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Self-Organization Theory and Its Applicability to "Economic System"

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There was an explosion of "scientific revolution" of "complexity" in Santafe Institute during 1980s. Self-organization theory developed by Stuart Kauffman mainly putting focus on the explanation of the birth of life was one of the most outstanding outcome of the revolution. In Japan, on the other hand, Dr. Hiroshi Shimizu originated more biology oriented self-organization theory named "Bioholonics" by himself. The paper is a trial to apply those self-organization theories developed by those outstanding natural scientists to such questions as system change or transitional economies. In particular an application of the theory to Japanese miracle during so-called high economic growth age is concretely taken up.

1. Introduction

For these couple of decades, I have been interested in transition of economic systems, which practically covers both process analysis of transitional economy and the change of Japanese economic system. Seeking these topics, I could not be exempted from not a little frustration caused by a lack of satisfactory economic theory well capable to explain those questions.

Meeting with evolutionary economics pioneered by such as Richard Nelson or Sydney Winter in 1982[1] and further developed a little differently by Geoffry Hodgson in 1993[2] could be an epoch-making step for me feeling a sort of deadlock as mentioned above.

The works of Nelson and Winter, however, have been found to not exactly match my real research purpose. Despite the fact that they deserve to be highly regarded for their pioneering role in this field and for their enlightening illustration of several key concepts in evolutionary economics (such as "routine"), they have, in my understanding, too much inclined to the question of economic dynamics mainly led by technological change, which eventually enabled them to pursue well sophisticated mathematical type simulation analysis at the sacrifice of analysis on organic aspect of economic system that are not so well adaptable to mathematical treatment.

1 Richard Nelson & Sydney Winter (1982) "An Evolutionary Theory of Economic Change" Cambridge MA. Harvard University Press

2 Geoffry Hodgson (1993) "Economics and Evolution" Polity Press

Hodgson, on the other hand, has much points not a little suggestive for my purpose. Above all, he puts great stress on organic nature of economy and denies introductions of mechanism or reductionism in the analysis of economic structure (or system), from which he has presented a lot of valuable methodological thinking to us, though he has not yet formulized any systematic evolutionary economics of his own. From these methodological suggestions given by him, including such as holistic (rather than reductionistic) comprehension of economy, organic (rather than mechanic) consideration or understanding evolutionary development as open, phylogenic and non-consummatory (rather than closed, ontogenetic and consummatory) process, I truly studied much available for my research of system change.

Greater impact, however, came from another side different from evolutionary economics : that is complexity science-in particular self-organizing theory.

It is obvious that in system change of economy, such as adaptation process reacting to circumstance change or selection between diversity of actual changes are very important, and to these questions evolutionary approach should work to some extent so that I still would not deny adoption of evolutionary approach in some area of my own system change analysis. But one undeniable point is that: whereas evolutionary change caused by adaptation process is more or less gradual process, there could also be found another phase, in an economy, where economic structure or system change more radically. Appearance of so-called postwar Japanese economic system in the era of "Japanese miracle" during two decades since 1950 to 1970 (which is clearly deteriorating in 90s and aftermath), or some of transitional economy, could be listed up as actual examples of these radical change. And for understanding those radical change, such term as "emergence," a key term of self-organizing theory, rather than such term as "adaptation," a key term of evolutionary economics, is considered to be more appropriate , though latter term is also usable as a part of explanatory words in such study.

For mainly above reason, I would put a greater focus on self-organizing theory in the following.

First I give illustration about three different types of self-organizing theory in section I of the article and try some adoption of some of these theories (as to be found mainly third one will be taken up) to Japanese problems in section II. I will finally give some analytical prospect about the possibility of adoption of it to transitional economies in section Ⅲ.

2. Three representative "self-organizing theories"

(1) Self-organizing criticality theory created by Stuart Kauffman

As well-known already, the first systematic theory of self-organization was

triggered and developed by scientists in Santa Fe Institute,[3] who executed so-called "science of complexity" revolution. And among them, most representative might be Stuart Kauffman, the author of "At Home in the Universe." [4]

Specifically he developed his theory of self-organization in his theoretical endeavour to explain the birth of life on this universe.

The basic idea of his explanation in this respect could be summarized as follows : The life was born as an emerging result of self-organization of diversity of prebiotic molecules; in other words under some circumstance (which can not be yet explained satisfactory) there gathered diversified molecules on the earth and they executed various interaction between each of them, and when the web of such interactions exceeded beyond some critical point, there emerged some qualities having ability to metabolize, reproduce or in other words self-catalyze, just as a result of self-organization of interacting molecules ; thus the first life was born (at the point it was a singular cell life). In this concern, he himself describes;

"Life, in this view, is an emergent phenomenon arising as the molecular diversity of a prebiotic chemical system increases beyond a threshold of complexity. If true, then life is not located in the property of any single molecule—in the details—but is a collective properties of interacting molecules. Life, in this view, is not located in its parts, but in the collective emergent properties of the whole they create. Although life as an emergent phenomenon may be profound, its fundamental holism and emergence are not at all mysterious" (ibid ; p. 24)

Here is found not only the essence of Kauffman's self-organization theory, but also his another important point to stress holism and deny a traditional Darwinian view to acknowledge a life located in single molecules and understand multicellular organism, including homo-sapiens, as a result of long accumulated evolution from single RNA. The latter type of his criticism on Darwinian view gets more clear when he goes further to understand "Cambrian explosion," when various multicellular life appeared on the earth explosively 550 million years ago, as a result of "principles of self-organization (this time participated by diversified single-celled life-forms; Tominomori) mingle(d) with chance and necessity" (ibid: p. 12-13). He also says here;

3 It may not be fair if we overlook the name of Herman Haken, a German physicist, who first discovered underlying principle of Laser beam and tried to apply it to other self-organizing physical order. However, with regard to far more general development of the theory, we had to wait until the foundation of Santa Fe Institute.

