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STRUCTURAL TRANSFORMATION OF THE METAMORPHOSIS GROUP: TOWARDS A METAECONOMIC THEORY OF METAMORPHOSIS

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Abstract

As a case study of metaeconomic analysis we discuss Marx's economic thinking on 'metamorphosis.' Our aim is to extend the coverage of the concept beyond the ordinary sphere of economic analysis. For that purpose, the formal structure of metamorphosis is represented by the algebraic structures of group and semigroup.

Such a conceptual formalization of metamorphosis enables us to investigate various aspects of socio-economic and physical phenomena. A few examples of its application are presented in the later part of this article.

Keywords: metaeconomics, group, semigroup, metamorphosis
JEL Classification: B00, B41.

I

Economists have examined aspects of our economic life, and constructed theories to drive working mechanisms in which various concrete structures sustain an inorganic relationship. These economists have investigated the theoretical operation of fundamental categories such as price, exchange, money etc., and at the same time introduced important concepts for understanding economic affairs.

Economics can also be studied itself as an academic discipline. There are many interesting questions in this area; for example, 'Is economics a sort of natural science?' or, 'Can economics be studied without any knowledge of politics, jurisprudence or history?' or 'Why do many economists know almost nothing of philosophy, art or literature?' etc. To deal with these problems it is necessary for us to construct another economic discipline, *metaeconomics*. Metaeconomics consists of a systematic collection of viewpoints for criticizing, reconstructing and transforming fundamental propositions of economics. Its function in economic research works in a similar way to that of metamathematics or proof theory, which forms a solid logical basis for *mathematical* method and thinking. We need a metaeconomic point of view so as to deconstruct creatively various economic doctrines that often lose their practical flexibility in a given economic system. The famous social and economic criticism of Karl Marx may well be valid for a metaeconomic approach. He proposed an effective antithesis to the mainstream political economy called the 'classical school,' and acquired a deeper understanding of social phenomena with economic activities than those of previous classical economists. However, he was not able to realize a transcendental foundation of socio-economic thinking capable of objectifying the frameworks of political economy, and consequently he did not construct any metaeconomic theories, though he created his own unique economic doctrines. Our main theme is to relativise and structuralize Marx's terminology and his own metaphysical notions developing a transcendental prospect based on his critical perspective.

From an abstract point of view the real world in which we live our economic life consists of two types of commodities, that is, monetary materials (gold or silver), and real goods and services. Let monetary materials and non-monetary commodities be denoted as ω and ξ respectively. Then the following associative operation ($\sim$) may be established; that is,

1) exchange between monetary materials ($\omega \sim \omega = \omega$),
2) identity of price and 'value' ($\omega \sim \xi = \xi$) and, as a corollary, the identity of price and exchange ($\xi \sim \xi = (\omega \sim \xi) \sim (\omega \sim \xi)$),
3) self-sustaining character of a monetary material within the exchange process ($\xi \sim \xi = \omega$).

Since these three 'laws' satisfy the axioms of a (mathematical) group with order 2 (ω is the unit for $\sim$ operation), we can interpret an abstract commodity 'space' to have a mathematical structure of a group called the *metamorphosis group* (hereinafter abbreviated as the M-group)[1]. What relationship can be established between the M-group and the technological structure of capitalist behavior? Firstly, we solve this problem according to the interpretation of fundamental economic activities from the angle of algebraic structures. Secondly, from a certain aspect of the real-economic satisfaction of physical and mental wants we explain several functions of the *aggregate transformation group* (hereinafter abbreviated as the T-group), which includes as a subset the M-group representing the structure of profit-making or 'capital' in a Marxian sense. In other words, our interest is to solve the problem of how the cycle of ordinary economic life can be 'harmonized' with the metamorphosis of capital. Thirdly, we must determine the theoretical contents of the autonomous movement of profit-making under the assumption that there exists an iterating structure of reproduction with a deviation from the simple repeating process of production in which the metamorphosis of capital can trace a logical path represented by the M-group. Lastly, reference will be made to some fundamental extensive arguments that are suggested by the term metamorphosis.

II

First, several concepts in Marxian analysis of capital must be replaced by mathematical expressions. Let three forms of capital, *i.e.* productive capital, commodity capital and money capital, be denoted as P, C and M respectively. The combination of these three factors may consist of three types of transposition:

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[1] See, Kamitake (2006).

$$(\mathrm{M\ C}),\ (\mathrm{C\ P}),\ (\mathrm{P\ M}),$$

and three forms of permutation:

$$\begin{pmatrix} M\ C\ P \\ M\ C\ P \end{pmatrix}, \begin{pmatrix} M\ C\ P \\ C\ P\ M \end{pmatrix}, \begin{pmatrix} M\ C\ P \\ P\ M\ C \end{pmatrix}.$$

These six operations can build the symmetric group of degree 3, which is called the T-group.

