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# Self-Organization of a New Economic Order — Based on the East Asian Quadrangle<sup>1)</sup> —

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Chinese foreign trade has increased explosively in the recent decade. Although based primarily on China's own radical trade opening policy, such trade would be impossible without organic relationships with other countries. Increasing FDI flows, a bilateral upsurge of trade with Japan and Korea in close technological relationships, and relatively unilateral relationships with the U.S. and EU as absorbers of Chinese goods were especially important in this concern. A second aspect that deserves notice is the reciprocal excitement relationships among those elements that have developed spirally. Such dynamics of spiral development in reciprocal excitement relationships with an emergent result cannot be explained adequately either by ordinary international economics or linkage theory. "Biological self-organization theory" may be useful in explaining such dynamics. The paper first depicts the emergence of the new international trade order, and then attempts an experimental analysis to explain its dynamics using "biological self-organization" theory.

*JEL Classification Numbers:* F02, F14

*Key Words:* Trade, International Economics, World Trade, FDI

## 1. Emergence of a Chinese-Initiated Trading Order

There may be no more conspicuous development in recent world trade than the Chinese exporting explosion. Not only is it felt in the daily lives of people in most advanced countries, is it also realized in various official statistics.

For example, according to DOT statistics from the IMF, which are summarized in Fig. 1 below, China (including both the mainland and Hong Kong) achieved the most consistent and largest expansion of exports during the recent decade (an increase of 2.5 times during the period between 1994 and 2003). Although both the U.S. and the EU<sup>2)</sup> attained a certain degree of export growth in the first half of the decade (presumably based on the IT boom), in the latter half of the decade this export growth stagnated.

Japan, the well-known mercantilist, experienced relative stagnation of its

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<sup>1)</sup>The paper is a performance attained from the collaboration with Prof. Ren Yun of Obirin university, so that the author greatly owes to him, although the author assume whole responsibility for the paper.

<sup>2)</sup>With regard to representative EU countries (France, Germany, Italy, Netherlands and the UK), export trade expanded 44% during 1993-97, but the ratio declined to 6.5% during the 1997-2002.

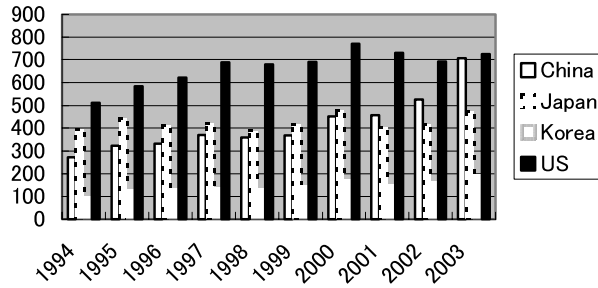


Figure 1. Exporting of various countries (billion dollars)

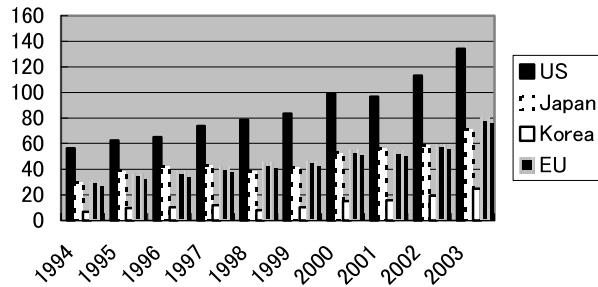


Figure 2. Chinese exporting toward various countries (billion dollars)

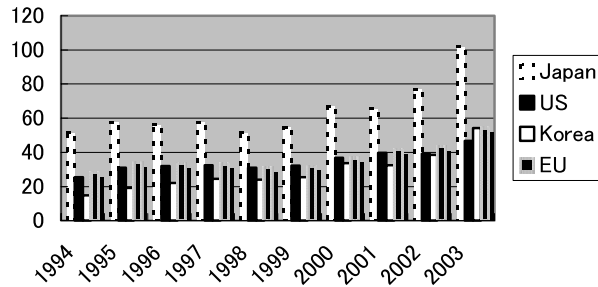


Figure 3. Exporting of various countries to China (billion dollar)

Source: DOT by IMF. Here China include both mainland and Hong Kong, and the total amount of France, Germany, Italy, Netherlands and UK represent EU.

export trade during the decade and by the end of this period had finally been surpassed by China. Korea showed steady growth, although in terms of the absolute amount this was not as large as the volume in other countries.

In addition, Fig. 2 reveals the U.S. has played a conspicuous role as an absorber of Chinese exports, both in terms of absolute value and increasing percentage. The EU and Japan also have played a similar role, albeit to a little smaller degree. Although Korea also has expanded its imports from China remarkably, its role as an absorber is still not so great.

If we combine the findings from Fig. 2 with those shown in Fig. 3, the following important points are also revealed.