4 Stuart Kauffman (1995) "At Home in the Universe-The Search for the Laws of Self-Organization and Complexity Oxford University Press

"A burst of evolutionary creativity generated almost all the major phyla now jostling one another in nooks and crannies on, above, under the earth's surface, everywhere, even thousands of feet down in solid rock. Only the vertebrates, our own lineage, arose a bit later, in Ordovician times." And "One of the wonderful and puzzling features of the Cambrian explosion is that the chart was filled in from the top down. Nature suddenly sprang forth with many wildly different body plans —the phyla—elaborating on these basic designs to form the classes, orders, families, and genera." (ibid: p. 13)

It is now clear that he is proposing another path of evolution, entirely different from traditional Darwinian explanation, mainly through the principle of self-organization. As Kauffman himself admits, "the route to the formation of such multicellular life remain obscure" (ibid: p. 13), so that Kauffman type of explanation of evolution should still be understood as a hypothesis. Darwinism is too nothing but a hypothesis, so the question just looks to be which hypothesis is more acceptable. However, if we bear in our mind that "all living things seems to have minimal complexity below which it is impossible to go" (ibid: p. 42), it cannot be so plausible to explain appearance of various multicellular livings as a final result of long accumulated evolution from single molecules (RNA), as explanation through self-organization principle seems more plausible and understandable.

One important point should not be overlooked here: that Kauffman's criticism on Darwinism does not necessarily mean his overall denial of evolutionary theory. On the contrary, Kauffman developed his own very sophisticated theory of evolution (mainly in chapter 8 of the book). His real standpoint could be paraphrased as the one to put self-organization theory in the core and situate evolutionary theory in complementary position to the former. He himself clarifies the point as following;

"Without a framework to embrace both self-organization and selection, self-organization has been rendered almost invisible, like the background in a gestalt picture. With a sudden visual shift, the background can become foreground, and the former foreground, the selection, can become the background. Neither alone suffice. Lfe and its evolution have always depended on the mutual embrace of spontaneous order and selection's crafting of the order." (ibid: p. 8-9)

It might be easily understood such stance of Kauffman has a close coincidence with my own direction described in the introduction; rather I should say I studied it from Kauffman.

As seen so far, Kauffman's basic idea of self-organization has been mostly developed in the field of biology, specifically along the question how to explain the birth of life. However, he is also known in his eager enthusiasm to try to

adopt the theory to the arena of social activities. According to his own words, it is said as following;

"Why would I, the other scientists at Santa Fe, or our colleagues around the globe studying complexity be interested in potential connections to the practical problems of business, management, government, and organizations? What are the biologists and physicists doing poking into the new arena? The themes of self-organization and selection, of the blind watchmaker and invisible hand all collaborating in the historical unfolding of life from its molecular inception to cells to organisms to ecosystem and finally to the emergent social structures we human have evolved—all these might be the locus of law embedded in history" (ibid; p. 246)

Not all natural scientists, however, shares the same eager with Kauffman. For example, another outstanding scientists as James Trefil, who have studied brain mechanism through complexity or self-organization theory, puts entirely reverse view, explicitly contrasting his view with Kauffman. He says;[5]

"Is there some genreralized <First Law of Complexity> that will describe both the human brain and the Adam Smith marketplace? Or are the two simply different phenomena that share the property of complexity the way a galaxy and a hurricane share the property of being shaped like a spiral? For the record, my guess is that the search for general laws that underlie all complex systems will probably not be successful. In other words, I think that the brain and economic systems will turn out to be much more like hurricanes and galaxies than they are like stars and tropical lakes. For a very eloquent and passionate presentation of the opposite point of view, I recommend Stuart Kaufmman's book, *At Home in the Universe*.

As taken up later, we have another outstanding biologist who has made a great contribution to the brain science using self-organization theory at least as one vital method, like Hiroshi Shimizu, who is also eager in poking into the arena of social phenomena including economy, just as Stuart Kauffman and his Santa Fe colleagues. The key to decide which side of the argument is more acceptable, however, seems to be in the hand of social scientists making use of self—organization theory learned from natural science. And as a representative example of those theoretical trial of social scientists, Paul Krugman is taken up next.

(2) Several trails by Paul Krugman to apply self-organization theory to economy

An well-known economist, introducing self-organization theory intentionally and explicitly into economics, is Paul Krugman, the author of "The Self-Organizing Economy" (1996, Blackwell).

5 James Trefil (1997) "Are We Unique?" John Wiley & Sons, Inc.

As he himself writes when he introduce Thomas Schelling's model with praise, he loves "a perfect example of how to wear your sophistication lightly" (ibid : p. 21). And with such light and beautiful sophistication he actually develops several models of self-organization.

The problem, however, is whether such light sophistication can be really compatible with truth or not. And my own response to it, to be frank, is quite negative. In fact, Krugman usually put forth tight and inflexible restrained assumptions on the participants (in other words, agents). Thus he simplifies the models.

Generally I don't deny simplification itself. Rather simplification should be understood as a necessary step for theoretical procedure. But what matters is what we simplify. If we oversimplify human participants, an extreme complexity filled with diversity, changeability and fluctuation, it must eventually lead to a vital departure from realization of complexity of organism.

