Why We Need Big Data?

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Abstract – *We describe necessity of Big Data from aspects of macroeconomics. In service science capitalism, measurements of values of products need Big Data to construct large knowledge systems. Service products are classified into stock, flow, and rate-of-flow-change. Immediacy of Big Data implements and makes sense of each classification. And we provide a macroeconomic model with behavioral principles of economic agents. The principles have mathematical representation with high affinity of correlation deduced from Big Data.*

Keywords: macroeconomics, service science, Thetical economics and Antithetical economics

1 Introduction

To manage our society, we need appropriate use of Big Data. Complication of society increases issues which we have to solve. If we solve an urban problem, the solution makes new issues. It is represented ironically as Parkinson's law. Strategic solutions for the issues often need large data. Urbanization, which makes ICT social infrastructures, and appearance of Big Data change our approaches for the issues. Before appearance of Big Data, we search data for causal relationships. But after Big Data, because of its huge size, we can acquire sufficient correlation to solve the issues. It means that correlation substitutes for causation (Figure 1).

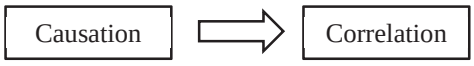

Figure 1. Relationship in the world dominated by Big Data.

ICT reduces sectionalism of governments and enables us to solve urban problems by collaboration of mutual sections. Importance of a person who plays role of control tower of each section increases in such mutual society. The person is CEO or president in corporations, and is prime minister in government. Decision makings of the person design our society. Grand design of society consists of designs of each sector of the society. Each design must be verified that the design is in accordance with the grand design. We need Big Data to construct a strategy by integrating designs and to verify accordance between the strategy and the designs.

The society is dominated by economics. Big Data from economic activities are important us for our decision makings or for the construction of the strategy. In this paper, we describe necessity of Big Data from aspects of macroeconomics.

2 Big Data for service science capitalism

In 1980's, researchers of macroeconomics recognized difference between goods products and service products, and they have tried to define what service products are. Now, service products are defined as products that have properties: intangibility, immediacy, variability, perishability, and customer's high satisfaction.

A major premise of macroeconomics is that our world is capitalism. If the world is not capitalism, then every theory of macroeconomics has non-sense. So, researchers of macroeconomics, managers of companies, or government administrators must consider whether we are in the world with capitalism.

The most important concept of capitalism is fixed price sales. Fixed price sales enable us to run our planned business and guarantee value of capitals.

To enforce fixed price sales without any contradictions on our business, we must measure values of our products precisely. In a word, precise measurements of products provide bases of every index about economics and managements in the world of capitalism; the measurement of values of products is an element forming economics and managements.

For any goods products, we can measure its values relatively easily. Because the goods have physical entities and properties, we can reduce eventually their values to their length, weight, temperature, velocity, or entropy.

On the other hand, we cannot measure values of service products easily. Service products often stand on relations between goods and goods, or between services and services. Relationship is combinations of products, and increasing the number of the combinations makes measurements of values of the products complex. As service products consist of some lower level services, they are developed in high abstraction level far from physical goods products. To overcome the complexity and the distance abstraction level, we need much knowledge of many fields.

In early 2000's, IBM researchers advocated a necessity of "service science" which is a new research filed to construct

knowledge systems for service products. We need accumulation of knowledge. It means that we must collect Big Data and extract new theories form Big Data.

We refer to a society in which almost all employees work for service industry as service science capitalism society. In the society, every price value has large amount of information in the background of the value, and the value is detected in high abstraction level far from its physical entity. To fill the gap between abstraction levels, we must learn techniques which reduce from Big Data to a value through experience.

3 Big Data and classification of services

Big Data provide us new measurements for service products, and enable us to classify service products into three services: stock service, flow service, and rate-of-flow-change service. Stock service is construction of social infrastructures or information infrastructures. Flow service is ordinary everyday service which provided by government administrators and private companies. Rate-of-flow-change service is unusual service.

There is an analogy between physics and economics. In physics, a phenomenon is described in distance, velocity, and acceleration. Establishing the three concepts makes modern physics since 17th century. While economics was made by establishing three concepts: stock, income, and growth rate. In economics, a product is described in the three concepts. Distance, velocity, and acceleration in physics correspond to stock, income, and growth rate in economics, respectively. Distance and stock are measured by some accumulations. Velocity and income are represented in time differentiations. Acceleration and growth rate are represented in twice differentiations. The classification of service products corresponds to the concepts of physics and economics. We summarize it in Table 1.

