of whether evolutionary game theory is suitable to institutional analysis. Institutional analysis using evolutionary game theory attempts to explain the process through which an accumulation of micro behaviors becomes a beyond-micro object ("institutions"). This method itself seems more "robust" than the thinking that presupposes "institutions" as "totality" or "transcendence" *a priori*. However, I fear that institutional analysis by evolutionary game theory also faces tremendous difficulties despite its refined theoretical style. I point out the following four problem areas:

(1) Underlying the explanation of the evolutionary game is "choice as a result." For instance, when we talk to a child, we often say "the lion's fangs are sharp because they are *for* attacking other animals for food." To be precise, however, this is wrong. If we want to be accurate, we instead must say, "it was easier for lions with sharp fangs to leave offspring, and *as a result,* the fangs of lions as we see them now are sharp."

Nevertheless, the first statement is not necessarily wrong in the ordinary sense, because the phenotypes and behavior patterns of living organisms are the results of tens and hundreds of millions of years of evolutionary processes. Living organisms exist here as we see them now because over the long-lasting process, they were challenged by numerous phenotypes and behavior patterns by mutation and yet maintained the "fitness" to prevail. Certainly they are not perfect, but they can be said to be the most fit for the time being. Therefore, such *functionalist* explanations as "lion's fangs are *for* attacking other animals" or "a peacock has beautiful feathers *in order to* attract peahens" have considerable persuasive power. It may be reasonable to some extent that if a certain situation A is "truly" an ESS, the analyzer, by retrograding from the result, may well set up such (exogenous) "rules of the game" and "game form" which can lead to A, and assume that they will not change during the time when the game is played. (This because if the "rules of the game" or the "game form" had changed, A would not have appeared as an ESS.) This "reasonableness" certainly is not something logical, but derives from the fact that the evolutionary process of living organism functions as a phenomenal laboratory that verifies the assumption that "A is an ESS."

What about social institutions? For the explanation that "institutions are stabilized strategies" as ESS to be reasonable, current institutions, as with biological evolution, should have been challenged by numerous other strategies and yet survived. Presumably, however, there are few such institutions. Even if the analyzer sets up "rules of the game," it is not uncommon for them to be stable in the game process (Taking the example of the above-mentioned skill selection, as the number of workers with contextual skills increases, the scarcity of such workers decreases and therefore, the pay-off to be obtained declines). As such, if an evolutionary game is used to explain institutions in general, it can also be applied to an institution that is not really an ESS. We face the danger of falling into wrong second-guessing and the functionalism contained in comparative statics[17]. When carrying out analysis of institutions in society, a distinction must be made between those that have undergone a long selection process and those that have not[18].

(2) In biological evolution, "selection by result" is passed down through genes; what acts as a substitute for genes in social institutions? An answer can be found in the argument that a strategy that generates a higher pay-off will prevail through "learning and imitation", no matter how bounded the rationality is[19]. It may certainly be a reasonable answer so long as the situation is simple and easy to judge. For instance, in the Kanto region (East area of Japan), a Nash equilibrium exists in that people who want to stand still on an escalator stand on the left side, making a space on the right side for people who are in a hurry and want to walk up the escalator. People who come to Tokyo from the Kansai region (West area of Japan) may stand on the right, not knowing the habit, but will eventually line up on the left after being poked from behind a couple of times[20]. In this case, "learning and imitation" is possible because behavioral choice is directly liked with a pay-off.

However, are such direct relationships common in society? Returning to the argument of contextual skills, in order for "learning and imitation" to be effective in choosing a skill, the worker should know that a certain pay-off can be obtained if he/she chooses a certain skill. However, the actual compensation system is extremely complicated, and does not simply respond to any single element (skill type in this case). Furthermore, in nearly all Japanese companies, employees are not in a position to know the process of personnel appraisal[21]. Therefore, even if contextual skills prevail in Japanese corporations, it is difficult to state that it is due to "learning and imitation". Speaking in more general terms, whom to imitate and how to learn may not seem obvious to an individual with "bounded rationality." Here again, a certain "institution" is necessary beforehand concerning "learning and imitation," and unless this problem is solved, the explanation will fall into an infinite retrogression[22].