- ① With regard to the relationship with the U.S. and the EU, the other side

of the trade flows (that is, Chinese importing) is not as large as the Chinese exporting shown in Fig. 2. This means the trade flows have brought about substantial trade deficits on both the U.S. and EU sides. Therefore so far as trade between China and the U.S. or the EU is concerned, we can state there was a more or less unilateral relationship. In other words, a technologically-related reciprocal evoking relationship cannot be discerned here.

- ② Japanese exporting to China not only has increased remarkably in parallel with its importing from China, but has also brought about a trade surplus on the Japanese side that is entirely different from the case of the U.S. and the EU.<sup>3)</sup> A similar phenomenon is also found in Korean trading with China.

Even from these simple findings taken from general trade statistics, we can now sketch out a broad picture of what has happened in recent international trade.

China occupies the central part of the picture, mainly through its enormous expansion of export trade. Other countries played their roles to help Chinese export expansion, each in a different way.

Areas such as U.S. or the EU played roles as absorbers of Chinese goods; Japan or Korea seem to have fulfilled another role.

Thus the whole picture could be summarized as “**an emergence of a new trading order initiated by China and based on an East Asian sub-order**”.

What must be addressed next are the issues of how this order has been formed, and the nature of the sub-order. We will first address the latter question in the following section, and then analyze the issue raised by the former question.

## 2. Reciprocal Evoking Relationships that are Technologically Interwoven between China and Japan or Korea

Unlike the unilateral characteristic noted in the trade relationship between China and the U.S. or the EU, a more parallel and apparently bilateral relationship is found between China and Japan or Korea. We presume from this relationship there must be some type of reciprocal, complementary relationship between the relevant countries that is in some manner organic. For this reason we have dared to refer to this relationship by using the expression “East Asian sub-order”.

Through a more detailed observation of the facts it is easily found that among Chinese export goods, the most growth has been in manufacturing

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<sup>3)</sup>Occasionally a misleading understanding about Japan's trade deficit with China has been reported. This misunderstanding is caused mainly by the exclusion of Japanese trade with HK from the statistics. Such trade is mostly intermediary trade through HK between mainland China and Japan, which should be included in the trade between Japan and China.

goods, in particular electric and electronic goods or other processed machinery, whereas trade statistics from Japan's Ministry of Finance clarify the fastest growing imports from Japan recently were generally high tech-oriented supplies of components for production in China of the items indicated above. In other words, trade flows between the two countries are found to have a deep, technologically interwoven relationship. And precisely from this relationship we can say there must have been a reciprocal, evoking relationship between China and Japan. For example, as Chinese computer production increased, it naturally expanded China's demand for printed circuits, an indispensable component, which evoked the import of high-quality, reasonably-priced Japanese-made printed circuits that enabled the further development of computer production. Thus there has developed a typical reciprocal, evoking (or exciting) relationship. We surmise such relationships have not only developed between two single goods, but also have developed as a nexus of such relationships. This is the reason we attempt to apply "biological self-organization theory" to this development, as we discuss below. For the moment, however, we would like confine our discussion to verifying the various technologically interwoven developments between various Chinese exports to Japan and the reverse trade flows of components from the Japanese side.

The following analyses are based on international trade statistics supplied by Japan's Ministry of Finance, which indicate trade flows of each commodity for each country (or area). The commodity classification is given here using the four-digit Harmonized System Number; flow amounts are based on a unit of one billion U.S. dollars. In each table, the left-hand column indicates Chinese exporting to Japan, and the other columns indicate Japanese exporting to China. We can now show the relationship of the trade flows between the two countries with regard to goods presumed to have a close, technologically complementary relationship.

- (1) Such a technologically complementary relationship apparently exists between computers (8471) and integrated circuits (8542) or printed circuits (8534). Table 1.1 indicates trade flows of Chinese exports of 8471 (computers) and Japanese exports of 8542 (IC) and 8534 (printed circuits) during the decade 1994-2003. We find not only that all relevant flows has increased enormously (by 10 times, 4 times and 8 times, respectively), but also that the simple correlation coefficients between them are reasonably high (0.9662 between 8471 and 8542, 0.8901 between 8471 and 8534).
- (2) As another technologically related case we checked the relationship between Chinese exporting flows of 8529 (parts for transmission apparatus, radar or reception apparatus for TV) and Japanese exporting of 8525 (transmission apparatus), 8534 (printed circuits) and 8542 (IC). This relationship is shown in Table 1.2. Again we found that all trade flows showed a conspicuous increase (14 times, 3.4 times, 8 times and 4.5 times, respectively), and the correlation coefficients are high (0.9766, 0.9465 and 0.9476 for 8529 and 8525, 8534, 8542, respectively).

