

Speculation in the Financial System as a 'Dissipative Structure'

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This paper is trying to understand the financial speculation through concepts from the non-equilibrium thermodynamics (NET for short). However in order to get a more concrete understanding of the phenomenon, I attempt to put together the Post Keynesian theory on expectations and Marxian perspective on production process into non-equilibrium thermodynamics. By using NET I argue that financial speculation must be understood as a dynamics occurring inside the financial structure. Therefore Neoclassical perspectives which are just stressing the equilibrium tendency in the economic structure can not succeed in explaining the usual phenomena of financial speculation, financial panic, financial crisis, etc. In order to see the actual processes of emergence or desolation of social conventions which determine the status of financial structure, we need to understand the two-dimension of expectations, so-called 'mimetic expectations' and 'extrapolative expectations'. Those concepts on the expectations can be derived from Keynes. Furthermore, NET demands to understand the relationships between the inner process and the exterior. In this paper the production process of capitalism is considered as the exterior of financial structure as a self-organizing dissipative structure. I argue that the Marxian conception of the antagonism in the production process can be useful in understanding the constraints that the financial structure has. (*JEL* Classification: G10)

"A curious event in the history of economic thought is that, years after the mechanistic dogma had lost its supremacy in physics and its grip

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[**Seoul Journal of Economics** 1998, Vol. 11, No. 3]

on the philosophical world, the founders of the Neoclassical school set out to erect an economic science after the pattern of mechanics – in the words of Jevons, as ‘the mechanics of utility and self-interest’.” (Georgescu-Roegen 1976, p. 53)

“Speculation by its nature is opposed to rationality.” (Shackle 1992, p. 158).

I. Introduction

This paper tries to understand the financial speculation by using the concepts of non-equilibrium thermodynamics (NET for short). As the concepts of NET only give us formal insights for the understanding it, I attempt to put together the Post Keynesian theory on expectations and Marxian perspective on production process into NET.

In section II, I attempt to show the relevance of the insights of NET in understanding financial speculation. First I point out the similarity between the chemical structure and social structure. After that I explain the concepts of NET: self-organization, dissipative structure, entropy and negentropy. Second I stress the strengths of this analogy: the concept of self-organization will show *not only* the dual processes of emergence and elimination of social antagonism in the financial sector *but also* the necessity of looking into the real sector as an exterior condition of the financial sector. Whereas first topic can be discussed fruitfully in the literature of Keynes, second topic can be investigated well in the literature of Marx.

In section III, I show how a theory of expectations formation process under ‘fundamental uncertainty’ can integrate the separate ideas of ‘extrapolative expectations’ and ‘mimetic expectations’, in the attempt to classify the two states of financial speculation in Keynes. I describe the process through which mimetic expectations often evolve into extrapolative expectations, and vice versa, by using the concepts of NET.

In section IV, in order to define the ‘bifurcation’ point of the financial system and to explain the interaction processes between the financial system and its exterior, I argue the need to investigate the real sector from a Marxian perspective. The most important thing in this investigation is to see the disproportionality of accumulation. While gross profit extracted from production process can reduce the financial fluctuation, the disproportionality among real

sectors in profitability and productivity can result in severe financial fluctuations by raising 'specific uncertainty'.

II. Dissipative Structure and Self-organization : Evolution and Dissolution of Conventions

Speculation is one of the important issues that differentiate heterodox economics from mainstream economics. Regarding speculation as the determinant motive effecting the investment behavior, Keynes took it seriously. Mainstream economics, however, cannot explain speculation effectively because they regard speculative behavior of economic agents (for example, arbitrage) as the process of recovering the equilibrium of the market:

"Within the traditional conception, speculation is a social force that obliges individuals constantly to try to improve the information they have... the speculative gains are a powerful stimulus for acquiring good information rapidly. This stimulus has a strong impact on the collective level. It makes possible an improvement of the evaluation on the real value. And this improvement leads to a better global distribution of scarce resources among the various economic activities." (Orlean 1989, pp. 63-4)

For Post-Keynesians, speculation is the general process related with uncertainty in an economy, through which the economy fails to arrive at a stable equilibrium:

"In Keynes's framework, by contrast, the fundamentals are permanently affected by speculation: speculation in part determines the rate of interest, the rate of interest in part determines investment, and investment is an irreversible change in the capital stock. This change may embody new techniques, but even with unchanged techniques, productivity is altered. Thus there is no hard and fast separation between the speculative and non-speculative part of the market; there are no pre-given fundamentals to converge to..." (Chick 1994, p. 383)

The most recent development in mainstream economics, however, finds two-foldness in speculation. For example, according to one of Rational Expectation Models, we can find the possibility of so-called 'rational bubble'. In the case of arbitrage in stock market, the price of risk asset (say, stock) can be written in the following equation.

$$p_t = d/r + b. \quad (1)^1$$

The 'fundamental' will be the expected dividend divided by the interest rate. This is derived by imposing the condition "that the expectation does not explode too fast. When we relax this arbitrary condition, equation (1) admits many other solutions." (Blanchard and Fisher 1989, p. 221) That is, in the case of increased uncertainty on p_t , 'b' can be any value except for 0, depending on the expectation on the future price of stock. This is called 'rational bubble' in the model.²

This model includes speculation even though it does not provide any explanation why bubbles arise. Using this model, we can observe the two-foldness in the bubble. The first one is the indeterminacy of the price of financial assets in a context of fundamental uncertainty and conventional decision making. The price of financial assets is not determined by an objective 'something', but by the imitating process of the others' expectations. Second, the dynamics has a self-enforcing characteristic. At least one of the many possible solutions must become dominant and this state continues.

Mainstream economics can not theorize these two dimensions in the same logic, even though they finally admit the two dimensions themselves. Now that we have recognized the two dimensions, we need to explain how and under what conditions, such a stable situation (self-enforcing stability) comes into being and what causes it to change.

The term "self-organization" as used in thermodynamics can be useful in understanding these processes. The concept of self-organization is able to explain the emergence and destruction of structure endogenously in the same logic.