The classification presumes that we can trace changes of values of service products every times. It corresponds to time derivative in physics. Immediacy of Big Data provides us feasibility the classification.

4 A macroeconomic model on Big Data

When we use Big Data sufficiently, correlation plays important roles in any analyses of economics. So we must build macroeconomic models which we can construct by detecting parameters from correlation deduced from Big Data.

4.1 Thetical economics and Antithetical economics

Kinoshita provides a macroeconomic model which is referred to as "Thetical economics and Antithetical economics." That is a rearrangement of theories of macroeconomics into two set; a set of them is Thetical economics and another set is Antithetical economics. If Say's law is valid in an economic phase in an economic cycle, then the Thetical economics dominates the phase. We feel that we are in normal economy and economic growth in the phase. While if the Keynes's effective demand is effective in an economic phase, then the Antithetical economics dominates the phase. We feel that we are in depressed economy in the phase. Economic phases dominated by Thetical economy and economic phases dominated by Antithetical economy are illustrated in Figure 2.

Easy to say, Thetical economics represents what prosperity is, while Antithetical economics represents what recession is.

With the macroeconomic model, we can provide behavioral principles of economic agents such as corporations and governments as follows:

A principle of corporations under Thetical economics

Objective function (maximize profits)

$$\text{Max } \sum_{j=1}^{n} c_j x_j \quad (1)$$

Constraint condition

$$\sum_{j=1}^{n} a_{ij} x_j \leq b_i, \qquad i = 1, \dots, m \quad (2)$$

A principle of corporations under Antithetical economics

Objective function (minimize debts)

$$\text{Min } \sum_{i=1}^{m} u_i b_i \quad (3)$$

Constraint condition

$$\sum_{i=1}^{m} a_{ij} u_i \geq c_j, \qquad j = 1, \dots, n \quad (4)$$

Following list is correspondence of variables and its meanings.

x_j : The number of units of a product j made by the corporation.

c_j : The amount of profits of one unit of a product j; $P_j - (1 + r)h_j$, where P_j is price of the product j, r is interest rate, and h_j is cost of the product j.

a_{ij} : Costs in an account subject i to produce the product j for one unit.

b_i : The amount debts of an account subject i.

u_i : Unpaid balance rate for the accounting subject i; $u_i = 1 - \text{amortization\_rate}$.

A principle of governments under Thetical economics

Objective function (fiscal reconstruction)

$$\text{Min } \sum_{j=1}^{N} G_j K_j \quad (5)$$

Constraint condition

$$\sum_{j=1}^{N} A_{ij} K_j \geq B_i, \qquad i = 1, \dots, M \quad (6)$$

A principle of governments under Antithetical economics

Objective function (fiscal stimulus)

$$\text{Max } \sum_{i=1}^{M} Y_i B_i \quad (7)$$

Constraint condition

$$\sum_{i=1}^{M} Y_i A_{ij} \leq G_j, \qquad j = 1, \dots, N \quad (8)$$

Following list is correspondence of variables and its meanings.

K_j : A rate of the remainder of national loans for an administrative service j . Increasing the rate increases expenses of the service j.

G_j : Demand for funds as national loans for an administrative service j.

A_{ij} : Satisfaction of a resident i when the government gives the resident one unit of costs of a service j.

B_i : A desiring level of total services of the government for a resident i.

Y_i : The amount of public money to increase satisfaction by one unit for a resident i.

In usual studies of the macroeconomics, economic agents, such as customer, corporations, and governments, are modeled simply. All agents expand their profits, they are well-disciplined, they can acquire all information of markets, and their behavior is rational. The principles, which we provide, give a concrete mathematical model of the rationality.

The behavioral principle is linear equation system. Construction the principle is detecting parameters of the equations. So, the model has high affinity with correlation obtained from Big Data.

4.2 Macroeconomic explanation on the model

As an example, we provide an explanation of macroeconomic phenomena in Japan since 1980 with the model. Let us see Figure 3, which represents transition of financial net worth of corporations (non-financial enterprises) in Japan. Japan is dominated by Thetical economics before 1995, and is dominated by Antithetical economics after 1995.