Table 1. Commodity trade between China and Japan

	8471c	8542j	8534j
1994	7.6	217	11.5
1995	24.7	272	17.1
1996	48.9	287	23.7
1997	59.7	383	31
1998	51.1	355	38.1
1999	60.5	396	40.8
2000	121	539	61.3
2001	228	543	66.4
2002	494	761	79.1
2003	766	981	94.4

	8529c	8525j	8534j	8542j
1994	11.3	54	11.5	217
1995	17.5	49.7	17.1	272
1996	29	47.7	23.7	288
1997	32	46.2	31	383
1998	28.7	49.3	38.1	355
1999	29.3	48.9	40.8	396
2000	58.5	87.7	61.3	539
2001	118.8	121.1	66.4	543
2002	122	153.5	79.1	762
2003	162.4	195.2	94.4	981

	8528c	8529j	8534j	8542j
1994	4.6	11.3	11.5	21.7
1995	10.9	17.5	17.1	27.2
1996	17	29	23.7	28.8
1997	21.7	32	31	38.3
1998	32.8	28.7	38.1	35.5
1999	37.5	29.3	40.8	39.6
2000	46.7	58.5	61.3	53.9
2001	79.7	118.8	66.4	54.3
2002	81.2	122	79.1	76.2
2003	77.6	277	94.4	98.1

	Chinese automobile production	8708j
1994	22316	138
1995	24523	145
1996	33174	150
1997	35040	155
1998	32833	160
1999	33957	180
2000	57693	200
2001	90553	220
2002	108629	320
2003	206723	450

Source: Japan Ministry of Finance, China National Statistic Bureau.

Unit: one billion dollars, except the left line of T.1.4 (where the amounts are given in terms of physical numbers of products).

Numbers are 4 digit harmonized system number.

c and j at the end of HS number each stands for Chinese export to Japan and Japanese export to China.

- (3) A similar relationship is found between Chinese exporting flows of 8528 (reception apparatus for TV, video recorder) and Japanese exporting flows of 8529, 8534 and 8542 (Table 1.3), which are conceived to have a close, technologically complementary relationship. The trade flows increased 17 times, 24 times, 8 times and 4.5 times, respectively, during the decade, and the correlation coefficients are 0.8628, 0.9575 and 0.8846 for 8528 and 8529, 8534, 8542, respectively.
- (4) Chinese production of automobiles and Japanese exporting of automobile parts also has a similar technologically complementary relationship. Both items increased outstandingly (Table 1.4), particularly in the latter half of the decade (6 times and 2.5 times respectively), with a high correlation coefficient (0.9833 for the decade as a whole).
- (5) Since it is known that IC (8542) are used in the production of computers (8471) and TV reception apparatus (8528), we attempted several multiple regression analyses by designating the former (exports of 8542 from Japan to China) as a dependent variable and the latter two catego-

ries (Chinese exports of 8471 and 8528 to Japan) as independent variables. The result (Appendix 1) is satisfactory, with high  $t$  values and significance levels.

- (6) A similar relationship exists between printed circuits (8534) and production of computers (8471) as well as TV reception apparatus (8528). We performed a similar multiple regression for these as well, designating the former Japanese exports to China as a dependent variable and the two Chinese exports to Japan as independent variables. This result was also acceptable (Appendix 2).

We must note here the existence of such high correlations between the time series change of two variables indicating interaction of trade flows, as noted in (1) to (4) above, does not directly signify a real, active mutual evoking relationship between the trade flows. It is at best circumstantial evidence. The multiple regressions described in (5) or (6) seem to give us stronger evidence for the hypothesis the recent upsurge of Japanese IC or printed circuit exports to China has been evoked by the increase in production and exporting of Chinese computers and TV reception apparatus. Still, this does not supply perfect evidence of such a “reciprocal evoking (or exciting) relationship.” Indeed, there is no analytical tool to prove such a relationship directly. If we have enough understanding about the indispensable technological relationships between various products as taken up so far, however, the accumulation of “circumstantial evidence” as mentioned above could, we believe, be sufficient to argue the reason there has been an explosive upsurge of trade flows between two countries is the existence of mutual complementary and evoking relationships of related trading goods.

### 3. FDI and Chinese Exports

#### (a) *China's FDI-assisted export upsurge*

Another very important fact lying behind China's remarkable export increase is the conspicuous role played by foreign direct investment (FDI) - related business in enhancing Chinese exporting, particularly in the electric or electronic industries that are more or less high tech-based.

Various official statistics clarify the following points;

First, Table 2 prepared from Chinese Statistical Yearbook data illustrates the basic fact that much of the recent increase of Chinese exports has been dependent on FDI business.

It is also reported that the fastest growing industrial sectors among China's exports have been the machinery and electric-electronic industries, which are among the industries with the largest share of FDI business.<sup>4)</sup>

<sup>4)</sup>According to Figure 1 in “Tokyo-Mitsubishi Review” (2003, issue No. 9), the machinery and electric-electronic fields have consecutively shown the largest export growth in a three-month moving average graph during the period 1998-2003, with the exception of a turning point around

Table 2. Share of FDI business in Chinese export

Year	%
1988	5.2
1989	9.4
1990	12.6
1991	16.8
1992	20.4
1993	25.8
1994	28.7
1995	31.5
1996	40.8
1997	38.8
1998	44.1
1999	45.5
2000	47.9
2001	50.1
2002	51.5

Source: Chinese Statistical Yearbook.