"The concept of bubble demonstrates that the organization of selfreferring group can not be adequately conceptualized as a mechanical adaptation to exogenous constraints... The group enjoys certain autonomy... With the concept of self-fulfilling theory, this autonomy takes the particularly interesting form. It becomes a matter of... setting up a common point of

¹In the mainstream economics, through arbitrage process stock price will be finally determined by dividend and interest rate of risk free assets. This is called 'the fundamental' which is supposed to determine the stock price in the long run. Here 'd' stands for dividend, 'r' is the interest rate or the rate of return on the risk free asset. Here 'b' denotes rational bubble.

²For more detail, see Blanchard and Fisher (1989, p. 218).

reference... This common externalized meaning making coordination possible is what we call convention. Thus, specularity is a process capable of radically transforming the group's organization by means of the emergence of a convention. In this case, we speak of self-organization... The interest of convention is that they eliminate specular expectations. *The agents no longer need to ask themselves questions about what the others are going to do.* They simply behave in conformity with the convention." (Orlean 1989, p. 75, italics added)

Then what is self-organization? Self-organization is defined by Jantsch as:

"(a) spontaneous formation of structures in open systems which exchange energy and matter with their environment. Such systems constitute the other basic class of physical systems, namely, non-equilibrium systems of a particular kind." (Jantsch 1980, p. 26)

In NET, 'dissipative structure', far from thermodynamic equilibrium, is able to achieve a degree of 'self-organization' which maintains itself by exporting entropy and importing free energy in order to facilitate development and reproduction.³ As long as any system exists, it produces entropy, i.e. the useless energy in the form of heat or the degree of chaos.⁴ Therefore as time goes on, the disorder will substitute the order in the system. This disorder or chaotic status is the most probable situation and equilibrium status in the thermodynamics. It is the result of the evolution and the irreversible processes. However in an open system, there is a

³The concept of 'self-organization' has been developed by I. Prigogine, a Nobel prize laureate in Chemistry in 1977. He pioneered the application of non-equilibrium thermodynamics to understanding the behavior of structures considered to be 'dissipative' in character. He attacks the static mechanical notion which has been utilized by mainstream economist in conceptualizing the economy as a 'clock-work' mechanism that obey timeless functional laws. It is in line with the Keynesian position: "It is now generally recognized that in many important fields of research a state of true thermodynamics equilibrium (which is the base of classical thermodynamics and presumes the concept of reversible process) is only attained in exceptional conditions." (Prigogine 1961, p. v). For this reason, his idea is considerably interesting to some evolutionary economists. Even though he uses the concept of 'entropy', he also criticizes the fatalistic use of that concept. Thus, he is radically different from Georgescu-Roegen, who tried to exemplify the accelerated deterioration of environmental resources as a result of the production process, using the concept of entropy. So his concept of 'dissipative structure' is designed to explain the process which acts against the second law of thermodynamics (so called the entropy law).

⁴Entropy is the Greek word for "evolution".

counter tendency of exporting the inner entropy to outside, even though outside the open system entropy can increase because of that process.⁵ Prigogine formalized this idea as follows:

$$dS = d_e S + d_i S. \quad (2)^6$$

In (2), $d_i S$ can not be negative. If $d_i S = 0$, it means that the processes are reversible, if $d_i S > 0$, it means that the processes are irreversible. In our case of studying the irreversibility in the complex system, $d_i S$ must be positive, not 0 nor negative. However, in the open system, $d_e S$ can be negative. If the value is big enough to crowd out the amount of entropy, the change of total entropy can decrease (If $|d_e S| > |d_i S|$ total entropy will decrease; if $|d_e S| < |d_i S|$ total entropy will increase). Therefore, the second law of thermodynamics is not a fatal destiny in open system any more.

Figure 1 shows the difference between the evolutionary process of a closed system and that of an open system. In the closed system, the state will inevitably go from the ordered state with low entropy to the disordered, chaotic, most probable state with high entropy through the irreversible evolutionary process. However an open system can disperse the entropy to outside.

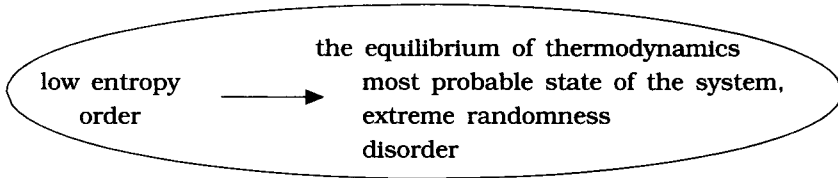
Jantsch divides the process of dispersing entropy in an open system into two kinds. The first kind is 'conservative self-organization', and the second is 'dissipative self-organization'. Conservative self-organization may lead to dynamic, steady-state equilibrium systems, an example of this is the solar system with its rotating planets. Such dynamics can be named 'devolution' since they run in the opposite direction of evolution (Jantsch 1980, p. 34).

On the other hand, dissipative self-organization is the self-organization which does not simply devolve the evolutionary process, but evolve the system by dispersing the inner entropy to the outside. Although both processes are the processes of decreasing the entropy inside the system, the first is the process where the present organization is not being changed, and the latter is the process where

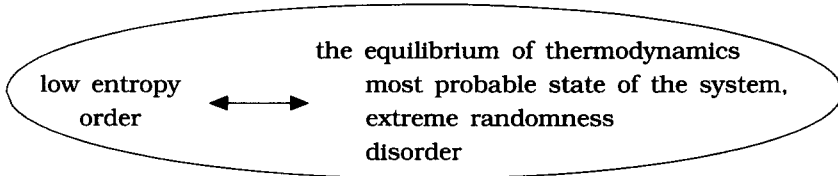
⁵Jantsch (1980, p. 31). Whereas the closed system is defined as a system which exchanges energy but no matter, the isolated system is defined as a system which can exchange neither energy nor matter. Prigogine (1961, p. 3).