Before 1995, corporations increase investments. It is an evidence of behavior of maximization of their profits; the Japanese economy was dominated by Thetical economics. In Japan, Heisei bubble collapse at February 1990. Five years later, Japanese economy was into recession in 1995. Since the year, corporations decrease their debts and increase their savings. It shows a change of behavioral principle of them; the economy is dominated by Antithetical economics.

GDP (Gross Domestic Products) is a macroeconomic index which represents business conditions of the nation. GDP (often denoted in Y) is sum of national consumption (C), national investment (I), governmental fiscal stimulus (G), and trade gap(E).

$$Y = C + I + G + E \quad (9)$$

Transition of GDP of Japan is shown in Figure 4. From the change of the index, we can confirm that Japanese corporations do not expand their profits since 1995.

5 Conclusions

We describe necessity for our society of Big Data in the macroeconomic aspect. Because our society has entered service science capitalism, the necessity becomes larger. In this paper, we explain that we need Big Data for measurements of service products, and we provide a macroeconomic model which can be constructed from correlation deduced from Big Data. As an example of use of the model, we show analyses of Japan since 1980. We enforce to analyses of other countries with the model in future works.

6 Acknowledgement

In Figure 3, financial net worth of non-financial enterprises in Japan from 1980 to 2015, we use data arranged by Dr. Takanobu Hiromiya.

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Table 1: Classification of Service Goods

Mathematics	Physics	Economics	Service goods	Service Examples	Measuring Service Values
Original variation	distance	Asset (stock)	Stock service	Government Service Social Security System Social Infrastructure Information Infrastructure	Measurement of Stock Service Values Integrating with time axis : cost-benefit analysis
Differentiate once with time	speed	Income (flow)	Flow service (common service)	Fast food Convenience stores Yoshinoya's "beef bowls,"etc.	Measurement of flow service values Differentiating with time axis: CS research
Differentiate twice with time	accelera tion	Growth rate (rate of flow variability)	Rate-of-flow-change service (uncommon service)	Kagaya Ritz-Carlton, Osaka Gion	Measuring Value of flow rate of variability service Comfortable variation : fractal measurement