Now we can construct a theoretical proposition of capital by way of the concept of the T-group. It can be reduced to the statement that, if we denote the M-group and the T-group as μ (an alternating group of degree 3) and τ (a symmetric group of degree 3) respectively, the quotient group of τ by μ (that is, τ/μ) is isomorphic to the group of order 2. Clearly in this case the quotient group consists of two parts. The first part expresses the M-group itself (an alternating group A_3), and the second part is constituted of the set of elements (vA_3) constructed by the transposition (v) of two arbitrary elements of the M-group. For example, operating a transposition (C P) as v on the M-group, we obtain three transpositions (M C), (C P) and (P M) corresponding to the three elements of the M-group, that is, all elements appearing in the process of metamorphosis. Then it should be noted that the transposition (C P) contains M—M implicitly. And the transpositions (M C) and (P M) also contain P—P and C—C respectively. As a result, we clarify the economic meaning of these transpositions (M C), (C P) and (P M). (M C) expresses the employment of raw materials and labour, especially the latter as the origin of profits. (C P) implies the employment of productive conditions, that is, the generation of rent. (P M) expresses the productive use of money, that is, the creation of interest.

On the other hand vA_3 can be interpreted as an abstract expression of the generation of income. But, in order that a concrete relationship of distribution can be expressed generally in mathematical terms it is necessary for us to connect the process of metamorphosis with that of income generation by way of abstraction from the three sorts of transposition. Now let A_3 and vA_3 be denoted as μ and η respectively.

μ can be defined as the abstract state of affairs in which capital keeps on performing normal metamorphosis and can take any forms of P, C and M. But η implies the state of displacing or income-generating movements of capital that can express lending and borrowing, the switching of production conditions, and the unequal exchange of commodities (especially employment of labour forces). Consequently the following associative operations(#) may be laid down as to μ and η:

1) $\eta \# \mu = \eta$(loan, lending of productive resources, the supply of labour),
2) $\mu \# \eta = \eta$(the borrowing of money and productive resources, the employment of labour),
3) $\eta \# \eta = \mu$(the offset of loan and debts by money capital and productive resources, the termination of employment).

Adding to these operations $\mu \# \mu = \mu$(metamorphosis of capital), the following group diagram can be constructed:

	μ	η
μ	μ	η
η	η	μ

Since this quotient group expresses the iteration of a given income distribution process that contains metamorphosis movements, it can be properly called the income distribution group (ID-group).

The ID-group can be interpreted as a formal structure of the commodity world with a price mechanism (mentioned in Section I) because there is a one-to-one correspondence between the latter's elements ω and ξ, and those of the ID-group (μ and η). In other words, the M-group transforms itself into the ID-group in the commodity world dominated by a pricing system, and becomes the logical expression of the infinite cyclical movements of capital. Therefore we must reconsider the structure of the ID-group from a slightly different angle, that is, from the viewpoint of the reproduction of household economy as a unit of subsistence without any interest in profit making.

III

Now we try to make another interpretation of the group of order 2, which consists of μ and η. From now on, μ can be regarded as an abstract state of production, because it represents the normal metamorphosis of capital. On the other hand η is to be regarded as an indicator of general exchange conditions, since it reflects the position-changing movements of capital. Upon these premises we investigate a model of coverage-of-demand economy (*Bedarfsdeckungs-wirtschaft*), in which production and exchange processes repeat themselves. A simple case of such a model has been formulated by Piero Sraffa in his famous work[2]. A representative type of pure production is a self-sustained or isolated one. In order to clarify its structure we begin with the simplification of the Sraffa's 'production of subsistence' model. Suppose that our economic system consists of only two distinct branches of production, A and B. Let each 'value' of product in A and B branches (abridged as A and B respectively) be denoted as P_a and P_b, and each 'value' of consumption in i or j (i, j=A, B) branch be denoted as A_i and B_j. Then the following relations are obtained:

$$A_A+A_B=A,\ B_A+B_B=B, \tag{1}$$
$$A_AP_a+B_AP_b=AP_a, \tag{2}$$
$$A_BP_a+B_BP_b=BP_b. \tag{3}$$