⁶ dS is the change of total entropy in the system; $d_e S$ denotes the flow of entropy due to interactions with the exterior, i.e. negentropy; $d_i S$ is the contribution due to changes inside the system. Prigogine (1961, p. 16).

[1. Process in a closed system]



[2. Conservative self-organization in an open system]



[3. Other possibilities in the dissipative self-organization]

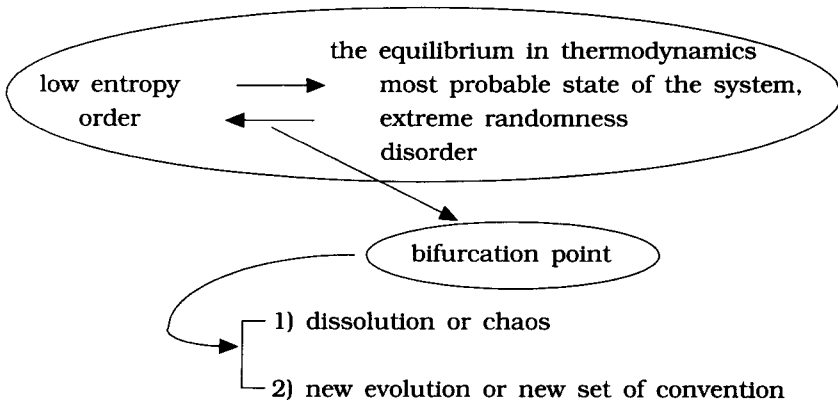


FIGURE 1

IRREVERSIBILITY OF THE SYSTEM AND THE PROCESS OF SELF-ORGANIZATION

the present organization is under change. Furthermore dissipative structures can exhibit two different types of behavior: near their equilibrium, order is destroyed, but far from equilibrium, order is maintained or emerges beyond the instability thresholds. This latter

type is called coherent behavior (Jantsch 1980, p. 31). The lower part of Figure 1 explains this through a diagram.

Now we can think that the financial structure has characteristics similar to the physical structure. For example, financial panic with severe speculation can be interpreted as a situation of failure in governing the entropy in the financial sector. On the other hand, the relatively tranquil period with mild speculation indicates success in controlling the entropy in the financial sector.

If we apply this concept to the analysis of financial structure, we can get several valuable insights on the dynamics of financial sector. First advantage of this analogy is that this concept demands to explain the dual processes of emergence and destruction of financial structure in the same logic. Second theoretical insight of this analogy is that we need to explain the relationships between the structure and its exterior, since a dissipative structure can only survive by importing energy from outside. However what are entropy and negentropy in financial structure? What is the exterior of financial structure? The concept of dissipative structure in NET can only give the formal, isomorphic reasoning in understanding the financial phenomena. We need the content to fill the form.

In order to answer these questions, we have to go into the area of traditional economic discourses: Post Keynesian and Marxian discourses.

III. Speculation and the Two Dimensions of Expectations: the Contribution of Keynes

We can classify three cases of financial phenomena by using Keynesian terminology. Keynes, in *The General Theory*, distinguished the term 'speculation' (s) as the activity of forecasting the psychology of the market in contrast to the term 'enterprise' (e) as the activity of forecasting the prospective yield of assets over their whole life (Keynes 1936, p. 158). The criterion of these two conditions can be the *propensity* of agents in the financial market.

First, in arbitrage in the stock market, (e) can be the activity of people who are looking for only the dividend from their stocks, and (s) can be the activity of people who are looking for the capital gains. In the Post Keynesian perspective, even though the quantitative value of (e) may be the same with 'the fundamentals' ($p_t =$

d/r) of mainstream economics, (e) happens under *fundamental uncertainty*.⁷ Therefore forecasting the variables of 'd' or 'r' is not certain either. In this sense, the agents who follow (e) are not genuine speculators in the financial market. As time goes on, the proportion of (e) becomes small relative to the proportion of (s). At the early stage of capitalism, agents who follow the rules of (e) could be a majority, but nowadays the group of such agents is not a majority any more. When the group of agents who follow the rules of (s) becomes dominant in the financial market, speculation will dominate the market.⁸ Therefore we must now investigate the dynamics inside the speculation.

Second, there can be at least two different styles in speculation (s), i.e. mild speculation and severe speculation or financial panic. Mild speculation happens under the stable convention, i.e. under the convention with high confidence which is the measure of the creditability of agent's projection on the future.⁹ The quantitative value of this case can be written as $p_t = (d/r) + c$ ('c' is determined by convention). Therefore even in a stable convention, speculation will occur. This is the case that, through a certain social process, one of many possible solutions becomes a fixed solution with a stable dynamics where prices are changing in a predictable fashion. Through the social process, a value is singled out by a conventional expectations formation.

Finally, on the other hand, severe speculation will happen under the convention with low confidence or occasional absence of convention. The quantitative value would be $p_t = (d/r) + a_e$ (' a_e ' is

⁷Fundamental uncertainty is Keynesian concept in the sense that we do not know the future. For more detail, see Runde (1991).

⁸On the other hand, noise-trade model tries to explain these phenomena under the neoclassical rational expectation assumption. In this model, if there are some irrational agents who will not use the fundamentals, the rational agents, specialists, must follow the irrational. "The main difference between modern noise-trade theories (or rational bubble model) and Keynes's theory of speculation markets is that Keynes's model does not require the assumption that there exists a subset of irrational investors who refuse to base their expectations on the knowable 'fundamentals' all the rational agents use..." (Crotty 1994, p. 128) The idea that there exist the fundamentals and we can know them is the basis of 'modernism' in theory.

⁹Convention can be defined as the expectation formation process, based on custom, habit, tradition, instinct and other socially constituted practices (Crotty 1994, p. 121).

determined by speculative expectation on future). In this case, any value can be the actual price of stock, so the potential instability in the dynamics of the system is extremely high. Because there is no convention with high confidence, imitation of others becomes the accepted behavior of maximizing one's benefits or minimizing the present danger. Instead of trying to watch the conventional expectations, by observing the movement of the price a fairly successful expectation can be achieved with low cost. The difference is: whereas in the case of severe speculation the value is underdetermined and unstable, in the case of mild speculation the value is stable.

