Cyclical Cooperation and Non-cooperation in an Economic Organization
-- Implications for the Japanese Economy

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Abstract

This study attempts to provide a model explaining the dynamic behavior of an individual's cooperativeness and the evolution of an economic organization based on the implication of prospect theory. By endogenizing an individual's willingness to cooperate through its direct impact on his utility function and incorporating the factors of cooperation attitude and the individual's output share in the Ricardian type of production function, this model is able to describe the cyclical fluctuation of the individual's willingness to cooperate. This study concludes that except for perfect alignment of the initial cooperativeness among its constituents, the dynamics of an organization's cooperation cycle will be very irregular. The gradually widening and divergent cooperation attitudes among its constituents will eventually lead to the collapse of the organization. Finally I discuss the implications of this model for Japan's recent economic reform.

Keywords: Cooperation Cycle; Economic organization; Prospect theory; Japanese Economy; Institution evolution

JEL: D2, D9, L2, O5, P1

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1. Introduction

Throughout history, an individual's free choice and the government's central authority have gone hand in hand. Nowadays the bottom-up mechanism like democracy or capitalism seems to transcend the top-down totalitarianism or communism.[1] However, these two mechanisms will alternate if the evolution of our economic system can be examined over a longer span of time. As Douglass North argued in his recent book (2005) that the key to human evolutionary change is the intentionality of the players, the alternation of these mechanisms, therefore, is for the most part a deliberate process shaped by the perceptions of the individuals about the consequences of their actions. My study basically follows North's analysis and ascribes the above institution change to the interaction of two opposing forces that dictate an individual's daily behavior: one is pro-individual's autonomy and absolute freedom; the other favors gregariousness and is prone to yielding to the central governance. This paper examines the deeper determinants of how these forces evolve and how economies change.

A country would behave like a representative individual if we could ignore the problem of aggregation. Henceforth, I will treat the issue of inter-country's relationship as the one of inter-person's, and focus on the general theory of organization that can bring in the cyclical consequence. Different structure of organization provides different incentives to the individuals of the organization. The bottom-up system is primarily driven by an individual's self-interest. The organization thus formed provides a platform to accomplish the benefit of cooperation based on a Nash non-cooperative solution concept. On the other hand, the individuals in the top-down system give up more of their own freedom of choice in return for a greater public benefit. The individuals distribute more of their utilities toward the public benefit rather than their own private benefit. The organization is thus constructed on a more cooperative basis. In general, the proportion of an individual's utility put on the organization as a whole (altruism) versus the proportion put on the individual himself should be dynamically determined in the system.

Modern society has thrived on the market prowess. The new upper-class generation has amassed great wealth through the corporate ladder. Giant multinational companies are the leviathan navigating the flow of capital and global resources. They

[1] Since World War II most of the countries in the second group with the top-down mechanism have reverted to socialism or "capitalism from above". In this case, we can re-categorize the first group (bottom-up mechanism) as the "capitalism from below".

are the owners of not only physical capital but also knowledge capital. Under the pretext of democracy and free market, their self-interest can be unflinchingly stretched and extended to every corner of the world market, grabbing most of the fruits of production. This trend of development has left remaining no other nexus between man and man than naked self-interest, than callous ‘cash payment’. It has resolved personal worth into exchange value and reduced the family relation to a mere money relation.

These new corporate elite cannot survive without constantly revolutionizing the instruments of production, and thereby the relations of production, and with them the whole relations of society. Into their place stepped free competition, accompanied by a social and political constitution adapting to it, and by the economical and political sway of the elite class. This bottom-up capitalistic system is initially constructed with the premise that all men are created equal. The ladder to the top is supposed to be open to all individuals. However, indefensible road-blocks, such as lack of social mobility, severe information asymmetry, and limitation of market, have endowed those front-runners with privileges in obtaining property rights of social resources and gradually eroded the foundation and stability of this system. We have witnessed the aggravation of income disparity around the world. A survey of the world economies at the beginning of the twenty-first century reveals unprecedented prosperity as compared to economic conditions in the past. Yet more than a billion people around the earth still exist on less than one dollar a day and more than two-and-a-half billion on less than two dollars a day. Even in the most praiseworthy capitalistic nation, the United States, income inequality has worsened. According to a study by the Economic Policy Institute, the rich have been doing dramatically better than the less well-off in the past quarter-century. Since 1979, median family incomes have risen by 18% but the incomes of the top 1% have gone up by 200%. In 1970, the bottom fifth received 5.4% of America’s total national income and the richest fifth got 40.9%. Twenty-five years later, the share of the bottom fifth had fallen to 4.4% but that of the top fifth had risen to 46.5%.

The polarization of income distribution in the Western capitalistic societies has gradually undermined the stability and jeopardized the foundation of the bottom-up market system. On the other hand, the consecutive collapse of communist countries in the late twentieth century portends the eventual demise of the top-down systems. We are in need of an economic theory to illuminate the above undulation of our economic systems. An interesting example of the impending system change is the recent economic reform conducted by Japan’s prime minister Junichiro Koizumi. Through a series of privatization or liberalization policies the Japan's government intends to put the long- and strong-held state enterprises into the "market tests". This reform has aroused a big backlash from not only the opposition parties but also his own Liberal Democratic Party (LDP) (Amyx, 2005). The heated battle between market-friendly reformists and the conservative old guard challenges all the Japanese's choices between central governance and individual's liberty. In the past Japan has been noted for her giant corporations and powerful government rather than complete reliance on the market mechanism. From a longer historical perspective, the merits and choices of external market mechanism or internal organization should be ultimately determined by the individual's predilection to cooperation or non-cooperation.

The tools of orthodox economic theory were constructed to explain the gains from trade between consumers and firms through an effective market operation. However, due to the limitation of markets, internal organization as an engine of growth has become more prevailing not only for multinationals but also for countries. Recently anti-globalization movement undermines the free-trade principle of WTO. There are instances where a group of countries will decide to completely eliminate all tariffs between them, without eliminating tariffs on goods imported from the rest of the world. This is so called regional agreement between countries involved. There must be some rationale behind the development of internal organization and the prevalence of regional economic agreement, especially its motivation, size and dynamic behavior.

This study attempts to provide a model explaining the dynamic behavior of an individual's cooperativeness and the evolution of an economic system based on the implications of prospect theory developed by Tversky and Kahneman (1979). According to the prospect theory, the objective function that a representative individual is intended to achieve is defined to be the gain or loss relative to some reference point. If the individual accomplishes more gain than loss in the past, his reference point will be raised by the Bayesian learning rule, thereby making the further gain less likely and bringing in the seed of withdrawing from his initial economic choice (e.g., backing up from the regional agreement). Analogously, when the individual suffers from more loss than gain and refrains from making an initial choice, his reference point will become lower and lower and facilitate the gain from his further choice.

The formation of reference point in determining the gain or loss from advancing a relation with its counterpart is critical to overturn an initial decision and result in a cycle. According to the experience of our learning process, our reference point is closely related to our past history and the position of our peers. As for the source of value from which potential gain or loss might be derived, it is defined from the content of each issue. For instance, if we would like to evaluate the consequence of joining a regional agreement, either the factor ratio difference (as in the Heckscher-Ohlin model) or the diverse relative comparative advantage (as in the Ricardo model) among the member countries in the region is the driving force that causes the gain or loss of the value function.