The next question is which kind of FDI has played the primary role.

According to the official statistics shown in Table 3, the major investors have been Hong Kong, the Virgin Islands, the U.S. and Japan. Taiwan ranks only fifth or sixth among the largest investors. For unresolved political reasons,<sup>5)</sup> however, real Taiwanese FDI in mainland China is understood to include so-called roundabout investment via Hong Kong or the Virgin Islands (a tax haven). It is not easy to make a precise assessment about how much of the HK or Virgin Island FDI is roundabout investment from Taiwan. Still, it could be safely said that total Taiwan-related FDI must be the largest if we add this roundabout investment.<sup>6)</sup>

*(b) Propensity of Taiwanese FDI in China to be in IT-related industries*

What should be remarked particularly with regard to Taiwanese FDI in China is its strong propensity to be in IT-related industries, and the sharp up-turn evident around 1997.

At the beginning of 1990, Taiwan IT-related FDI in mainland China was only at the 30 million dollar level. This increased to the 400 to 500 million dol-

2000. Professor Fukao (2003, p. 95) also gives us another table indicating the share of FDI business in Chinese industries, in which electronic and communication equipment shows the highest figure (65.4%).

<sup>5)</sup>Despite long-lasting political tension existing between the mainland and Taiwan, a gradual relaxation began in 1987 when the Taiwanese government first liberalized private remittances of money abroad within a limit of \$ 500, which was further enhanced by liberalization of direct investment via third-party nations. Due to the so-called "Look to the South" policy taken by the Taiwanese government, however, which feared sudden economic access to the mainland, regulatory policy on FDI, even after 1987, still remained in place to some extent.

<sup>6)</sup>An estimation given by reliable observers (Kawashima and Nonaka, 2003, p. 53) indicates the actual share of Taiwan in total FDI must be somewhere between 30~40%.

lar level in 1993, and stagnated again for a while thereafter. Such investment experienced another explosive upsurge in 1997, however, climbing to the 875 million dollar level, and accounted for 37.3% and 42.9% of total Taiwanese FDI in China in 1998 and 1999, respectively. Again in 2000 and 2001 such FDI showed another sharp upturn and reached 1.46 and 1.25 billion dollars, respectively, thus accounting for about 50% of all Taiwanese FDI in China.<sup>7)</sup> Thus the period 1997-1999 can be understood as a critical turning point with regard to the increase in Taiwanese IT-related FDI.

It should also be noticed the conspicuous upsurge of Taiwanese FDI in China inevitably brought about a so-called hollowing-out of Taiwanese industries. This phenomenon looks to be particularly large in the information technology sector, as shown in a data supplied by Taiwanese government. This data indicates that in most areas of the IT industry, production in mainland China already exceeded the 60% level in 2002, except in the case of final products such as notebook computers, where Taiwan domestic production was still at the 70% level.<sup>8)</sup>

*(c) Results of increased Taiwanese FDI in China*

The conspicuous increase of general Taiwanese FDI in China has naturally produced several important results.

First, it generated a remarkable export flow from Taiwan to China.

It is reported that Taiwanese exports to China increased 3.8 times during the decade 1991-2000, whereas total Taiwanese exports increased 2.2 times during the same period. The former increase was outstandingly higher than the increase of Taiwanese exports to the U.S. (approximately 60%) or Japan (approximately 50%) during the decade. Furthermore, the degree of Taiwanese export trading linkage to Hong Kong increased even more during the decade, by more than 7.0 times, even though the figure was already high (6.00) in 1991.

It is naturally understood that the shift of production plants to mainland China induced a flow of components or materials from Taiwan to mainland China, which must be the primary explanation for this matter. An official statistic of the Chinese government (China Ministry of Commerce Statistics, 2003), for example, indicates China's IT-related imports from Taiwan were 15.3% of total Chinese imports of this kind, the third highest after Japan (18.08%) and ASEAN (17.09%). The ratio confined to FDI business was also reported to be 17.18%, second only to Japan (21.13%).

The second important result of the increase in Taiwanese FDI in China is the general upsurge of Chinese exporting to the world. It is also widely known the main contributor to such a remarkable increase of Chinese exporting has been the increase of FDI, of which Taiwan accounts for the greatest share – nearly 40% as already described. In particular, Taiwanese IT-related FDI in mainland China has actually contributed greatly to the total upsurge of do-

<sup>7)</sup>Mukoyama (2002), p. 57

<sup>8)</sup>Even as to notebook computer, it is observed to move to Mainland after 2003.