We classified three cases by using Keynes' concepts: (*e*), mild (*s*) and severe (*s*). What seems to be interesting is that the degree of fundamental uncertainty is neither a condition of dynamics between (*s*) and (*e*) nor dynamics inside (*s*). In the first classification between (*e*) and (*s*), the determinant is *the propensity of people* who have different styles of investment in the financial market; in the second classification inside (*s*), the determinant is the degree of confidence. In Keynes, whereas the classification and definition of the three different conditions above are clear, the determinant of the last two conditions inside (*s*) is not clear. This is because those three cases happen under the same 'fundamental uncertainty' in the sense that "We simply do not know" (Keynes 1937, p. 214).¹⁰

¹⁰The argument of this paragraph seems to be too strong, because there are many Post Keynesian articles which deal with the relationship between instability and the degree of uncertainty. However, in my opinion, unless we understand the classification of Keynes on the three states of financial activities under the assumption of fundamental uncertainty, we can not understand the conventions formation process either. The originality of Crotty (1994) is in the attempt to explain how the conventions formation process appears under the same condition of fundamental uncertainty. This understanding is also in the same line with the Keynes's comment, "You must not confuse instability with uncertainty" (Keynes 1973, p. 137).

Nevertheless, we need to connect the state of stability to the state of uncertainty. The uncertainty of this case must be different from the fundamental uncertainty. Therefore, I distinguish the term 'fundamental uncertainty' from the 'specific uncertainty' which will be dealt with in this paper later. Uncertainty is different from risk in the sense that uncertainty can not be summarized into probability. However, it is fundamental because it is not much influenced by specific objective situations like capitalist production process. Fundamental uncertainty resides in the specific type of decision: crucial decision (Shackle 1992, p. 384). Even though Keynes tried

However, at least, we can find out one important point in this classification. The last two cases, i.e. mild and severe speculations, show the two-fold characteristics in financial dynamics: indeterminacy and the self-enforcing character. Whereas indeterminacy is dominant in the third case, the self-enforcing character is found in the second case. Once some value is selected and signaled as a conventional value through a social process, this value continues for a while. In this case agents just follow the conventional value rather than looking at other agents for the signal of value. Two-foldness in speculation can be found in the concept of 'conditional stability' suggested by Crotty, too. Crotty argues for the need to develop a theory explaining conditional stability. (Crotty 1994, p. 116) According to Crotty:

"(even though institutional structures) have their explicit purposes the reduction of uncertainty... institutions can never create more than conditional stability... They tend to create new obstacles to stability even as they eliminate old ones: they transform the effects of uncertainty and shift them across time..." (Crotty 1994, pp. 133-6)

Here, Crotty argues that the conditional stability is the other side of tendency of instability. He suggests the two-foldness of the institutional structure of economy (stabilization and destabilization), regarding the interrelation between the psychological behavior of agents and the role of structure.

Keynes also seems to know this two-fold character. In chapter 12 of *The General Theory*, Keynes shows several kinds of expectations, by explaining the dynamics of degree of confidence.

With stable confidence in the future:

"(I)t would be foolish to attach great weight to matters which are very uncertain... The essence of this convention lies in assuming that the existing state of affairs will continue indefinitely, except in so far as we have specific reasons to expect a change." (Keynes 1936, pp. 148-52)

In these paragraphs, Keynes is trying to explain so-called 'extra-

to explain the dynamics of degree of confidence under the assumption of uncertainty, in his explanation of Ch.12 in *The General Theory*, what determines the degree of confidence is not the degree of uncertainty, but mainly the psychological dynamics of people. Sometimes Keynes points out the problem of 'prospective yield' (Keynes 1936, p. 154) as a reason of a sudden fluctuation of opinion. I am trying to develop this idea under the name of 'specific uncertainty' in this paper.

polative' expectations.¹¹ A theorist of rational expectation would be tempted to regard this as absurd because they regard the extrapolative expectations as less reasonable than 'rational expectations'. But for Keynes, in the real world we need too much information to decide rationally. Therefore *if the situation permits*, people want to believe that the present will continue. This behavior of expectation can be another way of constructing rational expectation in the real world.

On the other hand, toward the end of chapter 12, Keynes raised a very important question: the vulnerability of convention:

"But it is not surprising that a convention, in an absolute view of things so arbitrary, should have its weak points. It is its precariousness which creates no small part of our contemporary problem of securing sufficient investment." (Keynes 1936, p. 153)

What causes this situation? In a much cited paragraph, Keynes suggests one example:

"...(P)rofessional investment may be likened to those newspaper competitions in which the competitors have to pick out the six prettiest faces from a hundred photographs, the prize being awarded to the competitor whose choice most nearly corresponds to the average preferences of the competitors as a whole; so that each competitor has to pick, not those faces which he himself finds pretties, but those which he thinks likeliest to catch looking at the problem from the same point of view. It is not a case of choosing those which, to the best of one's judgment, are really the pretties, nor even those which average opinion genuinely thinks the prettiest. We have reached the third degree where we devote our intelligences to anticipating what average opinion expects the average opinion to be. And there are some, I believe, who practice the fourth, fifth and higher degrees." (Keynes 1936, p. 156)

This paragraph shows well the reciprocal mimetic characteristics of expectations. These expectations differ from extrapolative expectations in the sense that mimetic expectations happen in the absence of stable convention or high confidence. Whereas agents working with extrapolative expectations look at the past for the project of future (diachronical), agents in the mimetic expectations look at one another for the project of future (synchronical). Mimetic expectations have the character of a contagion. Because of this contagion, a multitude of solutions at many degrees can occur.

¹¹The term of extrapolative expectation came from Crotty (1994, p. 118).

Using the previous example, any value could be the value of stock. However no one can predict the future with high confidence. This leads to the instability of the solution. When confidence changes and a kind of convention begins to form, such extreme flexibility might disappear. But what will determine these processes?