This study will reexamine the human decision by extending the implication of prospect theory in several dimensions. First of all, I categorize two different forces that drive the formation of our daily decision, that is, conforming (or cooperative) force vs. centrifugal (or self-loving) force. The former facilitates us to adapt to the outer environment by conforming our decision to the majority of society. The reference points or benchmarks for our decision are the imprints on our minds that are cultivated gradually from our education, experience, culture and history. To secure our survivorship we tend to seek a mental and physical safe harbor by abiding by the majority rule. The latter (centrifugal or self-loving) force accounts for the formation of self-identification. By purposefully distinguishing ourselves from others we are able to ascertain our own identity and pride. Under the patronage of property and human right an individual’s character can be nurtured and developed. The resulting idiosyncrasy of our society contributes to the innovation and the continuation of our growth.

Secondly, this study suggests a theory of organization that is able to relate its performance to the degree of compactness or coherence among its components. Akin to the concept of synchronization between two oscillators (Pikovsky, Rosenblum and Kurths, 2001), I measure the degree of compactness by the cooperation attitude embraced by all its members. It is a well-known physical phenomenon that whenever the phase difference between two interacting oscillators is not too big, a common congruous phase will be developed eventually. The speed of convergence is closely related to the degree of coherence among the components. Analogously, if the constituents of an organization have embraced a common goal or mission like most of the Japanese enterprises, their cooperative momentum will be more in tandem and more prone to developing into a common cooperation pattern. When the degree of coherence or correlation among the constituents exceeds some threshold, we will observe the formation of synchronization. As we change the correlation coefficient (or cooperation coefficient in my model) from null to one, the coupled system will evolve from strongly asynchronized, weakly asynchronized, to weakly synchronized, and strong synchronized. The generalization of this model can pave the way for understanding the corporate behavior with different degree of coherence among its members.

The third element of this study is to endogenize the degree of coherence among the constituents in an organization. Each individual will dynamically choose his weight associated with the aforementioned conforming (cooperative) force and centrifugal (self-loving) force in the determination of his ultimate welfare. If he puts more weight on the conforming force, he can gain more from affiliating with an organization as a result of increased coherence with his colleague but weaken his incentive to innovate and start his own business. If he favors more on the centrifugal force, he will gain more from his own way of life (business) than the shared benefit of a giant corporation. Depending on the adjustment of his reference point, we can depict a dynamic cycle of cooperation (more weight on conforming force) and non-cooperation (more weight on centrifugal force).

I lay out the basic model in the section 2. The optimal cooperative strategy for each individual is derived in the section 3. A computer simulation of the model is conducted in the section 4. Section 5 applies this model to the interpretation of recent Japan's economic performance. Finally I discuss some other implications of this study in the section 5.

2. Basic Model

There are basically two dimensions of forces interacting within each individual's mind: one is internal self-satisfying force, the other is the accommodating force with outer world. The former accounts for the activities that are primarily driven by self interest, including the seeking of social status, control right, and the satisfaction from material consumption. The latter reflects the interaction of our selves with others and derives the utility from harmonious relationship with outer environment. The internal self-satisfying force motivates the activities that distinguish our selves from others and contributes to the innovation and the idiosyncrasy of the real world. The outer accommodating force can explain our gregarious predisposition and cooperative behavior.

In the western economies, economic activities are driven by self-interest. Any interaction with others is described on the non-cooperated basis. Even the existence of cooperative behavior can also be illuminated by the spur of our self interest. In other words, there would be no such things as unconditional cooperation. In this study, I consider an individual's utility that incorporates the measure of harmonious relationship with outer world in addition to the conventional self-interest argument.

For simplicity it is assumed that there are two persons (A and B) and two goods (X and Y). Based on a Ricardian economy, each person is characterized by his productivity in X and Y. For instance, person A (B) can produce α_X^A (α_X^B) of X good and α_Y^A (α_Y^B) of Y good per unit of labor input. Initially person A has a relatively comparative advantage in producing X good while person B has an advantage in producing B, i.e., $\alpha_X^A / \alpha_Y^A > \alpha_X^B / \alpha_Y^B$.

Each individual can work independently as the Robinson in his island in such a way that he has to produce both goods with the proportion depending on his preference. Or he can work with the other as an organization in which he will specialize in the production of the good that caters to his comparative advantage, that is, person A specializes in producing good X while person B in good Y. When a person decides to work as a team, his working attitude and productivity as measured by $\alpha_i^j (i = X \,\&\, Y, j = A \,\&\, B)$ will change accordingly. I assume that the productivity of each individual is a positive function of the degree of his cooperativeness (η) and his share of the total output of the organization (S). More specifically, η measures the proportion of an individual's utility that he is willing to place on the welfare of others. The greater η is, the greater concern he will give toward the overall performance of the organization and the more cooperative he will become. It is also apparent that the greater share (S) of the total output for this individual, the more motivated he will be to work hard for the organization. Both η and S are changing in time in my model (see below). Therefore I can depict an individual's productivity as

$$\alpha_i^j(t) = \alpha_i^j(\eta_t^j, S_t^j), i = X \,\&\, Y, j = A \,\&\, B, \text{ with the property that}$$

$$\alpha_{i\eta}^j \equiv \frac{\partial \alpha_i^j}{\partial \eta_t^j} > 0 \quad \& \quad \alpha_{iS}^j \equiv \frac{\partial \alpha_i^j}{\partial S_t^j} > 0.$$

Each individual (say person A) will maximize the following inter-temporal utility by choosing the optimal weight (η_t^A) of the other's utility in his own utility for all time t $(t = 1, \ldots \infty)$:

(1) $$\sum_{t=1}^{\infty} \delta^t (U^A(t) - \gamma U^A(t-1)) \text{, where}$$

$$U^A(t) = (1-\eta_t^A)\left[\beta * \ln\left(\alpha_X^A(t) * S_t^A\right) + (1-\beta) * \ln\left(\alpha_Y^B * (1-S_t^B)\right)\right]$$
$$+ \eta_t^A\left[\beta * \ln\left(\alpha_X^A(t) * (1-S_t^A)\right) + (1-\beta) * \ln\left(\alpha_Y^B * S_t^B\right)\right]$$

$U^A(t-1)$ can be similarly derived. δ denotes the individual's time preference. We have taken a logarithm of the utility level that is of Cobb-Douglas type with parameter β. When person A maintains a relative comparative advantage in producing good A (so person B has an advantage in good B), S_t^A stands for person A's share of both good X and good Y in the joint production at time t while S_t^B stands for person B's share at time t. The first term in $U^A(t)$ represents the utility derived from the direct allocation to person A based on his productivity contribution while the second term reflects his altruistic satisfaction from the allocation to his working partner (person B). In case that person A's relative comparative advantage for good A and good B is reversed, he will shift to specialize in the production of good B instead. Then the $U^A(t)$ above will change to be

$$U^A(t) = (1-\eta_t^A)\left[(1-\beta) * \ln\left(\alpha_Y^A(t) * S_t^A\right) + \beta * \ln\left(\alpha_X^B * (1-S_t^B)\right)\right]$$
$$+ \eta_t^A\left[(1-\beta) * \ln\left(\alpha_Y^A(t) * (1-S_t^A)\right) + \beta * \ln\left(\alpha_X^B * S_t^B\right)\right]$$

The subtraction of $U^A(t-1)$ from $U^A(t)$ in the above inter-temporal utility function is considered so that I can examine the implication of the prospect theory. In other words, the reference point for the person A is his previous utility level. The parameter γ $(0 \le \gamma \le 1)$ is written to measure the degree of adherence for this individual's behavior to abide by the prospect theory. When $\gamma = 1$, he is only concerned with the relative change of utility by completely ignoring the absolute level of his present utility. When $\gamma = 0$, this model returns to the conventional economic setting in which the individual is only interested in his absolute utility level. When $0 < \gamma < 1$, this individual will pay attention to both absolute and relative utility level with the weight of $1-\gamma$ and γ respectively.