(3) Evolutionary game theory provides a good explanation of how a certain function or a certain strategy, after being obtained or being chosen, spreads and stabilizes as an "institution." With a living organism, the first phase of functional acquisition and strategic selection is governed by neutral "mutation," meaning change in coding at the level of genes. By contrast, the traditional argument on institutions (including the account of evolutionary game theory) in fact fails to explain where this first strike comes from. For example, Kiyotaki and Wright (1989) (1991) elegantly explain how certain goods, when obtaining the function of exchange medium, spread and stabilize as "money." However, the assumption that "certain goods obtained the function of exchange medium" is knowledge that is only obtained because we know "money" already, and therefore is an assumption based on an afterthought. If we want to discuss the "origin" of "institutions" (or of anything else, not just institutions), we should be able to explain the very first "emergence."[23]

(4) The evolutionary games I have dealt with in this article are all symmetrical, and I have discussed what kind of strategy will be evolutionarily stable as a result of pair-wise random matchings. However, we do not have to wait for the "contested exchange theory" of Bowles and Gintis to discover that in the actual society, the relationship between subjects is more often "asymmetric" than symmetric. The exchange relationship between money and goods contains asymmetry in that "money can purchase goods, whereas goods cannot purchase money" In employment relationships, too, the strategies that can be implemented differ between employers and employees, and even if the same strategy is implemented, the pay-off to be obtained is usually different. As such, in order to analyze actual society, the need arises to model such an "asymmetrical" world.

Game theory usually models an "asymmetrical" world in the following way. We can imagine a large (technically infinite) population of individuals. And we can imagine that all individuals in the player populations are initially programmed to have the same pure or mixed strategy available depending on one's position in the game. For example, in employment relationships, it is natural to assume that employers, who dispose of stronger power than employees, have the tendency to exert a "hawk" rather than "dove" strategy. Individuals are randomly drawn from the populations to play the game over and over again. In other words, each individual in any of the player populations is always matched with individuals from the other player populations. The game can be symmetric or asymmetric. The only restriction is that it must be a finite game in normal form.

When a mutant strategy arises in a small share of the population in some or all of these player populations, in the "Multipopulation Models," Weibull proves that strategy x is evolutionarily stable if and only if x is a strict Nash equilibrium[24]. But there are many usual games in which a strict Nash equilibrium does not exist, so in this case we cannot find any evolutionary stable strategy[25].

III. Interim Conclusion

Traditionally, economics either ignored non-market institutions or dealt with them only in peripheral discussions. Economists who squarely dealt with institutions were usually labeled "heterodox." However, a trend has gained momentum in recent years, in which both mainstream and anti-mainstream theorists discuss "institutions" by relativizing "markets." This development was likely caused by various factors, and I have focused in this article on the fact that ruling out the assumption of "rational *homo economicus*" makes it essential for "institutions" to be integrated into an economic model. After explaining the CIA approach, which does not take "institutions" as just givens but considers them as objects to explain, I have pointed out its limitations and problems.

The conclusion of this article is that socio-economic institutions are quite difficult to explain using evolutionary game theory. However, the conventional discussion of "institutions," which leaves out their emergence, in fact always leads to considering "institutions" as a missing link, no matter how they are conceived as a link connecting micro economic units and macro economic performance. Then, what kind of research program would be viable? Although I am still in the midst of a process of trial and error, my feeling is that using the accomplishments of evolutionary biology to set up a micro economic subject may give us leads.

In the article, We have advocated the exclusion of "rational *homo economicus*" and the adoption of "*homo economicus* with bounded rationality" as the micro economic subject. However, this "homo economicus with bounded rationality" has been given only a passive definition of "a non-rational homo economicus." In fact, the two types of economicus are identical in terms of their selfish nature, in that they "thin k of nothing but to get a higher pay-off for themselves." Attempts have been made to assume a *homo economicus* different from this "selfish" *homo economicus,* early on by A. Smith in his concept of "sympathy," and more recently by Gintis[26]. Gintis discusses the repercussions for the solution of the game when *Homo egualis, Homo reciprocuns* and *Homo parochius* are placed in a game situation instead of "Homo Economicus"[27]. Even though no one disputes that *homo economicus* has "bounded rationality," it is not traditionally common in economics to attach such adjectives as "*reciprocuns*" or "*egualis*" to *homo economicus.* The major reason for this is that there were few objective reasons for adding these adjectives, and they conveyed normative and idealistic nuances. However, what if such forms of human nature had been gained "adaptively" in the evolutionary process, since human beings diverged from chimpanzees 5 or 6 million years ago? In this case, this nature could well be identified as an objective fact growing out of no more than a subjective assumption.