In his attempt to explain the emerging process of conventions, Crotty (following Keynes) appeals to the existential situation of the human agents, faced with a 'crucial' decision:

"Even though we simply do not know the information that we must have, to make safe decisions, we have a human need 'to behave in a manner which saves our faces as rational economic men', a manner that allows us the comfort of the illusion of safety and rationality." (Crotty 1994, p. 120)

This is 'conventions formation process' based on the Keynesian fundamental uncertainty. Through this social process, mimetism will be eliminated. Once a convention has been established, extrapolative expectations would be substituted for the mimetic expectations. This social process of eliminating mimetism can be regarded as one of self-organization processes.¹²

Theoretical merit of introducing the concept of dissipative structure is that it enables us to understand the logic of conventions formation process better. In the financial market, when mimetic expectations prevail, there can be multiple equilibrium solutions. In order for one value to be selected as 'the solution', a kind of leader or common sense which can guarantee the stable process is needed. This process can be interpreted as a process of 'hegemonic

¹²For detail on the conventions formation process, see Crotty (1994, pp. 120-32). Here I am trying to suggest the alternative concept for understanding the evolution and dissolution of the social system. Till now, this trial is in the stage of analogy. This analogy is not new one. For example, Krugman (1996) is relying on the concept of self-organization like this paper. But it is not based on the self-organization in the dissipative structure of Prigogine (Krugman 1996, p. 6). Owing to this, the examples which are dealt with in the book seem to be the same with the natural processes. However, the concept of dissipative structure allows the room for the agents' influence. Furthermore, there are few works to reveal the self organizing process in the financial sector specifically. Arthur (1995) can be a trial with this similar agenda, it is not so successful though. My paper tries to give specific contents to the complexity theory, using several traditional heterodox economic theories. The difference between this paper and Arthur (1995) lies in the content, not in the form.

articulation' in which several conflicting powers/groups/classes struggle with each other in order to maintain a 'society-effect' as a social state where antagonism is displaced (Laclau and Mouffe 1985). This social process is the process of controlling the social antagonism in the financial sectors. It is not predetermined whether the process would be successful or which concrete form will be taken. We can regard this explanation on the process of convention formation and hegemonic articulation as contents of self-organization in the financial market. In the financial system, entropy means not useless energy, but mimetism. Therefore the contagion of mimetism creates the increased entropy or disorder; on the other hand, the elimination of mimetism indicates the controlled entropy or ordered situation.

The second strength of introducing the concept of self-organization in dissipative structure is that the process of convention destruction can be possible at any time. That process depends not only on the fundamental uncertainty, but also on the specific kind of uncertainty related with the capitalist processes. If this kind of uncertainty increases, the expectation of agents will become more imitative, looking at others' expectations rather than their estimates of real long term performance of the firm or the past result of decisions because the past will not be believed valid, owing to the change of surroundings. Even in these situations through mimetism the price of stock will be set, but it can be polarized or condensed easily. Even though this also can be regarded as a solution, it is unstable owing to its mimetic nature.

As the tendency of increasing entropy and that of dispersing it will conflict with each other in a physical structure, so the tendency of increasing mimesis and that of emerging convention will conflict with each other in the financial system. This conflict can develop itself into bifurcation point at any time under some condition. Therefore the self-organization itself is the problem in society. Such literature of Post Keynesian like Minsky shows an example of such studies. According to Minsky:

"In a system dominated by hedge finance, the patterns of interest rates (short-term rates being significantly lower than long-term rates) are such that profits can be made by intruding speculative arrangements. The intrusion of speculative relations into a system of mainly hedge financing of positions increases the demand for assets and therefore raises asset values - that is, it leads to capital gains. A regime in which capital gains

are being earned and are expected is a favorable environment for engaging in speculative and Ponzi finance. Profit opportunities within a robust financial structure make the shift from robustness to fragility an endogenous phenomenon." (Minsky 1986, p. 210)

However this study is not well combined with the process of conventions emergence. Concepts of NET demand such studies to be combined with the studies on the conventions formation process. For example we can construct the integrating theory on the dual processes of emergence and destruction of social conventions by using the Crotty and Minsky's studies. In this case, the quantitative aspect of bubble itself is less important than the qualitative aspect of bubble. Whereas the stability of bubble is conditioned by Crotty's conventions formation process, the instability of bubble is conditioned by Minsky's financial instability tendency.

Table 1 shows the analogy of the financial dynamics with the NET.

Now we can discuss the second question which I raised at the end of section II. The concept of self-organization demands an exterior as a source of elimination of mimetism. Even though the self-organization process or conventions formation process is by nature an endogenous process, the endogeneity must be supported from outside. The outside of the financial sector can be thought as production process of capitalism. The total profit made in production process can work as a kind of negentropy which is the flow of energy due to interactions with the exterior. The mass of total profit can guarantee the success of the financial sectors.¹³

However, there are few explanations on the conditions under which mimetism might arrive at a bifurcation point, causing an organization to change or dissolve. If we can not explain the bifurcation point, we will not be able to explain that: not every case of mimetism in the sector leads to panic and that some financial

¹³The concept of production process here is not the same with that of mainstream economics. In mainstream economics the real sector or fundamentals as a determinant is introduced for proving the market efficiency. Furthermore, the process of determination is mechanistic, deterministic. However, I stress the importance of production process in the sense that financial sector can survive only through the profits from the production sectors. This also means that financial sector can not enjoy high profits without continuous process of extracting surplus from production process. High rates of return can be achieved at the peak of speculation but finally collapse owing to this constraint.

TABLE 1

Dissipative Structure	Entropy	Increased Entropy	Dispersed Entropy	Exterior-negentropy
financial institution	mimetism (speculation)	contagion of mimetism ->panic	elimination of mimetism ->convention	production -> profit (surplus value)

dynamics can be stabilized easily.