3. Optimal Choice of Cooperative Strategy

Each individual will choose his best cooperative strategy so as to maximize his inter-temporal utility (1). According to the Ruler equation, we can derive the first order condition for person A as

$$(2)\quad \frac{dU^A(t)}{d\eta_{t-1}^A} + \delta \cdot \frac{dU^A(t-1)}{d\eta_{t-1}^A} = 0.$$

To analyze the equation (2) we first need to examine the terms $\frac{dS_t^A}{d\alpha_X^A(t-1)}$, $\frac{d\alpha_X^A(t)}{d\eta_{t-1}^A}$, $\frac{d\alpha_Y^B(t)}{d\eta_{t-1}^A}$ and $\frac{d\alpha_X^A(t-1)}{d\eta_{t-1}^A}$ in the case that person A specializes in the production of good X or the terms $\frac{dS_t^A}{d\alpha_Y^A(t-1)}$, $\frac{d\alpha_Y^A(t)}{d\eta_{t-1}^A}$, $\frac{d\alpha_X^B(t)}{d\eta_{t-1}^A}$ and $\frac{d\alpha_Y^A(t-1)}{d\eta_{t-1}^A}$ when person A specializes in the production of good Y. Initially I assume that person A has a comparative advantage and specializes in producing A. The share of both good X and good Y attributed to person A in the joint organization at time t is based on the relative productivity of person A in the organization in at time t-1, that is, $S_t^A = \frac{\alpha_X^A(t-1)}{\alpha_X^A(t-1) + \alpha_Y^B(t-1)}$. So the share of person B becomes $S_t^B = 1 - S_t^A$.

Therefore,

$$\frac{dS_t^A}{d\alpha_X^A(t-1)} = \frac{\alpha_Y^B(t-1)}{(\alpha_X^A(t-1) + \alpha_Y^B(t-1))^2}.$$

$$\frac{dS_t^B}{d\alpha_X^A(t-1)} = \frac{-\alpha_Y^B(t-1)}{(\alpha_X^A(t-1) + \alpha_Y^B(t-1))^2}.$$

Moreover,

$$\frac{d\alpha_X^A(t-1)}{d\eta_{t-1}^A} = \alpha_{X\eta}^A(t-1)$$

$$\begin{aligned}\frac{d\alpha_X^A(t)}{d\eta_{t-1}^A} &= \alpha_{XS}^A(t) \cdot \frac{dS_t^A}{d\alpha_X^A(t-1)} \cdot \frac{d\alpha_X^A(t-1)}{d\eta_{t-1}^A} \\ &= \frac{\alpha_{XS}^A(t) \cdot \alpha_{X\eta}^A(t-1) \cdot \alpha_Y^B(t-1)}{(\alpha_X^A(t-1) + \alpha_Y^B(t-1))^2}\end{aligned}$$

Also, person A's cooperativeness in the previous period, η_{t-1}^A, can affect person B's productivity in the present period, $\alpha_Y^B(t)$, through the indirect impact on output share, S_t^B. Therefore, we can get

$$\frac{d\alpha_Y^B(t)}{d\eta_{t-1}^A} = \alpha_{YS}^B(t)\cdot\frac{dS_t^B}{d\alpha_X^A(t-1)}\cdot\frac{d\alpha_X^A(t-1)}{d\eta_{t-1}^A}$$
$$= \frac{-\alpha_{YS}^B(t)\cdot\alpha_{X\eta}^A(t-1)\cdot\alpha_X^B(t-1)}{(\alpha_X^A(t-1)+\alpha_Y^B(t-1))^2}$$

The expressions for $U^A(t)$ and $U^A(t-1)$ can be simplified as

$$U^A(t) = \beta\cdot\left[\ln\alpha_X^A(t) - \gamma\cdot\ln\alpha_X^A(t-1)\right] + (1-\beta)\cdot\left[\ln\alpha_Y^B(t) - \gamma\cdot\ln\alpha_Y^B(t-1)\right]$$
$$+(1-\eta_t^A)\cdot\left(\ln S_t^A - \gamma\ln S_{t-1}^A\right) + \eta_t^A\cdot\left(\ln S_t^B - \gamma\cdot\ln S_{t-1}^B\right)$$

and

$$U^A(t-1) = \beta\cdot\left[\ln\alpha_X^A(t-1) - \gamma\cdot\ln\alpha_X^A(t-2)\right] + (1-\beta)\cdot\left[\ln\alpha_Y^B(t-1) - \gamma\cdot\ln\alpha_Y^B(t-2)\right]$$
$$+(1-\eta_t^A)\cdot\left(\ln S_{t-1}^A - \gamma\ln S_{t-2}^A\right) + \eta_t^A\cdot\left(\ln S_{t-1}^B - \gamma\cdot\ln S_{t-2}^B\right)$$

Therefore

$$\frac{dU^A(t)}{d\eta_{t-1}^A} = \beta\cdot\left[\frac{\alpha_{XS}^A(t)\cdot\alpha_{X\eta}^A(t-1)}{\alpha_X^A(t)}\cdot\frac{dS_t^A}{d\alpha_X^A(t-1)} - \gamma\cdot\frac{\alpha_{X\eta}^A(t-1)}{\alpha_X^A(t-1)}\right]$$
$$+(1-\beta)\cdot\left[\frac{-\alpha_{YS}^B(t)\cdot\alpha_{X\eta}^A(t-1)}{\alpha_Y^B(t)}\cdot\frac{dS_t^A}{d\alpha_X^A(t-1)}\right] + \left[\frac{1-\eta_t^A}{S_t^A} - \frac{\eta_t^A}{1-S_t^A}\right]\cdot\alpha_{X\eta}^A(t-1)\cdot\frac{dS_t^A}{d\alpha_X^A(t-1)}$$

and

$$\frac{dU^A(t-1)}{d\eta_{t-1}^A} = \beta\cdot\frac{\alpha_{X\eta}^A(t-1)}{\alpha_X^A(t-1)} - \left(\ln S_{t-1}^A - \gamma\cdot\ln S_{t-2}^A\right) + \left[\ln(1-S_{t-1}^A) - \gamma\cdot\ln(1-S_{t-2}^A)\right]$$

By substituting the above expressions into equation (2), we can solve an optimal η_t^A as

$$(3A)\quad \eta_t^A = S_t^A(1-S_t^A)\cdot\left\{\frac{\beta\cdot\alpha_{XS}^A(t)\cdot}{\alpha_X^A(t)} - \frac{(1-\beta)\cdot\alpha_{YS}^B(t)}{\alpha_Y^B(t)} + \frac{1}{S_t^A}\right\} + \frac{S_t^A(1-S_t^A)/\alpha_{X\eta}^A(t-1)}{dS_t^A/d\alpha_X^A(t-1)}$$
$$\cdot\left\{\delta\left[\frac{\alpha_{X\eta}^A(t-1)}{\alpha_X^A(t-1)} - \left(\ln S_{t-1}^A - \gamma\ln S_{t-2}^A\right) + \left(\ln S_{t-1}^B - \gamma\ln S_{t-2}^B\right)\right] - \frac{\beta\gamma\alpha_{X\eta}^A(t-1)}{\alpha_X^A(t-1)}\right\}$$