Equations (2) and (3) are put together into a matrix expression, that is,

$$\begin{bmatrix} A_A & B_A \\ A_B & B_B \end{bmatrix}\begin{bmatrix} P_a \\ P_b \end{bmatrix}=\begin{bmatrix} AP_a \\ BP_b \end{bmatrix}.$$

Since $B_A = A_B = 0$ in isolated production, the left coefficient of the above matrix equation becomes

$$\begin{bmatrix} A & 0 \\ 0 & B \end{bmatrix}\equiv\mu.$$

If the condition $A=B=1$ is added, it is further simplified as

[2] See, Sraffa (1960), pp.3-5.

$$\mu=\begin{bmatrix}1 & 0\\ 0 & 1\end{bmatrix}.$$

Suppose that there remain contingent surplus products A_B and B_A, all of which are to be put into exchange. Then it is represented as

$$\eta=\begin{bmatrix}0 & A_B\\ B_A & 0\end{bmatrix}, \text{ and } A_B=B_A=1.$$

This condition can be regarded as the definition of a complete exchange A_B and B_A.

If the exchange process advances further and transforms A and B branches in isolated production into two sectors called Agriculture and Industry, it is clear that the conditions in which a 'surplus' is produced regularly with complete maintenance of the structure μ can be fulfilled in such a situation. And we are able to assume that both the proportion of agricultural products available for agricultural production and the industrial products for industrial production are less than or equal to 100%, that is,

$$A_A+B_B=1. \tag{4}$$

Furthermore, let us suppose that there exists a planned division of labour that equalizes both proportions in which agricultural and industrial products are put into agricultural and industrial branches respectively. This type of division of labour is always possible in a household ($o\iota\kappa o\varsigma$) economy, that is, a subsistence economy or a 'coverage-of-demand economy' without any spontaneous division of labour. This assumption is expressed as

$$A_B \div A_A=B_B \div B_A. \tag{5}$$

From (4) and (5) we obtain the following equation:

$$\begin{bmatrix}A_A & B_A\\ A_B & B_B\end{bmatrix}\begin{bmatrix}A_A & B_A\\ A_B & B_B\end{bmatrix}=\begin{bmatrix}A_A & B_A\\ A_B & B_B\end{bmatrix}.$$

With μ and η as formulated above we can construct the same type of associative law as shown in Section II. It will be represented by the rules of multiplication of matrices. First, let's associate the first type of η with μ. In this case the following operation ($\times$, multiplication) rules are assumed:

$$\eta\times\mu=\eta,$$
$$\mu\times\eta=\eta,$$
$$\eta\times\eta=\mu.$$

Adding $\mu\times\mu=\mu$ (repetition of production) to these operations, we obtain the following group-diagram:

	μ	η
μ	μ	η
η	η	μ

On the other hand, we cannot obtain the same group-diagram by associating the second type of η with μ. From depicting a similar diagram by applying the above multiplication to the set {μ,

$\eta\}$, another type of diagram is deduced as follows:

	μ	η
μ	μ	η
η	η	η

The relation shown in this table characterizes a semigroup, not a group. Strictly speaking, it is a commutative 'band' or a semi lattice.

As mentioned above, the structure of μ is formally equal to that of the M-group, which can express the structure of 'industrial capital' or a profit-making enterprise. But μ and η cannot be separated in a coverage-of-demand economy, and therefore both of them constitute its structure. Consequently the total cyclical movements of economy represented by the T-group must be composed of two elements, that is, a coverage-of-demand economy and a profit-making economy, both of which may have a symbiotic relationship.

However, when the cyclical movements are joined by the factor of exchange, which is to transform an abstract production and reproduction into a concrete form, there appears irreversible movements. Our next subject is to analyze these aspects of an economic structure.

IV

An irreversible movement is generally repetition with a deviation. Here we try to structuralize an aspect of such a repeating process in discussing a Marxian scheme for reproduction on an extended scale[3]. Let the variable capital and the surplus value of the 'means of production' department be denoted as V_1 and M_1 respectively, the notions of which are also taken to indicate their quantities. Similarly C_2 is to indicate the constant capital of 'articles of the consumption' department. Moreover, σ denotes a certain positive number. Upon these notions the column vector

$$\begin{bmatrix} C_2 \\ V_1 \\ M_1 \end{bmatrix}$$

becomes our subject of investigation. Since no operation of the representation matrix of the M-group upon it can reflect the peculiar situation of extended reproduction, another type of (irregular) matrix must be devised for the operation. It is called the *extended representation matrix* denoted as R. Then,

$$\mathrm{R}=\begin{bmatrix} 0 & 1+\sigma & 1+\sigma \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}.$$

R is an idempotent matrix, because it has a property: $\mathrm{R}\times\mathrm{R}=\mathrm{R}$.