One example of a financial crisis which did not arrive at the financial bifurcation point is the stock market crisis of 1987. This case is a concrete example of financial instability which did not reach the critical point of Fisher's debt-deflation. According to a research this rapid recovery was not owing to the big government or the role of central bank, but relatively healthy real economy.¹⁴

This case shows that every financial speculation cannot be regarded as the indicator of a bifurcation point.¹⁵ For it depends not only on the absence of confidence in financial market itself, but also on the problem in the exterior of financial structure. So one question to be answered is what is the sufficient condition of financial panic? When the situation of real sector is better enough to absorb the problems of the financial sector, the crisis of self-organization coming from the spontaneous dynamics of the financial sector does not develop into a critical point. In order to identify the significant bifurcation point, we have to see not only fundamental uncertainty which is inside financial structure but also 'specific uncertainty' in the exterior of financial structure. The exterior must be the real sector of capitalism, i.e. the production process.

¹⁴"A final reason why a debt-deflation process did not occur following the stock market crash of 1987 has to do with its timing. The stock market crash of October 1929 occurred after a recession had begun earlier into the year. In contrast, the stock market crash of October 1987 occurred when the economy was still in the expansion phase of the business cycle." (Wolfson 1996, p. 327)

¹⁵This issue leads to circicizing Minsky. "...There is a major problem with Minsky's theory of capitalist instability as evaluated from a Marxian perspective: there are no real-sector source of instability in his model. The explanation of the transitory nature of both expansion and contraction is located exclusively in financial markets... This analytical imbalance leads Minsky to a one-sided and therefore inadequate explanation of the crisis of the 1970s and 1980s." (Crotty 1986, p. 300)

A controversial issue related with this topic is that even though we admit financial dynamics must be related with the dynamics of real sector, there is no agreement on what the real sector means.¹⁶ Instead of aggregating the real sector, or emphasizing the income distribution, I would rather see the disproportionality of real sector. In section IV, I will investigate the concept of disproportionality in production process and its effect on the financial sector.

IV. Uneven Accumulation Process: Marxian Perspective on Dynamics

When we regard finance as the simultaneous result of monetary and real aspects of capital accumulation, we understand that the uncertainty leading to the dynamics in monetary and financial institutions is not simply related with the expectation by the economic agents under 'fundamental uncertainty' but also with the antagonism in the production process: 'specific uncertainty'.¹⁷

'Antagonisms' in the production process affects the uncertainty in financial sector, through the expectations formation of agents. Increased antagonism in the real sector strengthens the uncertainty embedded in the financial sector and erodes the basis of the convention which is regulating the uncertainty. A chaotic situation resulting from the dynamics of antagonism forces the financial system to develop into a new form, as long as it is not controlled by the established regimes of regulation.

Of course we do not observe this increased antagonism everyday. At first the generation of antagonism will depend on the degree of competition, and next even though antagonism would be generated, established social convention (which is supposed to control the antagonism) can survive for a while by importing surplus-value from the production process as well as the intervention of govern-

¹⁶This paper is in the same direction with Crotty (1985, 1986), but has different contents. Whereas Crotty stresses the profit squeeze as the main source of instability, this paper stresses the effect of disproportionality in production. Also see Crotty (1994, p. 127).

¹⁷As in the case of 'extra surplus value', antagonism does not just mean competition among capitalists but the conflicts which come from the competition between capitalists and the resulting increase in the exploitation of labor.

ment or central bank.

Then, how can we describe the dynamic process of antagonism in production process and how the uncertainty in financial market becomes worsened and lessened by the production process? In this paper among many other aspects of production process I am stressing its unevenness. The purpose here is to sketch a model which permits an analysis of unevenness between capitalists, under which their antagonism develops. In order to make this logic clearer, I will suggest a simple model; the model of capital stratification.¹⁸ This model has four sectors using the two criteria.

First, we can categorize each sector according to the real rate of increase in the labor productivity.¹⁹ We can find the average rate of increase in the labor productivity in one year, in one country. Sectors can be divided into two groups. One group is the sectors where the rate of increase in the labor productivity is greater than the social average. The other group is lower than the social average. This criterion shows the difference or unevenness in the aspect of production of surplus 'value' among sectors (or firms).

Second, we can categorize each sector according to the rate of increase in degree of protection.²⁰ This concept represents the change

¹⁸The idea of this model came from Reuten and Williams (1989, pp. 125-38). We revised their ideas. They use the term of m_i as the "ideal money expression of the labor in plant (or sector) I." m_i actually can be gained by total value-added (in terms of price) divided by the total labor hours invested in the same sector. It represents the productivity in monetary terms. We divided m_i into a_i and E_i . a_i means the real productivity of labor and E_i means price level representing the monopoly power in the sector. Equation (3) and (3)' below show this relations.

$$m_i = \frac{p_i}{L_i} = \frac{p_i}{VA_i} \times \frac{VA_i}{L_i} = a_i \times E_i \quad (3)$$

$$\dot{m}_i = \left(\frac{\dot{p}_i}{VA_i} \right) + \left(\frac{\dot{VA}_i}{L_i} \right) = \dot{a}_i + \dot{E}_i \quad (3)'$$

¹⁹The real rate of the labor productivity in sector I can be calculated by dividing the nominal rate of labor productivity of sector I with the price level of sector I.

²⁰This concept originally came from Kalecki's degree of monopoly (Kalecki 1968, pp. 13-23). However Kalecki just indicated the price setting ability of monopoly using this concept. Gouverneur used the concept of 'degree of protection' in order to indicate the financial accessibility to borrowed money capital and the ability of price setting at the same time (Gouverneur 1983, pp. 119-22). This concept is very realistic, considering the present holding companies. The quantitative expression of this concept can be found in the

TABLE 2

	$\alpha_i > \alpha^*$	$\alpha_i < \alpha^*$
$E_i > E^*$	(a)	(b)
$E_i < E^*$	(c)	(d)

in monopoly power of the firm or the structure of competition in the sector. If this rate is higher than the social average inflation rate, we can conclude that this sector has more monopoly power than the other sectors. For owing to degree of the monopoly or oligopoly, the price level set by the firm could be realized in the market. This criterion shows the difference or unevenness in the aspects of 'price' among sectors. We do not have to assume that the sector with higher rate of increase in the labor productivity must be the more monopolized sector.