If there exists a reversal of productivity comparative advantage between person A and person B at time t-1, i.e., $\frac{\alpha_X^A(t-1)}{\alpha_Y^A(t-1)} < \frac{\alpha_X^B(t-1)}{\alpha_Y^B(t-1)}$ which implies $\frac{\alpha_X^A(t-1)}{\alpha_X^A(t-1)+\alpha_Y^B(t-1)} < \frac{\alpha_Y^A(t-1)}{\alpha_Y^A(t-1)+\alpha_X^B(t-1)}$, then person A will start to specialize in the production of good Y and person B in the production of good B. As a result,

$U^A(t)$ and $U^A(t-1)$ will become

$$U^A(t) = \beta \cdot \left[\ln \alpha_X^B(t) - \gamma \cdot \ln \alpha_X^B(t-1)\right] + (1-\beta) \cdot \left[\ln \alpha_Y^A(t) - \gamma \cdot \ln \alpha_Y^A(t-1)\right] \\ + (1-\eta_t^A) \cdot \left(\ln S_t^A - \gamma \ln S_{t-1}^A\right) + \eta_t^A \cdot \left(\ln S_t^B - \gamma \cdot \ln S_{t-1}^B\right)$$

and

$$U^A(t-1) = \beta \cdot \left[\ln \alpha_X^B(t-1) - \gamma \cdot \ln \alpha_X^B(t-2)\right] + (1-\beta) \cdot \left[\ln \alpha_Y^A(t-1) - \gamma \cdot \ln \alpha_Y^A(t-2)\right] \\ + (1-\eta_t^A) \cdot \left(\ln S_{t-1}^A - \gamma \ln S_{t-2}^A\right) + \eta_t^A \cdot \left(\ln S_{t-1}^B - \gamma \cdot \ln S_{t-2}^B\right),$$

where person A's production share at time t is redefined as $S_t^A(t) = \dfrac{\alpha_Y^A(t-1)}{\alpha_T^A(t-1) + \alpha_X^B(t-1)}$, and person B's share is equal to $S_t^B = 1 - S_t^A$.

Analogous to the preceding derivation, we can solve the optimal degree of cooperation for person A according to equation (2) as

$$(3B) \quad \eta_t^A = S_t^A(1-S_t^A) \cdot \left\{ \frac{(1-\beta) \cdot \alpha_{YS}^A(t)}{\alpha_Y^A(t)} - \frac{\beta \cdot \alpha_{XS}^B(t)}{\alpha_X^B(t)} + \frac{1}{S_t^A} \right\} + \frac{S_t^A(1-S_t^A)/\alpha_{Y\eta}^A(t-1)}{dS_t^A / d\alpha_Y^A(t-1)} \\ \cdot \left\{ \delta \left[\frac{\alpha_{Y\eta}^A(t-1)}{\alpha_Y^A(t-1)} - \left(\ln S_{t-1}^A - \gamma \ln S_{t-2}^A\right) + \left(\ln S_{t-1}^B - \gamma \ln S_{t-2}^B\right) \right] - \frac{(1-\beta)\gamma \alpha_{Y\eta}^A(t-1)}{\alpha_Y^A(t-1)} \right\}$$

where $\dfrac{dS_t^A}{d\alpha_Y^A(t-1)} = \dfrac{\alpha_X^B(t-1)}{(\alpha_X^B(t-1) + \alpha_Y^A(t-1))^2}$.

Similarly, we can derive the optimal choice of cooperativeness for person B when person A specializes in good X and person B specializes in good Y as follows:

$$(4A) \quad \eta_t^B = S_t^B(1-S_t^B) \cdot \left\{ \frac{(1-\beta) \cdot \alpha_{YS}^B(t)}{\alpha_Y^B(t)} - \frac{\beta \cdot \alpha_{XS}^A(t)}{\alpha_X^A(t)} + \frac{1}{S_t^B} \right\} + \frac{S_t^B(1-S_t^B)/\alpha_{Y\eta}^B(t-1)}{dS_t^B / d\alpha_Y^B(t-1)} \\ \cdot \left\{ \delta \left[\frac{\alpha_{Y\eta}^B(t-1)}{\alpha_Y^B(t-1)} - \left(\ln S_{t-1}^B - \gamma \ln S_{t-2}^B\right) + \left(\ln S_{t-1}^A - \gamma \ln S_{t-2}^A\right) \right] - \frac{(1-\beta)\gamma \alpha_{Y\eta}^B(t-1)}{\alpha_Y^B(t-1)} \right\}$$

where $S_t^B = \dfrac{\alpha_Y^B(t-1)}{\alpha_Y^B(t-1) + \alpha_X^A(t-1)}$, and $\dfrac{dS_t^B}{d\alpha_Y^B(t-1)} = \dfrac{\alpha_X^A(t-1)}{(\alpha_X^A(t-1) + \alpha_Y^B(t-1))^2}$.

And when there is a productivity reversal at time t-1, the optimal degree of cooperation for person B becomes

$$(4B) \quad \eta_t^B = S_t^B(1-S_t^B) \cdot \left\{ \frac{\beta \cdot \alpha_{XS}^B(t)}{\alpha_X^B(t)} - \frac{(1-\beta) \cdot \alpha_{YS}^A(t)}{\alpha_Y^A(t)} + \frac{1}{S_t^B} \right\} + \frac{S_t^B(1-S_t^B)/\alpha_{X\eta}^B(t-1)}{dS_t^B / d\alpha_X^B(t-1)} \\ \cdot \left\{ \delta \left[\frac{\alpha_{X\eta}^B(t-1)}{\alpha_X^B(t-1)} - \left(\ln S_{t-1}^B - \gamma \ln S_{t-2}^B\right) + \left(\ln S_{t-1}^A - \gamma \ln S_{t-2}^A\right) \right] - \frac{\beta\gamma \alpha_{X\eta}^B(t-1)}{\alpha_X^B(t-1)} \right\}$$

where $S_t^B = \dfrac{\alpha_X^B(t-1)}{\alpha_X^B(t-1)+\alpha_Y^A(t-1)}$, and $\dfrac{dS_t^B}{d\alpha_X^B(t-1)} = \dfrac{\alpha_Y^A(t-1)}{(\alpha_Y^A(t-1)+\alpha_X^B(t-1))^2}$.

4. Simulation of Cooperation Cycle

In this section I examine the pattern of cooperation cycle by computer simulation. To simplify the calculation, I choose a productivity function for both persons as follows:

$$\alpha_i^j(t) = \alpha_i^j(0)\cdot\frac{\eta_t^j + S_t^j}{\eta_0^j + 1},\quad i = X \,\&\, Y,\ j = A \,\&\, B,$$

where the output share to each person needs to take into account the possible change in the relative comparative advantage in the production of each good as explained in the preceding section. The functional form of productivity revises each person's productivity at any period based on the ratio of his current levels of cooperation coefficient and output share to his original levels at time 0 when he hasn't joined the organization.