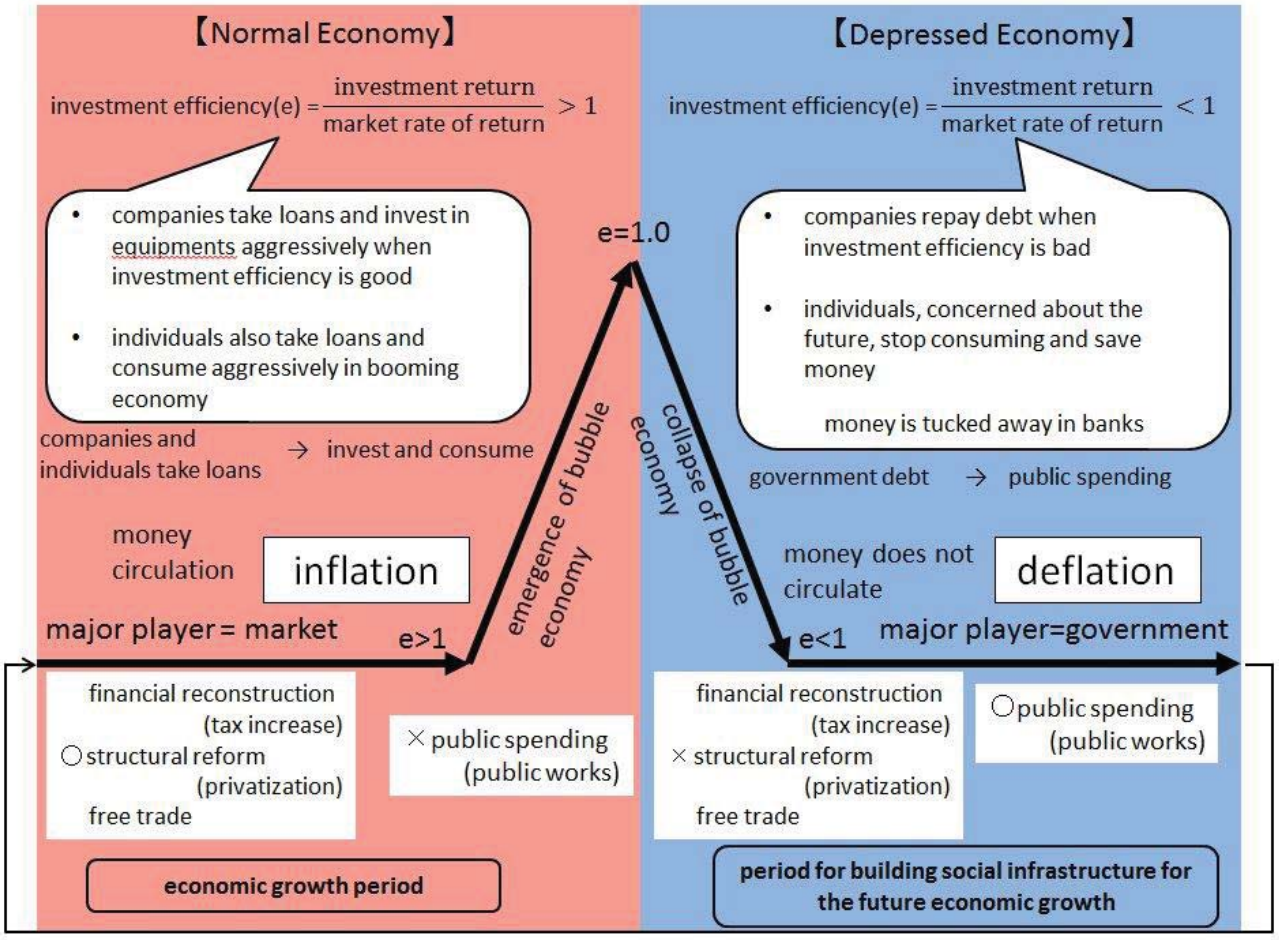

Figure 2. A macroeconomic cycle.