Let us take up questions of Krugman's such oversimplification with regards to his two representative models in the book. One is his refined model of Thomas Schelling's "Segregation Model" (ibid: p. 15-22) and the other his own "City Model" (ibid: p. 22-29).

The former model explains how people first reside in a completely random allocation pattern becomes to be completely segregated between two areas each only consisted with only one type of people. Here people is divided into two types of person @ and #.[6] And restraints are fixed as following.

> "an individual with one neighbor will try to move if that neighbor is a different *devotee*; one with two neighbors wants at least one of them to be the same *devotee*; one with three to five neighbors wants at least two to be his or her *type of devotees*; and one with six to eight neighbors wants at least three of them to be like him or her" (ibid: p. 17—here italics are revised expression as footnote says)

Even under such tightly fixed restraints, there is a possibility "to create an equilibrium residential pattern that is highly integrate" (ibid: p. 18 and Figure1. 2). But as Krugman says, the equilibrium is quite unstable one, so that once the pattern "messed it up a bit," a continuous move toward a clear residential segregation between @ and # (His Figure1. 4. ibid p. 20) would begin: light and beautiful sophistication through self-organization!

6 In original setting of Shelling and Krugman model, classification of these types of people @ and #, some ethnically problematic aspects was found, though Krugman a little acknowledged nasty nature of it. So that I abandon here original concrete characterization of @ and # even as a quotation. I rather prefer to define these two types of people as two different music devotees as devotee of classical music and that of jazz music. Thus I believe not only we can avoid the nasty way but also we can reach at more profound understanding of self-organization of human activities.

No problem is found in the illustrated procedure about how segregation is self-organized. A critical problem, however, should be pointed out in their restraints. The fundamental nature of human beings is its diversity, changeability and complexity that refuse simple and clear-cut classification of the between two types of persons. Kruguman, as well as Shelling, not only dared such undue oversimplification, but also neglected dynamic changeability of human beings, another fundamental points of them.[7]

In addition to the above point, there lies another point in their model isolating itself from the reality of living organism. That concerns with the nature of final equilibrium the model reach at the final stage. As shown already the model finally reaches at the point where two types of people reside perfectly segregated and never move again under the restraints. This is nothing but a static equilibrium of the kind usual in snow crystal. For the living organism, such stationary is only found when it dies. More fundamental for living organ is mobility and dynamism.

Despite of these critical defects, it is not denied that Krugman type model of self-organization could be used for some limited purpose under some limited conditions. I find such limited plausibility in his "edge city model" of self-organization. In the model (ibid: p. 22-29), he found "two business concentration opposite each other" (ibid: p. 26) gained "whatever the initial distribution" (ibid: p. 27). But it should be remarked again that these results of self-organization was also gained under at least two restraints set for the participants (in this case; business). These are as following;

Criterion 1. There must be a tension between centripetal and centrifugal forces, with neither too strong.

Criterion 2. The range of the centripetal forces must be *shorter* than that of the centrifugal forces: business must like to have other business nearby, but dislike having them a little away. (A specialty store likes it when other stores move into its shopping mall, because they pull in more potential customers; it does not like it when stores move into a rival mall 10 miles away. (ibid: p. 24−25)

These criteria also sacrifice the diversity or changeability of living participants of a self-organizing process. But here each participant is a business, mainly distribution business directly facing with individual customers, so that, different from the case where participant is individual person, homogenization

7 In their nasty example of segregation model, such sort of clear-cut classification might be admitted to some extent by some people. But though still I don't wish to refer it concretely, it should be recognized that there are variety of people in between @ and # type in their model. Negligence of such variety itself is a necessary result of this sort of nastiness. In our revision of their model, such variety and diversity is more apparent. There are variety of people favoring both type of music with various percentage stress, and changeability of devotee is also very frequently observed. It is frequently observed that a jazz devotee became to love classical music at some stage of his (her) life.

becomes more acceptable at least in limited time period because those business are acting aiming at more or less homogeneous profit purposes.

However, for us who are interested in highly complex self-organization of such as economic system participated by variety of stratified participants as individual human beings, business or business groupings, such simplification or homogenization of participants through tightly set restraints signifies nothing but an vital departure from the reality.

In a way, we can characterize methodology taken by Krugman is similar mechanism and reductionism with familiar traditional economics represented by neo-classical school. One important contribution of self-organization theory is to prepare a certain way to get out of neo-classical labyrinth to enable us to treat more wide and organic economic questions. In this sense, Krugman's way rather undermines real value of our new paradigm of economics. Is it too much to say, if I dare say Krugman has been thrown into hell again since he was caught by devil temptation of that "light sophistication"?

(3) Self-organization theory of Bioholnics

Whereas Krugman type of self-organization theory is considered to be a setback to mechanism or reductionism, an utmost accomplishment of organism type self-organization theory is found in "Bioholonics."

Bioholonics, the still unfamiliar term particularly for western readers, was first originated by an outstanding Japanese biologist Hiroshi Shimizu,[8] through his long research on muscle movement or brain activity, where he found various self-organization participated by muscle fibers or neurons.