For example, most of the primates, including ourselves, live permanent communal lives. To live in this way, relationships must be coordinated with other individuals, and human beings do not have to pay a great behavioral cost for this social coordination. Human beings greet each other, but we do not often feel the need to discontinue and change our behavior in response to the behavior of others. By contrast, chimpanzees, when approached by another entity, invariably discontinue what they are doing and take some action in response as a means to confirm their social relationship with the approaching entity. The lower cost for social coordination enables human beings to pay a higher cost for other areas (areas that are not heavily linked with fitness), but why is it that this has only been possible with human beings? One of the assumptions used to explain this is the "theory of mind."[28]

According to this assumption, the human brain has "evolved" to be able to simulate the inner workings of others, by reading their facial expressions, modeling its own. Consequently, unlike chimpanzees, when we meet other individuals we do not have to take any concrete action to coordinate our social relationship. (The difference in behavioral cost is obvious if you compare the case where you have to demonstrate a lack of hostility with each behavior, with that where you can indicate it just by glancing away or by maintaining an ordinary expression.) The ability to "simulate the inner workings of others, modeling your own" is precisely "sympathy." Thus, if the "theory of mind" is correct, the concept of "sympathy" obtains an objective ground. A human being with "sympathy" is capable of using that "sympathy" selfishly (deceiving others by reading their minds) or altruistically (sympathizing by reading others' minds). Using the terminology of "evolutionary psychology" (psychology with the application of evolutionary theory), such an attempt can be said to be a clarification of the "domain specificity" of the human mind[29].

It is true that the "theory of mind" is still an assumption, and that evolutionary psychology itself is a science that has just started. However, there seem to be two merits to presuming a profile of *homo economicus,* which constitutes the basis of economic models, based upon such "domain specificity." (The second merit is more important in terms of the relationship with institutions.)

1. The presumed profile of *homo economicus* is given an objective ground independent of the self-reflections of analyzers.
2. If there is a *social* direction in "domain specificity," new perspectives can be generated for institutional discussion.

Since the first point is self-explanatory, let me add some explanation of the second.

If human beings have the ability of "sympathy" in the sense indicated by the "theory of mind," then the individual has "something social" as an inborn character. The explanation of the genesis of "institutions" under game theory, whether classic or evolutionary, had an impact because it demonstrated that an institution is generated by the repetition of a game under certain conditions, even with the assumption that individuals don't have any knowledge of relationships with others. As long as the player's discount rate is not large, repetitions of the "prisoners' dilemma game" lead to the institutionalization of a form of "cooperation" in which "there is no betrayal unless the other betrays." However, if we presume that individuals have "sympathy," they will be highly unlikely to participate in the game without any knowledge of the other except in an artificial experiment. If "sympathy" is an "adaptive" ability, then any situation where this ability cannot be exerted is a situation that is uncomfortable or at least unnatural to a human being. If this is the situation, people will choose not to participate in the game[30].

The micro economic subject has, as a result of evolution, a "social" character in one way or another. Such a perspective, in understanding "institutions," may suggest a new direction that is neither a simple reductionist account nor a totalitarian explanation that institutions engrave a social mark upon "*tabula rasa*" individuals.

Notes

1 In this context, "institutions" do not mean systems that force inconveniences on people from the outside.

2 For the importance of "patterned behavior," see Shiozawa [1994] [1997].

3 Aoki [2001], p. 10.

4 *ibid.,* p. 14.

5 In this case, we choose the subgame perfect (Nash) equilibrium, excluding strategies which involve non-credible threats.

6 Aoki [2001], p. 9. To this explanation by Aoki, we must add the following point because we have rejected the premise of "*Homo Economicus.*" When we analyze the genesis of "institutions" using a very classic approach, we have to presuppose the existence of certain "(pre-)institutions." In others words, when we exert our ability to choose strategies rationally, we have to make some simplifications — reducing each player's pay-off table or reduction of opponents' various behaviors to comparatively few choices —. To realize this kind of simplification, "institutions" are indispensable.

7 For the development of evolutionary game theory in biology, see Maynard-Smith [1982].

8 Game theory implicitly presupposes the following:

- Rationality as "common knowledge": we know that we will be playing games with people who are instrumentally rational like ourselves, and so it makes sense to model our opponents as instrumentally rational.
- Consistent alignment of beliefs (so-called Harsanyi doctrine): no instrumentally rational person can expect another similarly rational person who has the same information to develop different thought processes.

These two premises enable "us" to adequately anticipate the strategies chosen by our opponents. However, they are still subjects of argument. See Hargreaves Heap/Varoukis [1995], Krepes [1990].

9 This mixed strategy Nash equilibrium [(1/3, 2/3), (1/3, 2/3)] means that each player plays the hawk with a probability of 1/3 and the dove with a probability of 2/3.

10 "I have no expectations of game theory becoming "practical" as the term is understood by most people" (Rubinstein [2000] p. 88).

11 Proof of this strategy — [(1/3, 2/3), (1/3, 2/3)] — as ESS assumes that I is ((1/3, 2/3), (1/3, 2/3)) strategy and J is any others strategies under which a player choose H with probability p′ ($p' \neq 1/3$) including two pure strategies. In this case, with $p = 1/3$ the expected benefit of H is the same as D.

ESS1 : equilibrium condition : $E(I, I) \geqq E(J, I) \forall J (I \neq J)$.