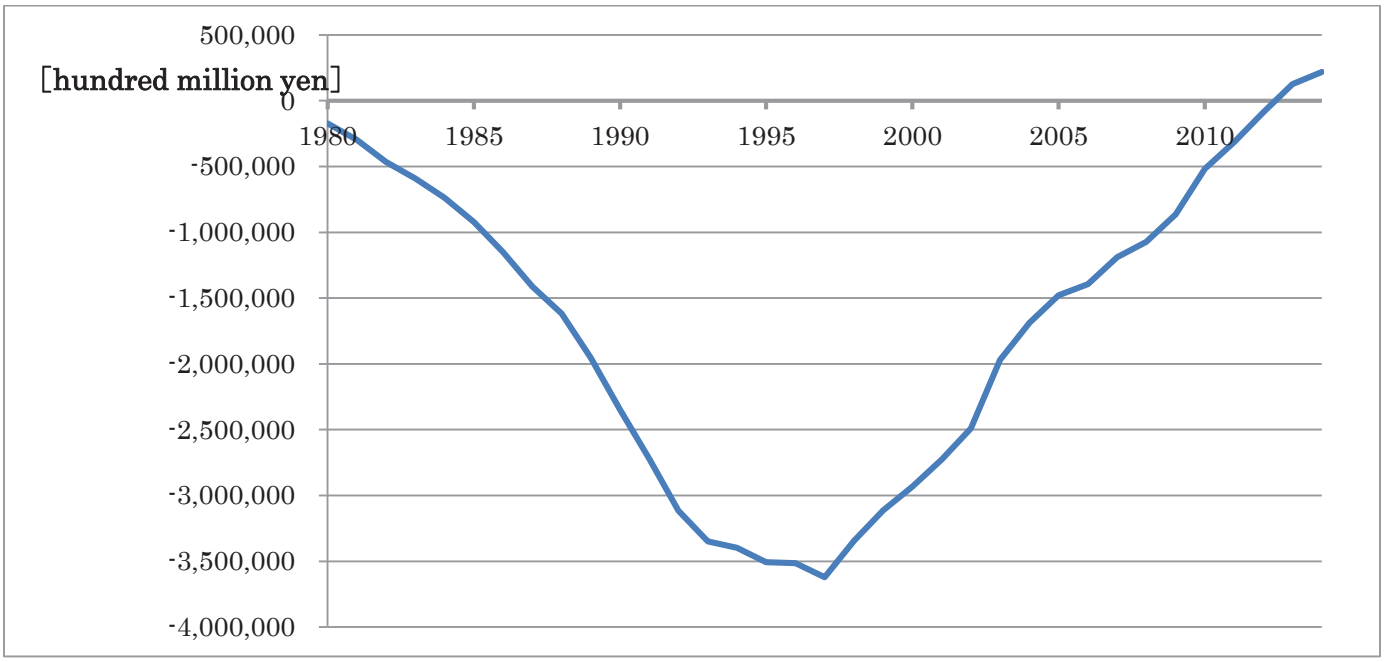

Figure 3. Financial net worth of non-financial enterprises (total) in Japan from 1980 to 2015. The data from the Bank of Japn.

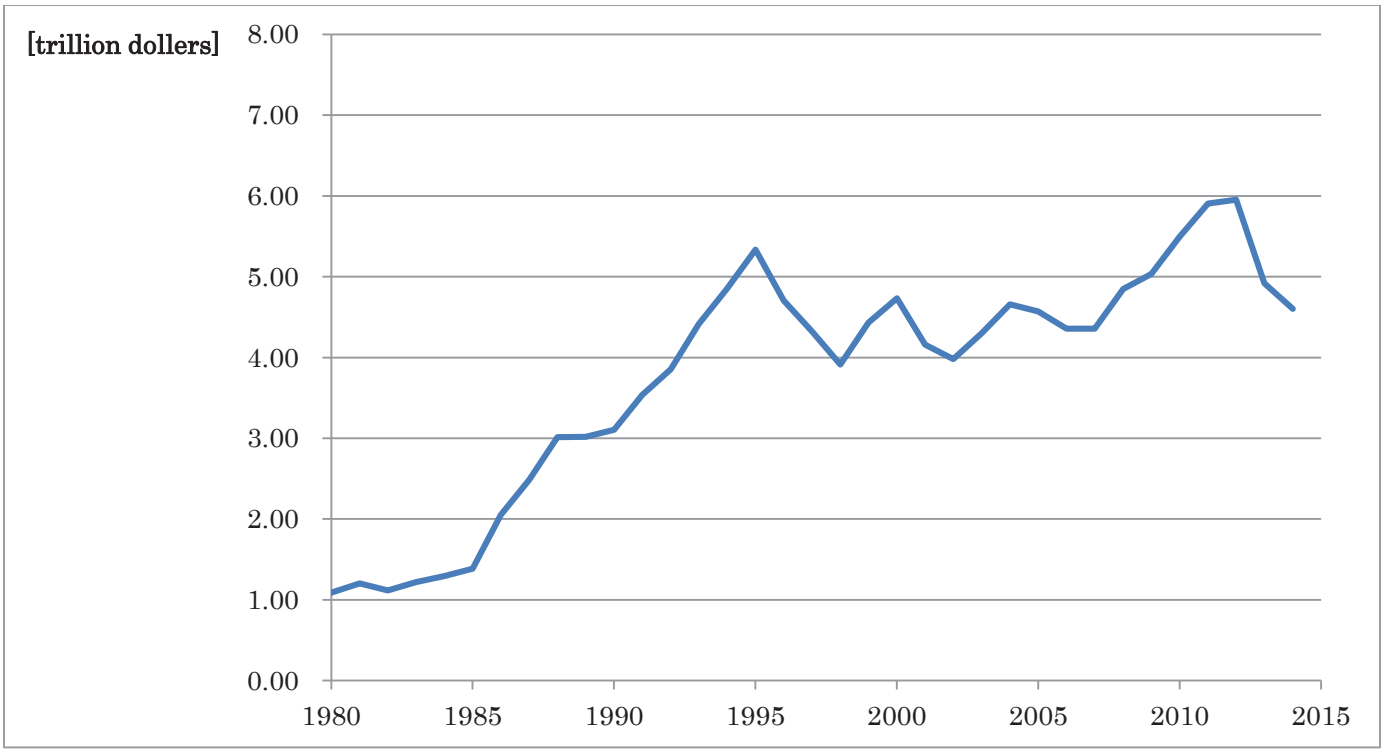

Figure 4. Nominal GDP of Japan since 1980. The data from the World Bank.