If R is operated upon the above column vector from the left side, we obtain the following

[3] Detailed arguments for simple reproduction and Marx's reproduction schema may be found in Marx (1967), Kamitake (2006) and Kamitake (2008).

equation:

$$\mathrm{R}\begin{bmatrix} C_2 \\ V_1 \\ M_1 \end{bmatrix}=\begin{bmatrix} (1+\sigma)(V_1+M_1) \\ V_1 \\ M_1 \end{bmatrix}.$$

Since R is idempotent, the repetition of these operations brings about the same result. From the equation we obtain

$$\mathrm{C}_2=(1+\sigma)(\mathrm{V}_1+\mathrm{M}_1). \tag{6}$$

Since $\sigma>0$, an inequality

$$\mathrm{C}_2>\mathrm{V}_1+\mathrm{M}_1 \tag{7}$$

is deduced from (6). (7) is the famous condition for extended reproduction.

Let's compare the above results with the case of simple reproduction. The latter has been conditioned by the representation matrix of the M-group, which consists of regular matrices. On the other hand, in the case of extended reproduction a direct operator is not the matrix of the M-group, but the irregular extended representation matrix. The latter matrix is irregular and idempotent, and therefore it belongs to the set of an idempotent semigroup or a 'band'. As this 'band' has no inverse elements, the operation of the same type of matrices cannot express any reversible cyclical movements. The second type of μ deduced above belongs to this type. In other words, once the process of exchange and extended reproduction starts, it is to repeat permanently an irreversible movement with a deviation. This 'law' established in that process reflects a mathematical structure, that is, a *functor* from the *category* of groups to that of semigroups. This situation means a more radical structural upheaval or restructuring than that of simple reproduction, which represents a functor from the category of groups to the category of general linear groups. Of course, the structure of reproduction in the real world is a mixture of simple and extended productions. But the theoretical distinction between simple and extended reproductions suggests the difference between abstract and more concrete productions. Next we examine the abstractness and concreteness of production on its relationship with the machinery system.

V

The simple reproduction that Marx assumed as the starting point of his theoretical analysis of the reproduction scheme corresponds to the economic activity of abstract production. This means a cyclical production, or a process in which the same quantity and quality of products can be produced repeatedly. It is 'capital' that makes possible simple production at the abstract level of logical inference. Then the movements or metamorphosis of capital are represented by a group-structure, especially the M-group.

Meanwhile, a concrete production is not 'simple,' because it may be accompanied by an exchange process that contracts and expands quantitatively, and sets up an irreversible motion. As suggested above, it can be formally represented by a semigroup. Generally any real process of production and reproduction appears at first as a concrete one.

Since a concrete production means 'making a thing' or a technical behavior of humans, it can be resolved into several independent parts. Each of them is originally undertaken by various organs of the human body. They operate themselves as tools, the function of which constitute technical behaviors. If we take up 'the hand' as a representative of these organs, a concrete production process is illustrated as follows:

$$\begin{array}{ccccc}
\text{Raw materials} \Rightarrow & \text{hands} \Rightarrow & \text{hands} \Rightarrow & \cdots\cdots\cdots \Rightarrow & \text{products} \\
\downarrow & \downarrow & \downarrow & & \downarrow \\
0 & 1 & 1+1 & & 1+1+\cdots+1 \\
 & & =2 & & =\text{n(number of production stages)}
\end{array}$$

From the lower parts of the diagram, which shows a series of natural numbers as an additive process, we can see that the structure of a concrete production is isomorphic to that of an additive semigroup. As 'hands' are being differentiated from the organs of the human body, tools as the extension of 'hands' become *machines*. Machine may include a *mechanism*, especially a closed mechanism that is the system of a continuous chain of input and output. In a mechanism, the output becomes the next input, and this successive chain makes up the circle, which is represented by the structure of a cyclic group of finite order.

While the closed mechanism corresponds to an abstract production, the machine or the machinery system appears as a pillar of concrete production. Its most formal structure is the so-called 'finite state machine,' or the mathematical structure of a noncommutative free monoid. In other words, a concrete production by machine reflects an irreversible structure represented by a kind of semigroup, which implies a one-way transition from the initial condition (the first input) to the final one (the last output).