Here I don't give detail introduction about how Shimizu's bioholonical version of self-organization has been created. I rather summarize the essence of self-organization theory of bioholonics from my own viewpoint in the trial applying it to the questions of economic system change or transitional economy. Despite of the fact that I owe really much to Shimizu, my interpretation itself is that of an economist, for which I am wholly responsible.[9]

Holonic participant: the basic unit participating the self-organization

The most important point of the theory distinguishing itself from other self-organization theory is to define the basic unit participating a self-organization as a complex living organism holding autonomous spontaneity as

8 Hiroshi Shimizu (1999) "*Seimei to Basho－Souzou suru Seimei no Genri*" (Life and its LocationPrinciple of Creative Life) NTT

9 Shimizu himself has not a little interest to apply his theory to some economic problems and actually several trials of this sort done by him is found in his book. These are, however, mainly confined to single market or the like.

well as diversified character and dynamism (or changeability). In this respect it entirely differs from Krugman type theory. Stuart Kaffman's self-organization, on the other hand, could be understood to be the one covering both aspects. When he explains the birth of singular cell life, the unit is mostly understood as various molecule. The emergent result of self-organization is obviously a complexity and unit molecules have diversity. Each one molecule, however, is not clearly defined as a complexity at this step. But when he try to explain the birth of multi-cellular life furthermore, the unit of self-organization itself is nothing but a complexity holding autonomy for itself.

Self-organization theory of bioholonics, from the beginning , deal with self-organization where every participants of self-organization is living complexity, which nature could not be fixed to any restraint and which is transforming or changing all the time through its own autonomous spontaneity.

Taking it into account, Shimize named the unit as "*holon (Kankeishi)*," which looks similar with holon defined by Arthur Koestler (1905-83). According to Shimizu, however, the connotation of the term is different from that of Koestler. Whereas Koestler defined the term as "both the autonomous properties of wholes and the dependent properties of parts,"[10] Shimizu put a greater stress on interacting relationship between holons and feedback or feedforward relationship between each unit holon and the self-organized whole (calling this two way relationship, he uses an expression as "holonic loop"). Shimizu particularly makes much of spontaneous participation of the unit in the self-organization, which is contained above "feedback" relationship.[11]

Although I basically agree with his idea of *holon*, I don't think the term is so appropriate to point the essence as referred above. I rather prefer to use another term as *holonic partipant*, which I believe better version.

Holonic-loop--relationship between holons, and between each holon and the emergent whole: mutual interaction and entrainment between holons

In the concern with explanation of holon, the essence of holonic-loop has been already mentioned to some extent. But the connotation of "holonic-loop" is more profound.

As already referred, the essence of the holonic participant lies in its com-

10 Arthur Koestler (1967) "The Ghost in Machine" Huchinson, p383

11 Such kind definition of holon is also found in Geoffry Hodgson, because Hodgson says as "A holon is subject to the influences not only above and below in its own hierarchy but also through the connections with other hierarchies or system" (Hodgson, ibid : p246). Difference left here are Shimizus stress on spontaneous participation of the holon and self-organization thinking not found in Hodgson explicitly.

plex diversity and changeability. Put it in a different way, it means that one holonic participant has diverse possibility in regards to what nature, out of those possibilities, is actually vitalized and come up to the surface. Originally real appearance of the nature is undetermined. And decision about what potentiality is actually chosen is made depending on the relationship with other holonic participants and the emergent whole that the relevant holonic participant does have at each moment. For example , relatively talkative and a little entertainer mind appears when I face with students in the class room, whereas tender and softer character come up when I am meeting with my little 5 years old grand daughter. Also what aspects of diverse and complex characteristics actually appears must be influenced by whole atmosphere of the emergent whole. If the class room as a whole get excited more than usual, due to several reasons partly including my own better teaching performance than usual day, I would be able to pull out further greater potentiality in teaching, thus the class room too would have emergent excitement as a whole. Off course, as just mentioned, each holonic participant is not merely influenced by others but also spontaneously affecting to others. And diverse holonic loop would be created depending upon actually formed interacting or entrainment[12] relationship between holons or that between each holon and the whole.

Box column1: Local information given to one cell and vitalization of a gene

It is somehow mysterious why one or only limited genes out of 100 thousand genes is vitalized in a definite cell in the ontogeny from an embryo. In present advanced biology, it is explained through local information given to one cell (in other words influence given to the cell by neighbor cells).

A simple explanation of such principle of local information given to a cell can be made in how two types of cell are differentiated in a very simple multi-cellular plant called Anabaena having only two types of cell, A and B ,each of which is distinguishable from both ostensible feature and function. Here only B can do cell division. It is observed, in the process of cell division of one B cell, that B varies to A when the distance between neighbor A exceed definite length. Through this observation, it is understood that some information preventing B's variation must be working

12 "Entrainment" is originally a term in physics, where beams, each having different wave length, finally became to have the same wave length through interacting affect to each other. The basic principle why strong lazar beam is formed is understood to be caused by such entrainment affecting. Here the term is used to indicated intimate interaction between holonic participants.

within this limited distance to extinguish beyond it.

Another proof indicating such working of local information is found in the case when an organ of human embryo is transplanted to other animal. The organ begins to repeat cell division indefinitely until it kills the relevant animal. It must be attributed to the lack of local information that should have been given when the organ has natural location in the human body.