I assume in the basic scenario the following value of exogenous variables contained in the equations (3A), (3B), (4A) and (4B) above:

<u>(i) Assumption in basic scenario:</u> $\beta = 0.5;\ \gamma = 1;\ \delta = 0.9;\ \eta_0^A = 0.75;\ \eta_0^B = 0.25$,

and the initial productivity for both persons $\alpha_X^A(0) = 0.8, \alpha_Y^A(0) = 0.2, \alpha_X^B(0) = 0.2, \alpha_Y^B(0) = 0.8$

In other words, each person only concerns with the relative change of his utility level ($\gamma = 1$) in this basic scenario. Moreover, a symmetry of product preference ($\beta = 0.5$) and relative comparative advantage of production for each person ($\alpha_X^A(0)/\alpha_Y^A(0) = \alpha_Y^B(0)/\alpha_X^B(0) = 0.8/0.2$) is assumed so as to pinpoint the impact on cooperation cycle as a result of changes in the other factors.

With these assumptions of functional form and parameter value, I can depict the evolution of cooperation coefficient for each person, $\eta_t^A \,\&\, \eta_t^B$, according to equations (3A), (3B), (4A) & (4B) in Table 1 and Figure 1. We can see from the Figure 1 that person A and person B alter their cooperative attitude irregularly. Initially, person A works harder than person B due to his more willing to accommodate person B's output share into his own welfare ($\eta^A > \eta^B$). But person B will take advantage of person A's altruism and gain more welfare increase than person

A. According to the implication of prospect theory, the greater welfare improvement in the current period will raise the hurdle of further welfare increase in the next period and dampen the cooperation attitude and productivity for both persons thereafter.

The time period of a cooperation cycle is ranged from 2 to 4 in an irregular pattern. We observe an enlargement of cycle amplitude as time goes on and there is not any indication that the dynamics of cycle will converge. If we compare the inter-temporal utilities of both persons in the beginning stages of cooperation (8 periods in the basic scenario), person B gains more from the join production than person A. By all means, the cooperation as a team elevates the welfare level of both persons from the one when they work independently.[2]

The pattern of cycle is affected by how a person visualizes his welfare in terms of the current absolute level or the relative change as compared to the past period. If he puts more weight on his current absolute amount of utility, i.e., γ is smaller, the impact of prospect theory will become less severe. I depict this scenario in Table 2 and Figure 2:

<u>(ii) Scenario with more weight on current absolute utility level:</u>

$\underline{\gamma = 0.2;}\ \beta = 0.5; \delta = 0.9; \eta_0^A = 0.75; \eta_0^B = 0.25$,

and the initial productivity for both persons $\alpha_X^A(0) = 0.8, \alpha_Y^A(0) = 0.2, \alpha_X^B(0) = 0.2, \alpha_Y^B(0) = 0.8$

It is apparent that the cycle is delayed, lengthened and dampened in its amplitude in the initial periods as the individuals think less highly of the relative change in utility level than their absolute utilities. Nevertheless, the alternation of cooperation attitude between these two persons is still inevitable in this scenario. Akin to the basic scenario, person B who is less cooperative than person A can accomplish more gain from the joint production than person A. As usual, both persons improve their inter-temporal utility levels from the ones when they work independently.

In the next scenario I consider the impact of the diversity of cooperation attitude between the two persons on the formation of cooperation cycle. Relative to the basic

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[2] The optimal amount of production in good X and Y at time t when an individual works independently is determined by the tangent point of his linear production frontier function and utility function, which ends up with $X(t) = \beta \cdot \alpha_X(t)\ \&\ Y(t) = (1-\beta) \cdot \alpha_Y(t)$. The total inter-temporal utility can thus be derived by substituting these amounts into $U^A(t)\ \&\ U^B(t)$ for all t in the equation (1) above.

scenario, I narrow the difference in initial cooperation coefficients for person A and person B from $\eta^{A} = 0.75 \,\&\, \eta^{B} = 0.25$ to $\eta^{A} = 0.55 \,\&\, \eta^{B} = 0.45$.

(iii) Scenario with small difference in cooperation attitude :

$$\underline{\eta_0^A = 0.55; \eta_0^B = 0.45;} \quad \beta = 0.5; \gamma = 1; \delta = 0.9,$$

and the initial productivity for both persons $\alpha_X^A(0) = 0.8, \alpha_Y^A(0) = 0.2, \alpha_X^B(0) = 0.2, \alpha_Y^B(0) = 0.8$

Table 3 and Figure 3 show that each individual will align his working attitude with his partner more closely. The diversity of their cooperation cycles will become more distinctive after period 5. Moreover, person A who is a little more cooperative than person B will now overtake person B in the overall welfare betterment.

An extreme scenario when both persons are perfectly in tandem in their cooperation attitude is examined in Table 4 and Figure 4:

(iv) Scenario with cooperation attitude perfectly in tandem :

$$\underline{\eta_0^A = 0.5; \eta_0^B = 0.5;} \quad \beta = 0.5; \gamma = 1; \delta = 0.9,$$

and the initial productivity for both persons $\alpha_X^A(0) = 0.8, \alpha_Y^A(0) = 0.2, \alpha_X^B(0) = 0.2, \alpha_Y^B(0) = 0.8$

An obvious conclusion derived from Table 4 and Figure 4 is that both individuals become even more cooperative after a couple of rounds. An effect similar to the synchronization between two coupled oscillators takes place here. When two persons with a perfect alignment in their initial cooperative tendency will lead to a complete synchronization and create an stimulus (synergy) in their working attitude once they work together. The welfare improvement is the greatest among all scenarios.

Another implication from the scenario with perfect alignment is that the cycle will taper off gradually. The resulting common cooperation coefficient will converge to a constant eventually (0.9 in this scenario). This scenario presents an ideal organization structure. If an organization is established by a group of people embracing an identical belief in their cooperation attitude toward others, the overall productivity of this organization will be buttressed by strong cooperative mentality mutually shared among its constituents. However, if there is a non-negligible disagreement of cooperation attitude among its constituents like the scenario in Table

3 and Figure 3, the cycle will no longer diminish. Instead we will observe a divergent and amplified cooperation cycle after a certain period. Eventually this organization is doomed to break down.

5. Implications for the Japanese Economy

The Japanese economy, once the world's greatest growth machine, spent 1990s hardly growing at all. Some studies (e.g., R. Katz, 1998; K. Yamamura, 1997) pointed out that the root of the problem is that Japan is still mired in the structures, policies and mental habits that prevailed in the 1950s-60s. After World War II, the battle to industrialize Japan in the 1950s-60s, the so-called "developmental state" policies that gave rise to the nickname "Japan Inc.", worked brilliantly. These studies argued that it was so only because the country was in the 'catch-up' phrase of its economic evolution. By the 1970s, when Japan had matured economically, "catch-up economics" had turned counterproductive. There were no more infant industries needing an initial push. Nonetheless, Japan continued to use the same economic tactics of protection and promotion in the 1970s and beyond. As this happened, Japan turned into a deformed dual economy—a dysfunctional hybrid of super-strong exporting industries and super-weak domestic sectors. The dazzling Japan's trade performance has hollowed out and eaten away at the nation's domestic foundations. When its exporting sector hit the diminishing returns in 1990s, the productivity of the entire economy was dragged down to the level of the stagnant sector.