Table 3. Mainland Chinese acceptance of FDI from various areas (Million dollars)

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Japan	1,324	2,075	3,108	3,679	4,326	3,400	2,973	2,916	4,348	4,190
HongKong	17,274	509	20,060	20,677	20,632	18,508	16,363	15,500	16,717	17,861
Taiwan	3,131	3,391	3,162	3,475	3,289	2,915	2,599	2,296	2,980	3,971
Korea	374	722	1,043	1,357	2,142	1,803	1,274	1,490	2,152	2,721
Singapore	490	1,180	1,851	2,243	2,606	3,404	2,642	2,172	2,144	2,337
Thailand	233	235	288	323	194	205	148	204	194	188
Germany	56	259	386	518	993	737	1,373	1,041	1,213	928
France	141	192	287	424	475	715	884	853	532	576
UK	220	689	914	1,300	1,858	1,175	1,044	1,164	1,052	896
US	2,063	2,491	3,083	3,443	3,239	3,898	4,216	4,384	4,413	5,424
Virgin Is	14	128	304	538	1,717	4,031	2,673	3,833	5,042	6,117
Others	2,193	21,894	3,034	3,746	3,785	4,670	4,128	4,861	6,091	7,535
Total	27,515	33,767	37,520	41,726	45,257	45,463	40,119	40,715	46,878	52,743

Source: Yearbook of Chinese foreign economic relations and Trade (1992-2003).

mestic production in mainland China's IT industry, which ranked fifth in the world in IT production in 1998, advanced to fourth place in 1999, third place in 2000 and finally to number two behind the U.S. in 2002. It is also reported that 56% of mainland China's IT production is that of Taiwanese businesses.<sup>9)</sup> If we confine the matter only to Taiwan's IT-related FDI and mainland China's computer-related domestic production, we find a strong meaningful relationship between them as explained below.

The basic data are given in Table 4, where  $X$  is the stock amount of Taiwanese IT-related FDI in China and  $Y$  is Chinese domestic production of computers and related commodities. We used these data to perform a simple regression equation analysis (Appendix 3).

The results are so satisfactory that we can conclude Taiwanese IT-related FDI undoubtedly contributed Chinese domestic production of computers.

Two other remarkable points in particular should be addressed here.

One is that Chinese exporting to Taiwan is not as great as opposite commodity flows. Mukoyama<sup>10)</sup> reported that Taiwanese imports from China were only a quarter of its exports to China. As Mukoyama describes, one reason is presumed to be remaining Taiwanese government regulations. This phenomenon is also understood, however, to reflect the strategy of Taiwan businesses to earn as much profit as possible just through expansion of Taiwan-origin Chinese business.

The other remarkable point is that although Taiwanese FDI attracted Taiwanese exports to China (mainly components or materials) as mentioned, it seems to have attracted an even greater commodity flow from Japan, which also is composed mainly of high-tech materials as already described above. Mukoyama presented another report, stating that in China's machinery indus-

<sup>9)</sup>Zhang (2003), p. 1

<sup>10)</sup>Mukoyama (2002), p. 60

Table 4. Taiwanese IT related FDI in Mainland China and computer production of Mainland China

	Y	X
1993	1735	445.01
1994	3343	602.02
1995	5299	816.82
1996	7829	1093.68
1997	11426	1968.72
1998	14196	2727.66
1999	18455	3265.42
2000	25535	4730.2
2001	28174	5985.03
2002	35225	8603.72

Here X is the stock amount of Taiwanese IT-related investment in Mainland China, whereas Y is Mainland Chinese domestic production of computers and related commodities (million dollars)

Sources : Chinese Ministry of Information Industry (1993-1997) Zhang (2003), and Cheng (2003).

try, more than 4% of materials and parts were imported from Japan in 1995 whereas the percentage from Taiwan was less than 0.3% in the same year, which suggests one aspect of the matter.<sup>11)</sup>

In any event, the fact Taiwanese FDI in China excited a China-Japan relationship more than a Taiwan-China relationship is really enlightening, in the sense it points to a vital part of the self-organization of a new international economic order as analyzed below.

#### 4. Summarizing the Process

So far we have described the emergence of a Chinese-centered new international economic order in the recent decade, by dividing it into several different aspects and not necessarily following the real time order. Now let us summarize this new order by depicting an entire picture of the process according to the actual time sequence.

At the very beginning of the process there appeared a remarkable upward tide of FDI in the Chinese market. Table 3 indicates a leap in the trend emerging in the mid-1990s (1995-96), in particular with regard to FDI by Taiwan (including roundabout investment via HK or the Virgin Islands). It is apparent that nothing but this tide triggered the entire process that followed.<sup>12)</sup>

Far more than actually expected, FDI in China greatly stimulated a successful expansion of Chinese production and exporting. In terms of exporting target markets, the U.S. (as well as the EU on a slightly smaller scale) has

<sup>11)</sup> Mukoyama (2002), p. 63

<sup>12)</sup> Another important question concerns what initiated the tide of FDI. At present we believe a certain maturity of China's market economy and the realistic prospect of China's entry into the WTO basically initiated the tide.

played an outstanding role as an absorber of Chinese goods. In terms of goods categories, machinery has played a vital role, particularly electric and electronic machinery.