Scenario (***or restraint***) ***for self-organization*** : actual direction of the self-organizing move

Each unit holonic participant has dual nature as mentioned above, spontaneity on one hand and passive response both to the neighbors and to the whole on the other hand. And how a definite feature out of diversified possibilities concealed in one unit holonic participant is chosen depends upon how interaction and entrainment between holonic participants would go on. But since each holonic partcipant is filled with too much diversified possibilities and there are too many probable interaction networks between holonic participants, it is still quite uncertain to see how actual self-organization develops. It resembles with simultaneous equations question inappropriately set up, where the number of variables exceed the number of equation and thus the question turns to be unsolvable. In case of the equation , some other restraints or conditions need to be put in to make it solvable. And here a sort of scenario directing the move of self-organization is necessary to be put in. For example , a class room where I meet with students should be that of some definite subject, say economics, and I also need to have some definite topic of the day. Without them, the room is nothing but an unstable chaos.

Thus an existence of a scenario should be listed as the third necessary requirement for the actual self-organizing move.

Box column 2 : Flexibility of the scenario

The scenario doesn't have to be fixed so tightly. Rather if the scenario put in the drama has more flexibility, the drama can be more excitingly creative by actors (holonic participants).

Once again let me take up music in two different *genre* : classical music and jazz. It is known that the score of jazz is quite flexible compared with that of classical music. So that jazz players very frequently resort to ad lib, which gives the music at least exciting uncertainty. Off course, classical music too do have freedom of performance according to different in-

terpretation of the score mainly initiated by the conductor, so that it must be quite unfair if we classify it as less exciting. What I want to stress here is just a clear difference between two genre music directly caused by the flexibility of the score.

However, it should be also recognized that if scenario for one self-organization is too tightly set, the procedure would more likely oppress the freedom of an holonic participant; a sort of slaving principle[13] would work here.

Anyway, how scenario is set must be understood as a critical factor in deciding the real nature of self-organization.

3. An application of bioholonic self-organization theory to Japanese economic system

Biological or bioholonic self-organization is found in so many cases of what are living. In a sense, it is so essential for living organism that we can find it in every living organism whatever it may be. It is found in the birth of life as Kauffman analyzed, in ontology and in many social phenemena including economic phenomena.

Since it is the principal purpose of the paper to search an applicability of the bioholinic self-organization theory to economic system, I wish to try taking up "Japanese system," a most interested question of my own, and to illustrate it through bioholoic self-organization theory. First I list up all holonic participants which participated in the formation of the system mainly during the time of Japanese successful high growth (approximately two decades from 50s to 70s), giving analysis of mutual relationship (interacted, complementary and entrained relationship) of each of those holonic participants on the other hand. And next I would indicate general feature of the scenario that actually directed the self-organizing process of the growth. Finally I analyze deterioration of Japanese system after 90s and give a brief prospect of probable reform of Japanese system from the standpoint of bioholonic self-organization theory.

(1) Holonic participants of self-organized high economic growth drama

Although most basic holonic participant in the economy is nothing but an

13 The term was first used by Herman Hakken, a German physicist who discovered the principle of lazar beam, to indicate a situation where one beam of a certain wavelength is forced to be aligned to a definite wavelength under a pressure coming down from macro level. In a social self-organization context, I use the term to indicate where individul holonic participant is more or less deprived freedom or flexibity in deciding acutual feature of him (her) self due to too tightly set scenario.

each individual person, now that it is also an human activity, if we focus on phenomenon on macro-economic level, direct participants of the self-organization game are found to be each firm or institutional factors around a firm. Individual person, as an manager, a worker in a firm or a consumer in a market, usually participates in the game from behind. Despite of knowing importance not to forget such living individual's participation, I wish to start with the discussion about institutional aspects directly participating in self-organizing Japanese system through their mutual relationship. Regarding individuals behind , I will take up them later mainly in their interacting relationship with a firm or macro whole.

Institutional factors surrounding workers:

As institutional subsystem participating in self-organizing game of Japanese system, what comes first must be institutions around workers and employees. And among them, what should be taken up first is Japanese peculiar "work way" system usually known as a "team system," not those as life-type employment or seniority order system which are rather supplemental system to the former.

(Grouping system of tasks: team production system) In this system, usually each individual is not given any clearly described individual job manual as in most of western system. In stead, he (she) is expected to have wide and flexible enough skills to be able to cooperate with other employee in diverse conditions. In order to make it possible, employee are first required to have well enough cooperative mind and next trained through rotation system to acquire skills of wider area. And due to peculiarity of the skill requirement more or less specific according to the firm, so-called OJT system of training is favored.

Having those employee as members of an group, grouping system of tasks , or team productions system is organized in most of workshops in a firm. Thus not only cooperative mind to the group became to be essential requirement for all employee as already referred to, but also for leaders and supervisors of firms sociability or "social skill," in stead of "technical skill," becomes a supreme requirement. At the same time, instead of encouragement of competition between individual employee, that of competition between small groups are greatly encouraged by the management.

(Long-term employment system) It would be easily understood why long-term employment system becomes necessary subsystem in Japanese firms, if the job system briefly illustrated above is well comprehended. So as to make employee to acquire wide range of skills through rotation and OJT, the length of career of the employee in a definite company should be long enough to some

extent. Also since style of team working, training system of rotation system can differ according to firm, such requirement for longer service in a definite company would get still longer. Finally possibly longest service, hopefully lifetime long service, may guarantee sufficient commitment and loyalty of an employee to the company, which is helpful for sustaining good enough teamwork and skills more or less specific in the relevant company.

Viewing it from employee side, leaving one company brings about a greater risk, since under this system labor market is more likely to be closed to make once left employee more difficult to find a new job.