Few in Japan still denied that the economy was in deep trouble and in need of big change. Once the economy picks up, they believe that Japan can muddle through its problem and retain its glorious success. The Economic Planning Agency has finally acknowledged that Japan's pervasive import barriers are the key factor causing the syndrome, and increased imports a necessary part of the solution. In its 1996 *Economic White Paper*, it declared, "An increase in imports would stimulate incentives to raise productivity of domestic industries." As a matter of fact, this "dual economy" syndrome has prevailed in most of the Asian countries which only differ in their degree of duality. The promotion and subsidy of the external (exporting) sector at the great expenses of internal (domestic) industries is not only due to their frenzy of economic growth but also from the influence of their cultural background. The model developed above can shed some light on the fluctuation of economic performance for the Asian countries, especially for Japan, from the viewpoint of their cultural diversity.

The foundation of modern Japanese economic structure was laid on the Meiji Revolution (1867-68). The Japanese have interpreted this theme of building a Western-standard modern state in a material-physical, and not a spiritual, sense. As the phrase *wakon yosai* (Japanese spirit with Western ability) indicates, the reaction has been an intense rejection of Western spiritual ideas. The Japanese have ardently desired to retain their culture, their way of life, the specific relationship between superior and inferior, and their family structure, yet simultaneously to build a modern nation endowed with power that is comparable to that of Western countries. The question is how long will this externally westernized and internally non-western state last.

The duality of Japan's economic structure reigns not only in the export vs. import sectors but also in the individual's choice of the entire group's welfare vs. his own self-interest. The Japanese spirit that has long been nurtured by Confucianism, Taoism, Buddhism, Shinto and her own historical conditions bring forth a conspicuous Japanese ethos that is always ready to sacrifice an individual's interest (or internal sector) in exchange for the benefit of the company or nation (or external sector). Based on the model developed in the preceding sections, I simulate Japan's economy by assuming a highly aligned cooperative attitude between the two individuals. The cooperation coefficients for person A and person B are $\eta^A = 0.51 \,\&\, \eta^B = 0.49$, respectively. Using the same initial values for other parameters as those in the basic scenario (see Table 1), I derive the Figure 5 as follows:

It is shown in the figure that due to the closeness of cooperation attitudes among the individuals, the Japan's economy had been elevated to a high plateau for quite a long period. After enjoying around 10 harmonious periods, the disparity of the cooperative spirit was getting wider and became unsustainable after period 20. It mirrors the history of Japan's economic performance. Since the Meiji revolution Japan has changed her economic doctrine from the *sakoku* (isolation and closure of the country) to the *kaikoku* (open her door to the foreign countries). Endowed with the strongly-held national ethos the economy exhibits an insurmountable prowess and resilience, helping Japan become the second largest economy in the world. However, this so-called Japanese spirit has undergone an intensified turbulence since the 1980s. The thrust of the Western individualism through the flow of international trade, investment and most importantly the mass media has greatly shaken her spiritual fortress, i.e., the unconditional cooperation and loyalty to the company and the nation. Unless Japan encounters another shock like the debacle in the World War or the stimulus of the Meiji restoration so as to rev up her strong sense of cooperativeness, her economic strength will subside gradually.

The worsening of an individual's cooperativeness in the corporation can be exemplified by the withdrawal of regular employment from big enterprises to small ones. Another indicator is the divergence of compensation to management and non-management employees. The data about the size of enterprises can be found in the Establishment and Enterprise Census by Japan. This census started in 1948 and had been repeated every three years until 1981. The interval became five years thereafter. As for the data of employee compensation, it is provided by the survey conducted every year by the Ministry of Finance. Both data sets are covered in the Japan Statistical Yearbooks.

Table 5 depicts a steady increase in the percentage of small enterprises, especially of those with regular employees under 4 persons. After 1990 these small (four and under) enterprises have exceeded one half of the total establishments. On the contrary, the big enterprises (especially for those with employees over 2,000) have shown a decline (though not so significant) in their percentage share of the total establishments. The last row of Table 5, the percentage difference between the smallest establishments (i.e., the "four and under") and the biggest establishments (i.e., the "2000 and over"), is calculated to capture the degree of diminution in the size of corporation. It unambiguously manifests the general diminishing trend in the size of the Japanese enterprises. As for the compensation difference between management and non-management employees, Table 6 shows a big shrink in the 1980s but a lift again in 1990s. The enlarged compensation gap between management and non-management employees from 1980s to 1990s would more or less trigger disgruntlement and uncooperative attitudes among non-management employees especially when the economy was getting sour in the 1990s.

I attempt to use these two factors (diminishing enterprise size and enlarged compensation gap) to explain the relative performance of Japan's economy compared with the rest of the world. The latter can be measured by subtracting the U.S.'s GDP growth rate from the Japan's growth rate. Based on the statistical data from the United Nations, I calculate the relative performance of Japan's economy as follows:

It is noted that one year delay between Table 7 and Tables 5 & 6 is considered to account for the causality effect of the above two cooperation-lessening factors on the relative economic performance. The correlation matrix among the percentage difference between small and big enterprises, the ratio of compensation to management vs. non-management, and the relative performance of Japan's economy vs. U.S. (i.e., the last row in Table 5, 6 and 7 respectively) is shown in Table 8:

The negative correlation between the size-diminishing factor (row 2) and the Japan's relative economic performance (row 1) or between the deteriorating compensation disparity (row 3) and the Japan's relative economic performance (row 1) reflects a non-negligible impact of employee's cooperation attitude on the general performance of an enterprise. The wider disparity in cooperation effort (as measured by the compensation ratio) and the lesser willingness to cooperate (as measured by the increase of small enterprises relative to big ones) will both lead to the decline of Japan's relative economic performance.

I have also run the regression of Japan's relative economic performance with one year lag (i.e., row 1 in Table 8) on the percentage difference between small and big enterprises (i.e., row 2 in Table 8) and the per capita compensation ratio between management and non-management employee (i.e., row 3 in Table 8) from 1971 to 2002. Since the census data about the distribution of incorporated enterprises is only available every three or five years, I have estimated the number of establishments for different sizes of enterprises for the remaining years by interpolating between two adjacent census years. The regression results are as follows:

The regression above highlights the important role played by the big enterprises in maneuvering Japan's economic performance in the past three decades. When the Japanese individuals change their mentality to pursue their own (and relative small) business, their economic prowess will gradually subside. The slightly worsening in the compensation disparity between management and non-management employees has a negative (but not significant) impact on the overall economy.

The miracle of Japan's spectacular economic success prior to 1991 has been challenged by the subsequent one-decade long stagnation. Should Japan continue adhering to and revitalizing her *wakon yosai* doctrine or gradually abandon her own spiritual ideas and allow the Western spirit (more weight on the individual self-interest) to fill in the vacuum of her mind? It is the central issue that underlies the heated debate of the recent Japanese economic reform.

6. Discussion and Conclusion

This study endogenizes an individual's willingness to cooperate with others through the direct impact on his utility function. By adapting the Ricardian production function to incorporate the impact of cooperativeness in a team and the individual's output share, this model presents a framework to resolve the optimal degree of altruism for each individual. At the beginning of the teamwork, everyone has an incentive to raise the weight of his utility that is associated with the other's wellbeing. The increased concern with the latter's output share in the team will drive him to work harder for an entire team and contribute to an improvement of his productivity in the organization, which will benefit himself and his team partner as well. The formation of a cooperation cycle is primarily due to the nature of human behavior as expounded by the prospect theory. The resulting utility enhancement after his initial elevation of cooperativeness will raise his reference point and render it more difficult to further improve his utility level, dampening the incentive to cooperate in the subsequent periods.