China's trade relationship with the U.S. or EU has been a relatively unilateral one, however, with the latter regions playing mainly a large role as export absorbers. Their relationships with Japan (and Korea in a smaller scale) have been entirely different in this respect. The enormous upsurge of Chinese production and exporting evoked another huge flow of commodity imports from Japan (and Korea), composed mainly of high tech-based intermediate goods indispensable for the production of goods such as electric and electronic products. Such conditions enabled Chinese manufacturing to benefit from a continuous supply of the necessary intermediate goods for a further production upsurge, in turn stimulating yet another increase in importing of these intermediate goods from Japan.

Here a typical reciprocal exciting relationship is found between Taiwanese FDI, Chinese manufacturing and Japanese (or Korean) suppliers. Each side, participating in the emergent process from a different direction, has given feedback or feed-forward effects to the relevant partners and thus self-organized a new emergent (or explosive) international economic order as a whole. According to our view, the phenomenon seems to be forming a typical social scientific example of the "biological type self-organization" mainly advocated by the prominent natural scientist Stuart Kauffman, offering us a valuable suggestion about the possibility of applying self-organization theory in economics. We discuss such an application in the final section of the paper.

## 5. Biological Self-Organization Theory and Its Application to the Present Case

In this section, we attempt to illustrate the extent to which the present case of the emergence of a new international economic order centered on China (or the East Asian Quadrangle) is becoming a typical example of biological type self-organization.<sup>13)</sup>

We first give a general definition of the biological self-organization concept, basically drawing on the ideas developed by Stuart Kauffman in his representative work, "At Home in the Universe" (1995), and additionally making use of other concepts such as "holon" (or holonic) based on Koestler (1967) or "scenario" based on H. Shimizu (1999). Next we show how well this thinking can be applied to the emergence of the new economic order we have outlined above, indicating at the same time how the theory is superior to other thinking such as "feedback or feed-forward linkage" or "cumulative causation" in explaining the present case.

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<sup>13)</sup> Here we use such expressions as "biological self-organization" to distinguish the concept from another type of self-organization thinking advocated by economists such as Paul Krugman, where the homogeneity of each participant, which by its nature denies "life process", is assumed from the beginning of the theory.

(General definition of the biological self-organization theory)

Biological self-organization could generally be defined “as a process in which holonic participants at the micro-level form an interacting web network by way of mutual interaction or reciprocal excitement guided by a certain scenario, eventually bringing about an emergent result at the macro level”. The emergent result at the macro level comes out when this interacting network at the micro level exceeds a certain critical point (or threshold). The result usually goes beyond mere linear addition of the holonic participants’ actions.<sup>14)</sup>

Crucial here is the complex nature of each holonic participant as a life process; that is, it has spontaneity, diversity, and changeability. In other words, a holonic participant takes part in self-organization spontaneously, gifted with diversified potentialities from which certain selected aspects emerge according to the changing dynamics of the self-organization process. Thus changeability forms another necessary element of a holonic participant. Due to such independent and spontaneous nature of a life process, a holonic participant also keeps some degree of robustness that cannot be easily destroyed by other holonic participants. It does not mean, however, such independence or robustness could be entirely absolute. As Arthur Koestler once clarified when he defined “holon”, it has “both the autonomous properties of wholes and the dependent properties of the parts”.<sup>15)</sup> That is to say, even though sustaining its own spontaneity and relatively robust independence on one hand, every holonic participant can only survive in organic relational order with other participants as well as with the macro self-organizing whole.

It is only in this relational order that holonic participants form a web network of reciprocal excitement relations among themselves or between each participant and the macro whole. Definite aspects of their diversified potentialities actually come to the surface just as a result of actual process of such reciprocal excitement.

Exactly how actual self-organization will develop remains uncertain, however, because each holonic participant represents numerous diversified possibilities and there are multiple probable interaction networks among holonic participants. The process could be compared to a simultaneous equation that is inappropriately set up, with a greater number of variables than the number

<sup>14)</sup>With regard to the detailed process of self-organization through accelerated reciprocal excitement among holonic participants, Shimizu has given an enlightening illustration as follows:

Each “holonic participant” (“KANKEISHI” in his original description) has sensors to accept signals from other participants. Whenever a participant receives a weak signal, it shows a weak excitement at first, although it is still uncertain whether the excitement is sustainable. However even at this stage the weak response, now that it is an excitement, may transmit another signal from itself to the partner; thus the excitement relationship is, from its beginning, a reciprocal one. And once a significant and stronger relational order is found somehow between them, the reciprocal excitement may strengthen to reach a threshold point, bringing about an emergent self-organization. (Shimizu, 1999, pp. 84-85; translation by the author).

<sup>15)</sup>Koestler (1967) p. 383

in the equation. Just as some other restraints must be added to an inappropriate simultaneous equation to generate solutions, some other direction, which we call a “scenario,” must be added to actual self-organization here. How such a scenario is given may differ according to each case. The scenario would be given with much flexibility in some cases. In other cases, the scenario may be tightly fixed. It is also conceivable such difference may greatly affect the characteristics of the relevant self-organizing dynamics.