Now we can construct the model of four industrial sectors, using these two criteria (Table 2).

(1) sector (a): higher (compared with average) rate of increase in the labor productivity and higher rate of increase in the degree of protection. This sector is the most prosperous among the four sectors. Owing to this, the problem of overaccumulation seems to disappear; this sector, even in a global recession, can enjoy some rapid rate of accumulation. The rate of profit and that of accumulation can be higher than any time, at the recession of other sectors, and thus money capital will flood into this sector.

(2) sector (b): lower (compared with average) rate of increase in the labor productivity and higher rate of increase in the degree of protection. In this sector, even though the rate of increase in labor productivity is very weak, the firm has some monopoly power to transfer its problem to market. Monopolized but not high technology industry can be example of this. In this case the problem of overaccumulation which results in the slowdown of the profitability of new investment project can be deterred, because of the mono-

price level in sector 1. This concept is a very Post-Keynesian, for a Post-Keynesian such as Kregel argues that in the determination of price the rate of markup is crucial (Kregel 1989, pp. 84-5). Even though he assumed that the markup would be stable, in real situation the markup would change and this change shows how much the firm or the sector has a monopoly power.

polistic relationships between the capitalist firms in this sector.

(3) sector (c): higher (compared with average) rate of increase in the labor productivity and lower rate of increase in the degree of protection. In this sector productivity is increasing very rapidly and the market structure is very competitive. In this case, the problem of overaccumulation can be deterred also but for a different reason: high rate of exploitation or high profitability. The unstable future expectation does not come from the performance itself but the market structure of competition.

(4) sector (d): lower (compared with average) rate of increase in the labor productivity and lower rate of increase in the degree of protection. In this sector, the ability to generate surplus value is weaker and, at the same time, the ability of setting price or financial accessibility to borrowed money capital is weaker. Because this sector is highly competitive, the decreasing rate of profit can not be compensated by price mark-up. So the firms in this sector must face the difficulties in accumulation and expectations on future returns.

Using this simple model, we can show the increased or decreased diversity of the productivity, the rate of accumulation and profit margin among sectors in production area. Regardless of the aggregate economic situation, some sectors of capitalist enterprises can succeed in producing great amounts of profit and higher accumulation rates. On the other hand, in other sectors capitalist enterprises could fail and collapse. Such potential for bankruptcy is not even, so that expectations of economic agents for the future are very unstable. This unevenness in the profit rates and accumulation rates forces the funds to move fast to more prosperous areas. However this rapid movement of funds happens under the condition of unpredictability.²¹

²¹This can describe the present economic performance in developed countries properly. One of the main characteristics of modern capitalism is high disproportionality among the income earners and among the capitalist sectors. Because of this, some business sectors or some groups of people can enjoy the prosperous economic situation, whereas some industrial sectors or some groups of people must face great economic difficulty. This results in high possibilities of financial instability. Therefore we can infer that the robust economy like U.S. capitalism can enter into financially instable state owing to its mal-distribution of income and increased disproportionality among business sectors.

This can be called uncertainty in the real sector: 'the specific uncertainty' in capitalism. When this real sector uncertainty is combined with the uncertainty in monetary or financial sector, some point in financial dynamics becomes a meaningful point, i.e., bifurcation point. At this time, change of the structure itself is inevitable. Financial panic or severe speculation will continue until the next new self-organization emerges.

As I already pointed out, the financial sector itself has its own dynamics. Therefore financial panic can happen within the financial sector endogenously. However, because the production process will function as an exterior to the financial system as a dissipative structure, financial sector will be influenced by the production process. On the one hand, the production process works as a source of diminishing the mimetism in the financial sector through the whole mass of profit. Profit here works like negentropy in the physical structure. On the other hand, the dynamics and disproportionality in the production process will provide the other source of uncertainty.

Increased specific uncertainty in capitalism has two effects on the financial sector. The first one is to increase the instability of the financial sector. In this case, "agents respond to increased uncertainty by reducing their exposure to irreversible positions such as purchasing a specialized piece of equipment." (Ferderer 1993, p. 20) Or severe speculation can occur. Owing to the increased specific uncertainty, when the established confidence becomes lower and previous convention proved to be invalid anymore, agents must find other point and through mimetism such a point can be achieved. However this point is too flexible to be believed as a stable point.

The second effect is as follows: Owing to the increased specific uncertainty in production process, the dynamics of mimetism (entropy in the financial sector) can not be absorbed by the production process. That is, production area can not function well as an exterior which guarantees to disperse the entropy endogenously generated. It seems as if the tendency toward financial panic depends on whether the real sector can absorb the pressure (entropy or heat) of the financial sector and it can sustain its profit flows even in the face of this pressure. If it can, the pressure seems to evaporate in the real sector; the potential for panic dissipates.

This whole story shows that the dynamics of financial sector are

not simple, but complex phenomena.²²

V. Conclusion

In this paper I introduced the concepts of self-organization in a dissipative structure from NET. Using this concept, I found the similarities between financial structure and physical structure, and drew out some of the implications to economics in understanding the process of formation and destruction of convention. I stressed the strengths of this concepts in the sense that, through the concept of self-organization in a dissipative structure, we can investigate the dual process of emergence and destruction of convention, and we are demanded to study the relations between the financial sector and the real sector as well.