Such a structure can be extended to the universal mega machine of capitalism, in which the reproduction of capitalist societies ruled by various types of mega corporations must be performed through the medium of the capitalist system. Politically, that huge machine may be characterized as a regime of *mechanical totalitarianism*, where all humans mutually govern and are governed through the hierarchical and collective systems of bureaucracy[4]. They gradually change from human beings into, so to speak, *automaton monsters*[5] who only show calculation in their adaptive and selfish patterns of social behavior and are indifferent to the creation of any new social environment. The so-called 'one-dimensional man'[6] who exclusively carries on a unary social operation under the system of 'controlled desublimation' may be regarded as an archetype of automaton monster.

Incidentally we refer to the extended and more general form of automaton monster, that is, the *digital monster*. It is an egocentric human machine for organizing and economizing every digitized information on human life to subordinate the welfare of society to self-interest. Its illustrative and impressive example was presented in the famous SF film 'Forbidden Planet'[7]. As is commonly known, it had 'monsters from the id' appear on the scene of the ruins of a high civilization where its 'people' had developed the technology to materialize or reify any object[8].

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4 See, Kamitake (2007).

5 It is considered unsuitable to use the word 'animal' instead of 'monster', because any species of animals except mankind cannot develop and disseminate the culture of vice and fratricide. In relation to my choice of words Toynbee gives a suggestive historical interpretation. See, Toynbee (1976).

6 See, Marcuse (1964).

7 That film was presented by MGM in 1956.

However, various digital monsters also emerge in our civilized societies, not from personal psychology, but from system-rationality[9]. For example, an information industry as a social system perform its own function of digital data processing to become an autopoietic finite state machine or a digital monster. Similarly the media system follows the same sort of evolution, and yet its autopoiesis may often allow the ruling class of broadcasting circles an exclusive privilege to enjoy the freedom of speech and information, and transform its whole system into a giant digital monster.

VI

Some important points have not been discussed concerning metamorphosis analysis. Amongst others, we must take into consideration that the above theoretical formulations suggested by Marx contain no temporal elements. Indeed Marx failed to evaluate and formulate the 'profits upon alienation' posed by James Steuart[10], and consequently the principle of 'comparative costs' devised by David Ricardo[11]. These concepts necessarily contain a discussion on economic time-paths that cannot be analyzed within the system of Marxian economic theory. Now we introduce a new system of symbols and terms to construct a temporal system of commodity exchange. Here we examine the 'profit upon alienation' introduced by Steuart. It may be considered an essential factor that makes possible the existence of a capitalist system, but its theoretical formulation can be conducted through an abstract comparison of various cost-structures, as was first performed by Ricardo.

Such a formulation may be performed under two situations of commodity exchange; (1) exchange between real goods, and (2) monetary exchanges. Both cases can be represented as follows;

(1) If we suppose the exchange between a good X and two kinds of goods Y and Y'(= Y + δY), we have the following equations or input-output schema:

$$\begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} \times \begin{bmatrix} X \\ Y \end{bmatrix} = \begin{bmatrix} Y \\ X \end{bmatrix}, \text{ or } \begin{bmatrix} X \\ Y \end{bmatrix} \rightarrow \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} \rightarrow \begin{bmatrix} Y \\ X \end{bmatrix},$$

$$\begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} \times \begin{bmatrix} X \\ Y' \end{bmatrix} = \begin{bmatrix} Y' \\ X \end{bmatrix}, \text{ or } \begin{bmatrix} X \\ Y' \end{bmatrix} \rightarrow \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} \rightarrow \begin{bmatrix} Y' \\ X \end{bmatrix}.$$

Consequently, a profit is likely to accrue.

(2) If we suppose the situation that money (M) and two different sorts of goods (X, Y), we have the following equation;

$$\begin{bmatrix} 1 \times M & 0 \\ 0 & 1 \times M \end{bmatrix} \times \begin{bmatrix} X \\ Y \end{bmatrix} = \begin{bmatrix} MX \\ MY \end{bmatrix} = \begin{bmatrix} M' \\ M'' \end{bmatrix}.$$

As a result a profit can also accrue as a different quantity of money ($|M' - M''|$).

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[8] Technology is, Herbert Marcuse puts it, 'the great vehicle of *reification*'. See, Marcuse (1964), p.168.

[9] See, Luhmann (1975), S.119ff.

[10] See, Chapter 4 in the Book 2 of Steuart (1767).