The final important point with regard to a biological self-organization is the emergent result at the macro level. As easily imagined by such expressions as “emergence”, the critical essence of the macro result lies in its nature as a “leap” or geometric series that is something beyond a mere linear addition of the holonic participants’ actions, as mentioned previously. The degree of the leap—in other words, how explosive the emergent result will be—may differ according to the case. Any self-organized result itself, however, should be comprehended as a life process. It is conceived to be a life process at higher dimension with higher level of spontaneity, changeability and independent robustness.

As is known well, Stuart Kauffman, the originator of the theory, has shown the dramatic birth of the life as the most typical example of biological self-organization.

According to Kauffman, life was created as an emerging result of self-organization of diverse pre-biotic molecules. First, under certain circumstances that cannot yet be explained satisfactorily, diverse molecules on earth gathered and executed various interactions among themselves, and when the web of such interactions exceeded some critical point certain surprising qualities emerged, gifted with the ability to metabolize, reproduce, or in other words self-catalyze, merely as a result of the self-organization among interacting molecules. The first life with a singular cell was born in such way.<sup>16)</sup>

Kauffman also developed a far more fascinating story about the birth of multi-cellular life in the “Pre-Cambrian Explosion”, in which various multi-cellular life-forms appeared explosively on earth 500 millions years ago, as a result of a condition when “principles of self-organization mingle with chance and necessity”,<sup>17)</sup> this time through participation by diversified single-celled life-forms.

(Application of the theory to the emergence of the East Asian Quadrangle-centered economic order)

Kauffman and Hiroshi Shimizu themselves eagerly advocated their readers including the author apply their theories to social science, including economics.

Indeed, attempts of the author to apply Kauffman’s and Shimizu’s theories to several economic situations, including formation of the “Japanese system”<sup>18)</sup> or the explosive IT-related boom in the U.S. economy in the late

<sup>16)</sup> Kauffman (1955), pp. 3-30.

<sup>17)</sup> Kauffman (1955), pp. 12-13.

<sup>18)</sup> Tominomori (2002).

1990s,<sup>19)</sup> were ultimately the result of such suggestions.

We are convinced biological self-organization theory can be applied suitably to the present case of the emergence of a new economic order we have discussed so far.

Here, the holonic participants of self-organization are the relevant investing and exporting sectors that have shown remarkable growth in recent years within the East Asian Quadrangle area.

First, after forecasting further promising market developments after China's entry into the WTO, various Taiwanese investors attempted direct or indirect FDI in the mainland Chinese market. Some industries into which this investment flowed, and electronics industries in particular, have been especially successful because Chinese production in these areas, combined with mainland China's low-cost and pretty skillful labor, resulted in an unexpected upsurge in exporting to the U.S. or EU markets, which eventually evoked another enormous upsurge of Japanese intermediary goods exporting to China. The latter trade flows not only enabled further development of the relevant Chinese industries, they also awakened the relatively stagnant Japanese (or Korean) high-tech industries and determined the direction of development of all related sectors in these areas.

Here what is realized is a typical biological self-organization process, letting each industrial sector in these regions a "holonic participant" in the process. Each sector in these regions could potentially embrace various development possibilities. In that sense, each holonic participant had initially maintained diversity and changeability. Only definite directions of development that were supported by reciprocal complementary and reciprocal excitement relationships among the relevant players (holonic participants in our terminology), however, could be actualized. Exactly because of such reciprocal excitement relationships, there appeared an enormous upsurge of development in all related sectors.

The next questions that must be asked, then, are what was the guiding scenario and when did the threshold (critical point) of the self-organization appear.

Because China initiated her policy of economic reform and opening to the rest of the world from 1978 under the strong leadership of Deng Xiaoping, and the first stage of this policy—in which mainly development of township enterprises played a key role in the process and FDI business expanded—was drawing to a close at the start of the 1990s, it might be natural to consider the leading scenario of the self-organization to be the second stage of China's reform and opening policy. A more thorough search for a market economy apparently represented the core element of the second stage, which was taken over by the decision to enter the WTO in the latter half of the 1990s. In other words, China's policy to enhance industrialization, through further opening both her commodity and capital markets to the outside, was doubtlessly the key element of the scenario.

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<sup>19)</sup>Tominomori (2001).

We understand the critical point of the self-organization to have been around 1998-99, because in each set of data we have used (Fig. 1, Fig. 2, Fig. 3 and Table 2) we find a turning point emerging in a leap after temporary stagnation. To state the case in a slightly different way, we observe that in the first half of the decade (1994-97) the process advanced rather slowly to a threshold around 1998, which brought about an explosion afterwards, although it may not be easy to give a direct proof of the threshold point mathematically.<sup>20)</sup>

One criticism against our argument attempting to apply biological self-organization theory to the recent explosive emergence of a new international economic order centered on China (or the East Asian Quadrangle) might be to assert there are already tools in established economics to explain such a process. So-called “backward linkage” and “forward linkage” thinking or “cumulative causation” thinking in particular are mentioned in this regard. We believe the above alternative thinking cannot explain every aspect of what has been actually self-organized in the East Asian Triangle, however, for the following reasons.