An important implication of this study is that except for the perfect alignment of cooperativeness among its constituents, all the cooperation cycles are irregular and lead to a widening divergence of cooperation attitudes and the breakdown of the entire organization eventually. This outcome is analogous to the synchronization behavior of two coupled oscillators. Unless the initial frequencies of the two oscillators are close enough, the coupling of two distinct oscillators will easily end up a chaotic cycle when confronting a nonlinear interaction between the two. However, the system provides a striking self-fulfilling force to align the two interacting entities and generate a great synergy when these two entities are close enough in their initial conditions (i.e., frequency in the oscillator case and cooperation attitude in this study).

The relationship between capitalists and laborers captivates the enduring academic interests in social sciences, especially in economics, and politics. Despite the uncontested influence of Marxism in the mid twentieth century and its rapid and undignified exit from history after the fall of the Berlin Wall in 1989, the collapse of the Soviet Union in 1992 and the extinction of communist parties everywhere outside China and Cuba, the questions raised in the classic book *The Communist Manifesto* (1848) still cannot completely be erased even when we have started a new millennium and have witnessed endless chatter about globalization and deregulation. The inherent natures of the modern economic organizations that continue inventing new needs and the means to satisfy one group of constituents (capitalists) more than the others (workers) and subverting all inherited cultural practices and beliefs into an object for sale can not escape the eventual destabilization outcome unless capitalists and laborers can collaborate unconditionally and align their cooperativeness perfectly.

In the beginning, any organization will provide noticeable benefit to all its constituents due to the exploitation of comparative advantage for each individual. However, unless there is perfect alignment in cooperativeness, the widening divergence of benefit and cooperation attitude among its members will challenge the stability of the organization and trigger the inevitable collapse in the end. Therefore, the cultivation of a common cooperation attitude among its members at the inception is very crucial for the persistent prosperity of an organization. We can witness the success of the Japanese economy in the last century as an evidence of this proposition. A strongly-held national ethos that took root in Japan by the influence of Confucianism, Taoism and Buddhism helps her rise swiftly to the status of a first-rate power following the Meiji Revolution after 1867 (Michio Morishima, 1982). This consensus of complete loyalty to the firm and to the state as transformed by the ethical doctrines plays a critical role in the creation of Japan’s economic success. Of course we cast a reasonable doubt about the continuation of this Japan ethos once she is more receptive to liberalism and individualism in the Western societies.

This study points out a caveat on the instability of an international organization. Japan’s past economic success was built on her extraordinary congealing force nurtured in the fertile cultural background. However, the international organizations such as the United Nation or WTO were established by the countries with diverse cultural backgrounds. Despite the early success in meeting their original goals, the enlarged disparity of economic or political benefit among their member countries will bring the organizations into a collapse unless some measure of the realignment of common goal for its participants is seriously taken. The recent surge of regional economic agreements among the countries with similar economic or cultural background seems relatively encouraging. Nevertheless, we should not be too sanguine about the prospect of these agreements if the member countries could not tolerate and accommodate the cultural shock from other countries even though the distinction might be nominal.

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Table 1: Simulation of Cyclical Cooperation - basic scenario									
Basic Assumptions:		β	0.5		η_0^A	0.75		η_0^B	0.25
		γ	1		$\alpha_X^A(0)$	0.8		$\alpha_X^B(0)$	0.2
		δ	0.9		$\alpha_Y^A(0)$	0.2		$\alpha_Y^B(0)$	0.8
Time Period (t):	0	1	2	3	4	5	6	7	8
$\alpha_X^A(t)$	0.8	0.571	0.591	0.608	0.466	0.634	0.921	0.795	0.268
$\alpha_Y^A(t)$	0.2	0.143	0.148	0.152	0.117	0.158	0.23	0.199	0.067
$\alpha_X^B(t)$	0.2	0.12	0.113	0.237	0.235	0.248	0.059	0.347	0.252
$\alpha_Y^B(t)$	0.8	0.48	0.452	0.948	0.94	0.993	0.237	1.39	1.007
S_t^A	0.5	0.5	0.543	0.567	0.391	0.332	0.389	0.795	0.364
S_t^B	0.5	0.5	0.457	0.433	0.609	0.668	0.611	0.205	0.636
$dS_t^A / d\alpha_X^A(t-1)$		0.313	0.434	0.415	0.392	0.476	0.375	0.177	0.291
$dS_t^A / d\alpha_Y^A(t-1)$)		1.25	1.737	1.661	1.566	1.902	1.501	0.708	1.164
$dS_t^B / d\alpha_X^B(t-1)$		1.25	2.068	2.172	1.005	0.943	0.957	2.746	0.666
$dS_t^B / d\alpha_Y^B(t-1)$		0.313	0.517	0.543	0.251	0.236	0.239	0.687	0.167
$\alpha_{X\eta}^A(t) = \alpha_{XS}^A(t)$		0.457	0.457	0.457	0.457	0.457	0.457	0.457	0.457
$\alpha_{Y\eta}^A(t) = \alpha_{YS}^A(t)$		0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114
$\alpha_{X\eta}^B(t) = \alpha_{XS}^B(t)$		0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16
$\alpha_{Y\eta}^B(t) = \alpha_{YS}^B(t)$		0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64
η_{t+1}^A	0.75	0.75	0.763	0.629	1.054	1.625	0.945	0.222	-0.88
η_{t+1}^B	0.25	0.25	1.048	0.859	0.884	-0.24	1.967	0.938	4.321
PV{ $U^A(t)$ }		-0.34	0.6	1.952	2.927	4.404	5.027	5.54	6.458
PV{ $U^B(t)$ }		-0.34	0.6	2.169	2.71	3.746	4.854	8.132	6.369
Total utility_A (join)	26.57			Total utility_A (disjoin)		23.12			
Total utility_B (join)	28.24			Total utility_B (disjoin)		23.12			

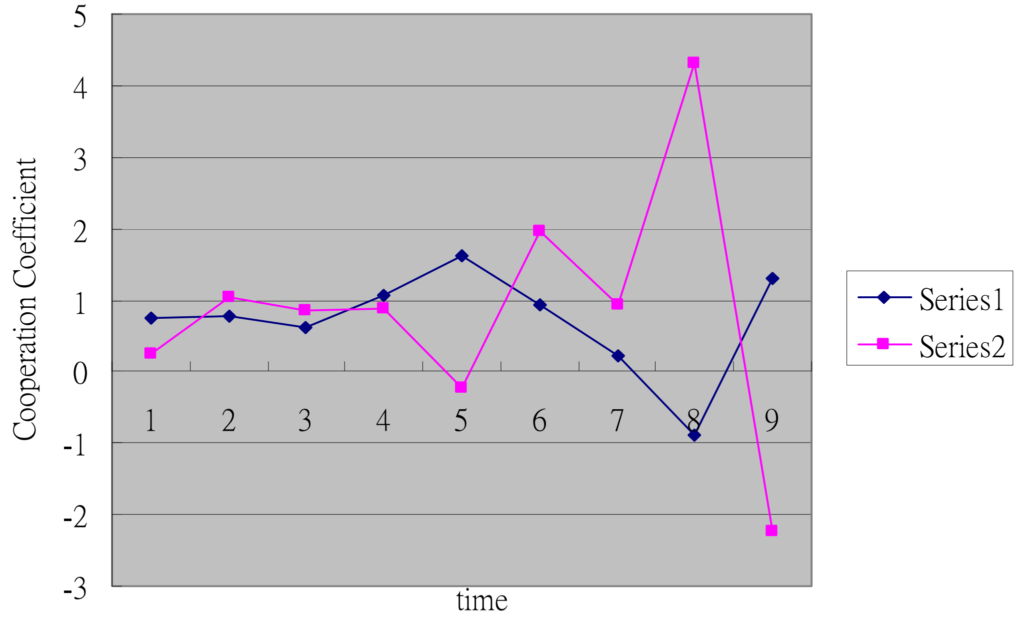

Figure 1: Simulation of Cooperation Cycle (basic scenario)