Thus no doubt about tight complementary relationship between long-term employment and team production system ; in particular it should be recognized that here the former is a necessary result of the latter and not vice versa. (Seniority order system) Another necessary result of Japanese work-way is seniority order system that covers both wage and promotion. Under the system where wider skills are acquired through OJT and rotation, the length of service may indicate better skills to some extent. And also under OJT system, in particular, the first few years of service rather signifies investment on the employee from management side, so that separation of the employee earlier than before 10 years service can be a loss of the company. It also explains why too short employment is disliked in Japanese system.

Additionally seniority order wage and promotion system can work an effective incentive of an employee who is supposed to work for long in a group system. As well as in the case of long-term employment, the relationship is such that seniority order system is the result or child, not vice versa.

Another important point that should be remarked here is that under these systems, interacting each other tightly or coherently, stability of the relevant company, and a greater possible expansion of it, becomes vital for the company, sometimes even at the sacrifice of short term profit. It is widely known that Japanese business favors stability-oriented or expansive strategy rather than short-term profit ratio. It must be understood here, such Japanese style business strategy also has an intimate relationship with work-way system or employment system. In this sense, subsystems or holonic participants around employee illustrated so far much concerns with other holonic participants described below.

Institutional factors surrounding business:

(Main-bank system) Japanese system is also peculiar in its business related concern. And the core of it is a unique banking system known as the main-bank system, which is a long term relationship between a definite bank and definite non-financial business.

Ways of forming the relationship are many. Whereas basic is exclusive loan, which is usually treated as inferior credit to other consortium loan, such as bond issue service, setting up of settlement account, stock-holding, monitoring of management or information service and others are working as means of long enough relationship mainly initiated by the main-bank. Although it is true that loan activity is most basic, other means becomes more important depending upon the case. For example, despite that setting up of settlement account may look rather trivial, it is highly critical factor enabling the bank to do daily monitoring on the affiliate business, since through watching the account the bank can have well enough comprehension about what is going on around the relevant business.

From the standpoint of non-financial firms having a main-bank, the system has been an effective tool enabling them to seek for continuous expansion through repeated innovative investment on equipment and machines. The system also could guarantee stable sustainability of those firms due to various help given by the main bank under difficult business condition except an extreme case when even the main bank dared to abandon the relevant firm.

(Business grouping) As Aoki and Patrick[14] clarified, the main-bank usually execute "contingent monitoring" on affiliate business which differ according to business conditions of the relevant firm: if it is normal and sound no intervention and if it is shaky or having problems various intervention from supportive intervention to liquidation. So as to execute such intervention, in particular, stock-holding makes a great sense. However under Japanese anti-trust law, it is not allowed for a bank to hold more than 5 % of total stocks of affiliate firm. Group formation through mutual stock holding, in which the main-bank plays main role holding usually greatest percentage stocks among the firms in the same group, is nothing but a supplemental to it: in other words, it enables the main-bank to intervene the business cooperated by other firms in the group, mobilizing great enough percentage of stocks in total. Thus business grouping works as a necessary complementary subsystem of the main-bank system.

Business grouping, however, does have other purpose different from a mere supplemental role to the main-bank system. Most central of them must be defense of the management from probable taken-over or intervention. The total of mutual stock-holdings by member firms of a group differ according to each group. Actually it is from 15% to 25%, and even in the case of the least percentage it is obvious that the management, including the main-bank behind , the sum is more than enough to defend from acquisition of the manage-

14 Masahiko Aoki & Hugh Patrick (1994) "The Japanese Main Bank System—Its relevance for Developing and Transforming Economics "Oxford University Press.

ment by outside business power.

There are several other research proving the reason why, in Japan, business groupings are formed. Nakatani[15] once attributed the main reason to guaranteeing security or stability of the business (in terms of profit), whereas Ren[16] pointed out expansion of debt-capacity as a reason from non-financial business side.

Other holonic participants

There are many other players participating in holonic self-organization of Japanese system. In a sense all institutional factors existing should be considered as those players. Here, however, we would abbreviate most of them, except referring to two other participants that should not be neglected : one is government and the other is each individual person.

(Government) As a market economy, Japanese economy is widely known as highly interventionist one. Industrial policy executed by MITI as well as various financial intervention practiced by MOF are particularly well-known.

Industrial policy covers such as directing industrial targets for manufacturing firms, giving subsidy including various tax exemption or investing on infrastructure and others. In other words, MITI worked as a scenario writer of the self-organization as well as supportive coordinator.

It should be remarked that MITI's intervention was not necessarily successful. In particular, regarding passenger car industry, it is known that their intervention rather worked harmful for it sometimes. However, at least MITI and their industrial policy was indispensable factor in the self-organization of Japanese system.

(Individual person) Although it is not any reductionism thinking, the most basic participation of each individual person in the self-organization should never be overlooked.

In self-organization of Japanese system and its consequently emergent high growth, each individual person participated in it as an individual consumer and a worker (or manager) as well. As a consumer, he (she) participated in mass consumption to support mass production. Seeking for quantity rather than variety or diversity of a commodity was basic purpose of consumption during the period. In addition to it, he (she) contributed in supplying money for investment through well known high-ratio saving. As a worker, he (she) was involved into crazy explosive growth of the time in the framework of group way

15 Iwao Nakatani (1982) "The Economic Role of Financial Cooperate Grouping" in *Masahiko Aoki (ed). The Economic Analysis of Japanese Firm, North Holland Elseivier Science Publisher B.V., Amsterdam.*

16 Yen Ren (2002) "Cooperate Governance under Banks' Initiative—The Theory and an Applied Study to China," Gakubunsha.

job. Hardworking sometime at the sacrifice of individual free life and highly committed cooperation was main feature of the working style of him (her). In a sense, a sort of "slaving principle" was working to each individual. It may not be correct if we say the creativity was entirely sacrificed, because, as observed in well-known TQC activity widely observed in Japanese factories or suggestion system there, creativity in application was encouraged greatly. Just individual break-through freed from group pressure was almost impossible in it.