$E(I, I) = E(J, I) = 2/3$.

So We know that P=1/3 is an ESS only if E(I, J) >E(J, J).

$E(I, J) = 4/3 - 2p'$, $E(J, J) = 1 - 3p'^2$.

$E(I, J) - E(J, J) = 1/3(3p' - 1)^2$.

$\therefore E(I, J) > E(J, J)$ It satisfy ESS 2, stability condition.

12 Weibull [1995], Chapter 5.

13 Selten [1980].

14 We can generalize the existence of a "stable" strategy by weakening the stability criteria. In a double symmetric game (if the payoff matrix A to player 1 is symmetric: $A^T = A$), NSS (Neutral Stable Strategies) should certainly exist in a compact strategy set. As the Nash equilibrium is invariant when the pure-strategy function "locally" shifts, the replacement of a symmetric two-person game by a double symmetric game does not disturb this generality. And the Nash equilibrium includes ESS and NSS — or more precisely speaking, ESS set ⊂NSS set ⊂ Nash equilibrium set — this replacement should not change the essential character of ESS and NSS. On this subject, see Chapter 2 of Weibull [1995].

15 For economic selection pressure, see Nelson/Winter[1982].

16 In the CIA, not only does the pay-off table represent an "institution," but the "complementarity of institutions" exerts a great influence on the genesis of "institutions." However, in order to focus on the relation between evolutionary game theory and the genesis of "institutions," it seems sufficient to treat one "institution." A detailed account of the CIA is given in Aoki [1995] [2001] or Aoki/Okuno [1996].

17 Critics on the comparative static character of game theory are quite popular (for example, Takeda [2001]). Aoki himself, without referring to "the rule of the game", says : "In my view, a more serious limit common to both approaches as tools for institutional analysis may lie (...) in the presumption of the fixedness of the agents' sets of choices. How can the agents know all the possibilities of their actions?" (Aoki [2001] p. 196).

18 The Micro-Macro Loop Schema of Shiozawa [1999] and Ebizuka/Isogai/Uemura [1998] does not deny the stability of "institutions" as the CIA supposes, but for them it is not a necessary condition for defining the concept of "institutions."

19 To use Axerlod's term, it is the "principle of reinforcement." See Axelrod [1984].

20 Game theory researches based on "learning" have just recently been published (see Samuelson [1997] and Fundenberg and Levine [1998]). Araki [1998] suggests with some reservations that the social evolution process led by "learning" can be explained as a kind of "replicator dynamics."

21 Endo [1999].

22 Yamagishi explains the genesis of "trust" in human society using the evolutionary game approach. But he also has difficulty indicating what diffuses this "trust" in society. It remains a "missing link" for him. He calls it, as a working hypothesis, "social trust," which is a individual capacity of estimating the others' "trustworthiness." For this argument, see Yamagishi [1998] Chapter 6.

23 To analyze the "origin" or "emergence" in this context, it is necessary to have a perspective of "internal measurement." On the "internal measurement", see Gunji/Matsuno/Otto [1997] and Matsuno [2000].

24 If we define a strict Nash equilibrium by using the p2. definition, 「$u_i(s^*) > u_i(s_i, s_{-i}^*)$, $\forall s_i \in S_i$」 must be changed to 「$u_i(s^*) > u_i(s_i, s_{-i}^*)$, $\forall s_i \in S_i$」

In other words, while the Nash equilibrium criterion requires that no unilateral deviation should be profitable, a strict Nash equilibrium requires that all such deviations should be costly. Thus, a strict Nash equilibrium can not contain any randomization at all ; it should be a pure strategy profile.

25 While the definition of "evolutionary stability" in multipopulation models depends on

the authors, even weak criteria for "evolutionary stability" in multipopulations reject all but a strict Nash equilibrium (e.g., Selten [1980]).

26 For further details of "*Homo Economicus*" in economic thoughts, see Danner [2002].

27 See, in particular, Chapter 11 of Gintis [2000]. These three types are not isolated-independent "*Homo Economicus*" at all, because their profit could be well influenced by the change of others' profits.

28 On the "theory of mind," see Hasegawa/Hasegawa [2000] and Hasegawa [2002]. For detailed arguments on this theory see Baron-Cohen [1996].

29 "Domain specificity" is presumed to be an important property of psychological adaptations. "Domain specificity" means that adaptations evolve to solve problems in particular domains, and therefore are less well suited to solving problems in other domains. Even if there are differences in race and ethnicity, it is said that man has a "specificity" where he insists on power more strongly than do woman. This "specificity" is an inborn character for the individual. See Hasegawa/Hasegawa [2000].

30 Hasegawa [2002] reports that some researches indicate that the "prisoners' dilemma" is inappropriate for explaining the cooperative behaviour of primates.

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