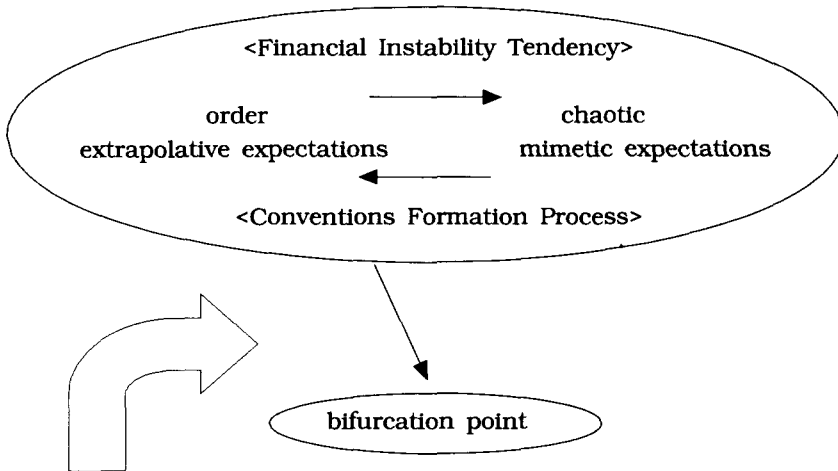
In order to fill the formal, isomorphic logic with the concrete contents, I introduced several concepts from Keynesian and Marxian perspectives: two-foldness of expectations and uneven accumulation process.

I have shown the two-foldness of expectations, accepting the explanation on financial instability tendency (for example, Minsky) and conventions formation process (for example, Crotty) under fundamental uncertainty of Post-Keynesian theory. By these concepts, we can understand the concrete mechanism by which the dissipative structure called 'financial system' works.

Finally by using a Marxist concept of uneven accumulation process, I postulated how the production process influence the financial dynamics. The increased disproportionality of profit rates and accumulation rates among sectors in the production process erodes the confidence of the established convention and finally can cause the financial panic or severe speculation. On the other hand, because the unhealthy situation in the real sector which results from the increased disproportionality can not absorb the mimetism endogenously generated in the financial system, this case also causes the financial turbulence. Figure 2 summarizes the previous explanations.

²²One limitation of this paper is that I did not show the historical relationship between increased disproportionality in capitalist development and the increased financial instability. This project would be the topic of next study.

Financial System as a dissipative structure:



production process as an exterior:

mass of profit (positive effect on the financial system: + of free energy)

disproportionality of production process (negative effect on the financial system: - of free energy)

FIGURE 2

SUMMARY OF THE SELF-ORGANIZATION IN THE FINANCIAL SYSTEM AS A DISSIPATIVE STRUCTURE

I expect this paper to give valuable insights to the researchers who try to understand the financial dynamics by using the various traditions of economics including the complexity theory, Keynesian and Marxian perspectives.

(Received January, 1998; Revised June, 1998)

References

Arthur, W. B. "Complexity in Economic and Financial Markets." *Complexity* 1 (No. 1 1995).
 Blanchard, O. J., and Fisher, S. *Lectures on Macroeconomics*. The MIT Press, 1989.

- Chick, V. "Speculation." In P. Arestis and M. Sawyer eds., *The Elgar Companion to Radical Political Economy*. Edward Elgard, 1994.
- Crotty, J. R. "The Centrality of Money, Credit and Financial Intermediation in Marx's Crisis Theory." In S. Resnik and R. Wolff eds., *Rethinking Marxism: Essays in Honor of H. Macdoff and P. Sweezy*. New York: Autonomia, 1985.
- _____. "Marx, Keynes, and Minsky on the Instability of the Capitalist Growth Process and the Nature of Government Economic Policy." In S. W. Helburn and D. F. Bramhall eds., *Marx, Schumpeter & Keynes: A Centenary Celebration of Dissent*. New York: M.E. Sharpe, 1986.
- _____. "Are Keynesian Uncertainty and Macrotheory Compatible? Conventional Decision Making, Institutional Structures and Conditional Stability in Keynesian Macromodels." In G. Dymski and R. Pollin eds., *New Perspectives in Monetary Macroeconomics*. Michigan University Press, 1994.
- Ferderer, J. P. "Does Uncertainty Affect Investment Spending?" *Journal of Post Keynesian Economics* 16 (No. 1 1993).
- Gouverneur, J. *Contemporary Capitalism and Marxist Economics*. Barnes & Noble Books, 1983.
- Georgescu-Roegen, N. *Energy and Economic Myths*. Pergamon Press, 1976.
- Jantsch, E. *The Self-Organizing Universe-Scientific and Human Implications of the Emerging Paradigm of Evolution*. Pegamon Press, 1980.
- Kalecki, M. *Theory of Economic Dynamics*. Monthly Review Press, 1968.
- Keynes, J. M. *The General Theory of Employment, Interest and Money*. 1936.
- _____. "The General Theory of Employment." *Quarterly Journal of Economics* 51 (1937).
- _____. *The Collected Works of J. M. Keynes, Vol. 14: The General Theory and After, Part II*. Macmillan Press, 1973.
- Kregel, J. A. (ed.) *Inflation and Income Distribution in Capitalist Crisis*. Macmillan Press, 1989.
- Krugman, P. R. *The Self-Organizing Economy*. Blackwell, 1996.
- Laclau, E. and Mouffe, C. *Hegemony and Socialist Strategy: Towards a Radical Democratic Politics*. Verso, 1985.
- Minsky, H. P. *Can "It" Happen Again?: Essays on Instability and*

- Finance. M.E. Sharpe, 1982.
- _____. *Stabilizing an Unstable Economy*. Yale University Press, 1986.
- Orlean, A. "Mimetic Contagion and Speculative Bubbles." *Theory and Decision* 27 (1989).
- Prigogine, I. *Introduction to Thermodynamics of Irreversible Processes*, 2nd edition. New York: John Wiley & Sons, 1961.
- Reuten, G., and Williams, M. *Value-form and State: the Tendencies of Accumulation and the Determination of Economic Policy in Capitalist Society*. Routledge, 1989.
- Runde, J. H. "Keynesian Uncertainty and Instability of Beliefs." *Review of Political Economy* (1991).
- Shackle, G. L. S. *Epistemics and Economics*. Transaction Publishers, 1992.
- Wolfson, M. H. "Irving Fisher's Debt-deflations Theory." *Cambridge Journal of Economics* 20 (1996).