(2) Given scenario, the explosive self-organization of Japanese system and emergent high growth

Scenario given to the system:

Due to long interval of innovation and destruction during the war-time (1930 to 45), there appeared a tremendous gap of industrial techniques and productivity with the US in particular, which consequently made it an imperative for Japan to perform industrial or technological catching up with advanced countries. Without it, survival of the economy was understood to be almost impossible.

Such imperative of catching up itself was nothing but a scenario given to Japan as direction of postwar economy. And so as to do it, many Japan firms urged repeated investment activities in various manufacturing sectors, first dependent on imported technical know-how mainly from the US and next adding improvement for themselves.[17]

Explosive self-organization and emergent high growth:

What is particularly important, however, is that Japanese system illustrated above became to be proved remarkably adaptable to this kind of scenario.

And exactly because of such high adaptability, an explosive self-organization was called upon directed by this scenario.

First main bank system enabled stable money supply for repeated investment supported by high saving of people at its foundation. Government policy supported it from behind by exempting tax for importing strategic machines, by giving some direct subsidy and by building infrastructure. Also set-up of the

17 Such improvement was not merely that of application skills. Rather a sort of outstrip appeared in many fields of industry as electronic, steel or automobile industry. It is commonly observed that such technical outstrip were done at a turning point of technology, such as turning point from vacuum cube to diode in the case of TV set, usually through team work of engineers much sophisticatedly organized. This type of innovation, which Shintaku classified as architectural innovation as innovation situated in between radical innovation and incremental innovation (Junjiro Shintaku "Competitive Strategy of Japanese Firms" [in Japanese] 1994, Yuhikaku), was found to be much adaptable to Japanese system based on groupism.

target industry by the government helped manufacturing industry indicating where to go safely avoiding risk of miss-investment. Business grouping not only guaranteed stable management but also supported effective activity of main banks. Thus intimately interaction and entrainment between holonic participants went on, resulting in high growth eventually.

Employment related holonic participants are also strengthened in this process. Due to high growth actually leaded by vigorous investment as above, business could seek for growth strategy, in which long-term employment and seniority order system could easily and effectively work out. Thus loyalty and commitment of employee was so much enhanced that Japanese style teamwork functioned quite successfully.

Such wide range of mutual interaction between holonic participants of the system overlapped with another coherent interaction between different industrial development.

For example development of steel industry helped various machinery industry, —industrial machine, electronic machine or transportation machine including cars—, through supplying cheap and high quality materials, and the development of the latter prepared a great market for the former.

Thus a huge scale of interaction networks expanded to exceed a threshold, which brought about an explosion of tremendous self-organization of the system and eventual emergence of high economic growth. The growth was principally emergent result of the explosive self-organization from inside, but, at the same time, was furthermore enhanced by Japanese exporting success itself brought about by strengthened competitive power as the result of successful self-organization.

(3) Deterioration of the system after 90s stagnation

Emergent high growth induced by an explosive self-organization of Japanese system was naturally over when Japanese economy performed a level exceeding "catching up" in the former half of 70. Although the timing happened to coincide with oil-shock, the real reason for the 70s stagnation, at least so far as Japan is concerned, should be mainly understood as a necessary result of accomplishment of the scenario that had leaded the self-organization and the emergent growth, not mere impact of the oil shock.

The economy in 80s, however, showed some extent of growth, thanks to Reaganomics boom that enabled Japanese export expansion to US in the former half, and due to so-called bubble economy mainly triggered by financial deregulation and worsened by unsound increase of real-estate related investment activity.

And from the beginning of 90s when bubble finally collapsed, Japan got

into a long-lasting slump troubled by bad loan accumulation not easily solved.

Above all, the Japanese system, which really worked very effectively during the period of the self-organization and the growth, has been found to be meeting with a deadlock since this time, and many discussion over probable reform of the system became to be spoken widely and repeatedly.

Here I would take up this question, making a brief observation about what is actually occurring regarding the system and prospecting the future of the system for myself.

Deterioration of the system :

The main feature of what is actually going on in Japanese system could be summarized as a deterioration or a gradual down, not yet as any sort of real reform or change, despite of repeated advocatory or exaggerated discussion made by some economists or media.

For example,[18] although a decline of the power of the main banks is apparently observed, the system itself is proved to be still surviving basically. As to business groupings too, the ratio of mutual stock holding, the key tie to connect group firms, diminished from 20-25% level to 10-15% during the decade, which still indicates survival of basic group tie. Despite of assertion by some economics to advocate that direct financing should take over indirect financing more than before, still great majority of saving of ordinary people are gathering around banks as deposit, even under 0 interest rate, not around the market.

Speaking of employment related aspects too, interesting to say, separation rate of employee working in the long-term employment system is, on average, rather diminishing, whereas it is another apparent tendency that management became to rely on contingent workers more than before, at least so far as newly employed are concerned. Although seniority order wage system is changing, mainly due to high wage cost of elderly employee, the system to promote from employee within the company, another aspect of seniority order system, is observed to be still stubbornly surviving.