[11] See, Chapter 7 of Ricardo (1817).

In both cases there must be a difference between two rates of exchanges (=prices) for the existence of the 'profit upon alienation'. Then we define the set of time-points (T) when exchanges with profits (or losses) are made and the set of prices (P) in these exchange transactions:

(i) a set of time-points T

In $T=\{t\}$ the structure of an ordered semigroup is generated and an index set with an order ($<$) is defined as follows;

$$t_i < t_{i+j} (j \geqq 1),$$

where i, j are supposed to be natural numbers.

(ii) a set of prices P

In $P=\{p\}$ the structure of an ordered group is generated and an index set with a reversible order ($><$) is defined as follows;

$$p_{t_i} >< p_{t_{i+j}},$$

where the difference of prices may be occasionally determined and there are profits or losses according to the sign of the term $(p_{t_{i+j}} - p_{t_i})$.

Under these definitions the mapping from T to P makes the pricing operator and the inverse mapping from P to T creates a more fundamental operator that transforms periods of time into commodities. These two mappings represent the time-structure of commodity-metamorphosis.

The next and final consideration is the relation between metamorphosis and time. As remarked above, the extended reproduction of capital means an irreversible process of metamorphosis of capital. It may be reduced to an abstract structure of *semi-metamorphosis* that is represented by the algebraic structure of semigroups. In a more general expression metamorphosis transforms itself into *irreversible* metamorphosis or semi-metamorphosis, and finally universal one-way metamorphosis with an infinite series of apoptosis of all natural beings. However, when the temporal structure of metamorphosis as such should be considered, a formal contradiction may be incurred. Since time does not 'fly,' but converges to a *null point* where past and future play the same role[12], the metamorphosis of time is reduced to the nullifying of time. In other words, every span of time makes a set of measure zero in our real world. As time goes by, the entropy of our universe increases at an accelerating rate and at a certain point of time, the metamorphosis of life in the synusia or *οίκουμένη*[13] of the animal world (biosphere) cannot take place any more. Especially in the *οίκουμένη* of humans, the so-called 'double contingency[14]' of information exchanges may decrease the content of real and meaningful messages because of the explosive increase of junk information. As a result, the majority of time for humans that can be represented by necessary information will disappear and at the same time the metamorphosis of real life may gradually cease to operate. Ultimately the third industrial revolution[15] in the twentieth and twenty-first centuries may lead to *an*

[12] This point of reasoning is suggested by Prigogine (1997). Logically the null point indicates the evanescence of modality.

[13] As to the *οίκουμένη* in the biosphere, see, Toynbee (1976).

[14] See, Chapter 3 of Luhmann (1984).

industrial counterrevolution that will raise the grade of 'social uncertainty[16]' up to an irreversible and uncontrollable level.

References

Kamitake, Y. (2006), 'The Formal Structure of Metamorphosis of Capital,' in *Hitotsubashi Journal of Economics*, Vol.47 No.1.

Kamitake, Y. (2007), 'From Democracy to Ochlocracy,' in *Hitotsubashi Journal of Economics*, Vol.48 No.1.

Kamitake, Y. (2008), 'The Formal Structure of Industrial Revolutions,' in *Hitotsubashi Journal of Social Studies*, Vol.40 No.1.

Luhmann, N. (1975), 'Funktionale Methode und Systemtheorie', in Bühl, W.L., *Funktion und Struktur: Soziologie vor der Geschichte*, München, Nymphenburger Verlagshandlung.

Luhmann, N. (1984), *Soziale Systeme: Grundriss einer allgemeinen Theorie*, Frankfurt am Mein, Suhrkamp.

Marcuse, H. (1964), *The One-Dimensional Man*, USA, the Beacon Press.

Marx, K. (1967), *Capital: A Critique of Political Economy*, Vol.II, Moscow, Progress Publishers.

Prigogine, I. (1997), *The End of Certainty*, New York, the Free Press.

Ricardo, D. (1817), *Principles of Political Economy, and Taxation*, 2nd ed., London, Murray.

Sraffa, P. (1960), *Production of Commodities by Means of Commodities: Prelude to a Critique of Economic Theory*, Cambridge, Cambridge University Press.

Steuart, J. (1767), *An Inquiry into the Principles of Political Oeconomy*, Vol.1, London, A. Millar and T. Cadell.

Toynbee, A. (1976), *Mankind and Mother Earth*, New York and Oxford, Oxford University Press.

[15] See, Kamitake (2008).

[16] *Ibid*., p.53.