Paul Krugman, depending on A. Hirshman’s “The strategy of Economic Development” (Yale University Press, 1958), has given a definition of backward linkage and forward linkage as follows:<sup>21)</sup> “an industry creates a backward linkage when its demand enables an upstream to be established at minimum economic scale”. Similarly, he describes forward linkage as occurring when “development of an upstream industry reduce the cost of downstream user industry to push them over threshold of scale economy”.

As easily understood, such linkage thinking both backwards and forwards is considered basically within one developing country and does not cover an international borderless area such as the East Asian Quadrangle we are considering. For example, under backward linkage the development of a Chinese computer industry should generate demand for upstream industries such as liquid crystal devices or integrated circuit production by Chinese firms themselves; it is not considered as having any affect in evoking a further increase of already advanced Japanese (or Korean) liquid crystal device or integrated circuit production, which are already far beyond the threshold of scale economy. With regard to forward linkage as well, what is lowering the costs of Chinese downstream industries is not developing Chinese upstream industries, but rather already-developed Japanese upstream industries (in this sense it is rather hampering Chinese upstream industries! ), although such a real relationship between Chinese downstream and Japanese upstream industries might be considered as a variant of forward linkage in international context to some extent.

So-called “cumulative causation” also definitely differs from our concept

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<sup>20)</sup>In detonating the explosion at the critical point (1998), two things should be noted particularly: one is the fact China was exempted from Asian financial crisis in 1997, and the other is the real approach of China’s entry into WTO. Both developments gave a certain guarantee to foreign business in trading with China.

<sup>21)</sup>Krugman, P (1995), p. 20.

of self-organization of the East Asian Quadrangle.

Paul Krugman gives a brief interpretation of cumulative causation as follows:

Suppose that a regional economy grows to the critical point at which it becomes profitable to replace imports of some good subject to scale economies with local production. This import substitution will expand regional employment, drawing in workers from other regions; and in so doing will further expand the local market. This market expansion may, in turn, provide the market size necessary to induce a second round of import substitution, and so on — a cascade of growth reflecting the circular relationship between market size and the range of industries that a region possesses.

The story can, of course, be elaborated. In particular, if you add forward as well as backward linkage, the growth need not be solely due to import substitution, but may involve some export growth as well. But surely the basic idea is very clear.

(P. Krugman, *Development, Geography and Economic Theory*, Cambridge, Massachusetts: MIT Press, 1995, p. 49)

It is true the development of some Chinese industries boosted by FDI has contributed to the substitution of these industries' products for imports and further cumulative causation through expansion of local labor and commodity markets. It has also resulted in their strong export growth as already described. One important fact is overlooked in the cumulative causation thinking described above, however: i.e., the fact the development of Chinese industries evoked greater-than-expected growth in Japanese or Korean high-tech industries. And it is now obvious the boundary of the "cumulative causation" was caused by its local context, without an international perspective.

We may be able to apply a part of above approach to our case, however, by widening the thinking to a more international context. Still, another question arises here as follows.

Our self-organization does contain both micro and macro aspects in its theoretical constellation. In its micro level, this includes a reciprocal excitement relationship between the holonic participants (in the present case, various industries in relevant areas) in our self-organization. So far as such micro matters are concerned, already established ideas such as backward and forward linkage or cumulative causation could be partly applied to our case with an important modification as described above. But the self-organization theory also points to the macro phenomena, such as an emergence on an unexpected scale of a new economic order, which cannot be addressed by those ideas that have appeared in established economics so far.

Thus, obviously, explaining developments such as the emergence of a new economic order having the East Asian Quadrangle as its core urgently requires us to apply a new theoretical method such as biological self-organization theory. This paper is an attempt to move in such a direction.

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## Appendix

1: Multiple regression between Japanese IC export to China ( $Y_i$ ), and Chinese computer export to Japan ( $X_i^1$ ) and Chinese TV & video recorder reception apparatus ( $X_i^2$ )

$$Y_i = 244.25 + 0.696X_i^1 + 2.430X_i^2$$

(7.826) (5.942) (2.431) ( ) = t value  
\*\*\* \*\* \*

$R = 0.982 \quad R^2 = 0.964$

2: Multiple regression between Japanese printed circuit export to China ( $Y_i$ ), and Chinese computer export to Japan ( $X_i^1$ ) and Chinese TV & video reception apparatus to Japan ( $X_i^2$ )

$$Y_i = 12.824 + 0.037X_i^1 + 0.65X_i^2$$

(3.191) (2.45) (5.05) ( ) = t value  
\*\* \*\* \*\*

$R = 0.977 \quad R^2 = 0.955$

3: Simple regression between the stock of Taiwanese IT-related FDI in China ( $Y_i$ ) and Chinese domestic production of computer ( $X_i$ )

$$Y_i = 2487.006 + 4.1784X_i$$

(t = 15.46)  
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$R = 0.9836 \quad R^2 = 0.9676$