On the other hand, it should not be overlooked that various efforts of business in adopting new business strategy, so as to adapt to new circumstance are also found to some extent : such as putting more stress by banks on hiring more specialized expertise in the field of dealing activity, expansion of coalition between big business covering them indifferent groupings or more dependence on foreign investors in several big firm like Sony or KDD. Such move, however, is still partial and quite insufficient for drastic change of the system.

18 As to detail empirical background, I put them in my new authored book, "Economics of Self-organization and Emergence" (2001, Springer Verlag Tokyo : Japanese Version), which are abbreviated here.

In a sense, launching for a new system is too risky for a business, so that basic conservatism combined with very careful trial and error for new way seems to be forming the core strategy of present business. These are quite understandable, but under such situation, economic stagnation for the time being must be unavoidable, since adaptability of the system has already been lost, to some extent, in a new circumstance.

Prospect of a new system :

As known, new Koizumi cabinet is repeatedly speaking out about the reform of Japanese system. I admit that they can tackle with solving bad loan problem, or maybe they can play an important role in squeezing down traditional intervenient policy means , partly through abolishing various half government sponsored facilities.

However, a new system should be again self-organized from the bottom in a different way. In other words, it is nothing but a contradiction to organize self-organization by the power of the government.

Taking it into consideration and observing stubborn conservatism of acting business, I can hardly be optimistic in seeing remarkable emergence of new system in near future particularly with regard macro level economy.

On the other hand, from the standpoint of bioholonics, now that I believe in survivability of human lives, I also hold fundamental optimism about the possibility of new self-organization of a new system.

In general, I see relative inflexibility of organism in the core of typical old system. So that I see a greater possibility of a birth of new system in more periphery area of the economic society. Any how, I see such possibility at more micro level (say new self-organization of a new type of business that are not found in the old system). Also I consider such a new enterprise should be not only novel, but also the one taking over good tradition of Japanese business (for example such as intimate cooperation). May be a sprout of them detected already at some part of the economy. A new macro level self-organization of a new system will come out as the result of accumulation of such micro level creation. But it may take more years to reach at it, until when it seems relatively longer stagnation may be unavoidable: a period of "Japan disease"?

4. Several remarks on applicability of the theory to transitional economy

Although another starting point of me in getting interested in the new theoretical paradigm was a search for theoretical tool to analyze transitional economy as referred in the introduction, yet at present I am not ready to develop meaningful analysis of it through self-organization theory. However,

mainly for the sake of future task of my own, I would give some preliminary remarks about applicability of the theory for such analytical purpose.

The first remark given here concerns with an applicability of the theory to Russian transitional economy.

As known well, during a decade of transition main feature of Russian transitional was somehow that of confusion. There have been pointed out various reasons to explain it. I myself once developed a discussion[19] to attribute the confusion to the failure of shock-therapy, not shock therapy itself as insisted by some of other analysts. What I insisted was : although they tried to introduce a type of shock-therapy like policy, they eventually brought about an awful hyper inflation, since they didn't stopped traditional soft budget problem under liberalization of commodity price. My point was to stress critical partiality of the policy as a main cause for the confusion afterwards, and, from such standpoint, to oppose against widely prevailing wrong discussion around that time, particularly in Japan, to attribute the main cause of the confusion to shock therapy itself.

It is not my intention to repeat this argument here again. On the contrary, I would point out another aspect of which I myself was not well aware then.

That concerns with essential duality of Russian economy that they have taken over from their *"ancien regime."* In other words, Russian economy has outstanding peculiarity in having duality in its self-organization ; one is more official economy being observed through official statistics and the other is so-called underground economy. Such duality is known as having existed widely in Russia in the time of central planned economy. However, what should not be overlooked is that the duality is still surviving in the economy even after transition perhaps partly due to economic confusion.

From the standpoint of bioholonics or self-organization theory, it means that there exist self-organized economies in two-fold, so that we can hardly speak about real Russian economy only through taking up official one. Put it differently, it should be born in mind that there must be another economic energy hidden behind, so that we need to seek for what sort of self-organization mechanism is working there. But so as to analyze it, we need to have detail facts about underground economy, which is tremendously difficult for its own nature. So except just putting forth the question itself, I have to confess here I cannot go further now.

Polish transitional economy could be well contrasted with Russian case, in the respect that it made relative success apparently triggered by bold introduction of shock therapy. Balanced combination of both price liberalization

19 Kenji Tominomori (1993) "Late Awakening for the Market Economy—Case Studies of Russia and Poland" (in Japanese) Shakaishisousha.

and hard budget caused some extent of setback of living in the beginning, which, however, eventually brought about stability of macro economy in which privatization too could be safely or successfully executed.

In this process, new self-organization of the economy entirely different from old central planed organization went on. It might have proceeded not only in domestic market but also in the field of international trading. With regard to the latter, in particular, the change from forced trading, both in terms of traded commodity and partner countries, to free trading with EU countries, mainly with Germany, must be especially remarked. Whereas former forced organization was somehow distorted one from the standpoint of bioholonics, the new tide of free trading indicates nothing but a natural participation of Poland in real spontaneous self-organism of the trade economy.

So that it turns to be critically important to research the real nature of trade relationship of Poland with EU countries : questions such as how much they are interacted with each other or in what field they are getting entrained. By gaining sufficient idea about them, it may be possible to forecast future of Polish, as well as German economy to some extent. For example, if the self-organization is giving novel and strong impetus that has not worked before, to technically high level division of labor between two sides, it may be particularly significant.

However, I don't have sufficient empirical facts to analyze the point right now. Just I would remain the question too as one subject of my own study in future.

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