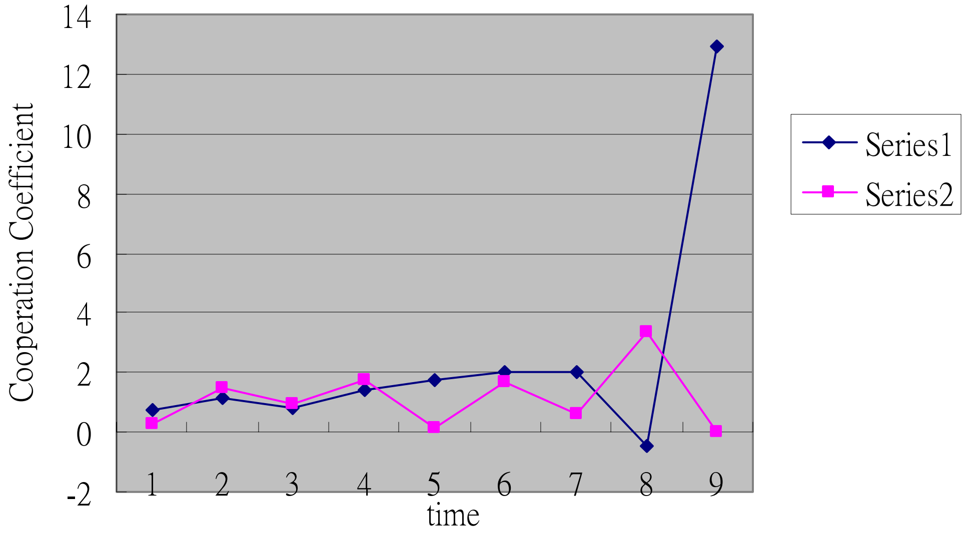

Figure 2: Simulation of Cooperation Cycle (gamma equals 0.2)

Table 2: Simulation of Cyclical Cooperation - more weight on present absolute utility

Basic Assumptions:						
	β	0.5	η_0^A	0.75	η_0^B	0.25
	γ	0.2	$\alpha_X^A(0)$	0.8	$\alpha_X^B(0)$	0.2
	δ	0.9	$\alpha_Y^A(0)$	0.2	$\alpha_Y^B(0)$	0.8

Time Period (t):	0	1	2	3	4	5	6	7	8	9
$\alpha_X^A(t)$	0.8	0.571	0.591	0.785	0.563	0.796	0.968	1.213	1.131	0.079
$\alpha_Y^A(t)$	0.2	0.143	0.148	0.196	0.141	0.199	0.242	0.303	0.283	0.02
$\alpha_X^B(t)$	0.2	0.12	0.113	0.305	0.252	0.381	0.132	0.324	0.177	0.598
$\alpha_Y^B(t)$	0.8	0.48	0.452	1.22	1.008	1.523	0.528	1.297	0.709	2.391
S_t^A	0.5	0.5	0.543	0.567	0.392	0.358	0.343	0.647	0.483	0.615
S_t^B	0.5	0.5	0.457	0.433	0.608	0.642	0.657	0.353	0.517	0.385
$dS_t^A / d\alpha_X^A(t-1)$		0.313	0.434	0.415	0.304	0.408	0.283	0.236	0.206	0.209
$dS_t^A / d\alpha_Y^A(t-1)$		1.25	1.737	1.661	1.214	1.633	1.132	0.944	0.823	0.837
$dS_t^B / d\alpha_X^B(t-1)$		1.25	2.068	2.172	0.781	0.912	0.592	1.73	0.77	1.337
$dS_t^B(t) / d\alpha_Y^B(t-1)$		0.313	0.517	0.543	0.195	0.228	0.148	0.432	0.192	0.334
$\alpha_{X\eta}^A(t) = \alpha_{XS}^A(t)$		0.457	0.457	0.457	0.457	0.457	0.457	0.457	0.457	0.457
$\alpha_{Y\eta}^A(t) = \alpha_{YS}^A(t)$		0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114
$\alpha_{X\eta}^B(t) = \alpha_{XS}^B(t)$		0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16
$\alpha_{Y\eta}^B(t) = \alpha_{YS}^B(t)$		0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64
η_{t+1}^A	0.75	0.75	1.15	0.84	1.384	1.773	2.007	1.991	-0.44	12.95
η_{t+1}^B	0.25	0.25	1.472	0.967	1.738	0.169	1.674	0.591	3.351	0.009
PV$\{U^A(t)\}$		-1.14	-1	-0.3	-0.05	0.877	0.945	-0.02	0.896	0.685
PV$\{U^B(t)\}$		-1.14	-1	0.137	-0.41	-0.36	0.334	1.599	0.79	1.577
Total util_A(join)	0.891			Total util_B (disjoin)			-5.48			
Total util_B(join)	1.531			Total util_B (disjoin)			-5.48			

Table 3: Simulation of Cyclical Cooperation - small difference in cooperation attitude

Basic Assumptions:	β	0.5	η_0^A	0.55	η_0^B	0.45
	γ	1	$\alpha_X^A(0)$	0.8	$\alpha_X^B(0)$	0.2
	δ	0.9	$\alpha_Y^A(0)$	0.2	$\alpha_Y^B(0)$	0.8

Time Period (t):	0	1	2	3	4	5	6	7	8	9
$\alpha_X^A(t)$	0.8	0.542	0.546	0.716	0.641	0.733	0.782	0.763	0.671	0.552
$\alpha_Y^A(t)$	0.2	0.135	0.137	0.179	0.16	0.183	0.195	0.191	0.168	0.138
$\alpha_X^B(t)$	0.2	0.131	0.13	0.195	0.183	0.2	0.164	0.191	0.199	0.241
$\alpha_Y^B(t)$	0.8	0.524	0.52	0.78	0.732	0.802	0.656	0.763	0.795	0.963
S_t^A	0.5	0.5	0.508	0.513	0.478	0.467	0.478	0.544	0.5	0.458
S_t^B	0.5	0.5	0.492	0.487	0.522	0.533	0.522	0.456	0.5	0.542
$dS_t^A / d\alpha_X^A(t-1)$		0.313	0.461	0.457	0.349	0.389	0.34	0.317	0.328	0.37
$dS_t^A / d\alpha_Y^A(t-1)$		1.25	1.845	1.83	1.395	1.554	1.361	1.269	1.31	1.48
$dS_t^B / d\alpha_X^B(t-1)$		1.25	1.907	1.924	1.279	1.36	1.245	1.512	1.31	1.249
$dS_t^B / d\alpha_Y^B(t-1)$		0.313	0.477	0.481	0.32	0.34	0.311	0.378	0.328	0.312
$\alpha_{X\eta}^A(t) = \alpha_{XS}^A(t)$		0.516	0.516	0.516	0.516	0.516	0.516	0.516	0.516	0.516
$\alpha_{Y\eta}^A(t) = \alpha_{YS}^A(t)$		0.129	0.129	0.129	0.129	0.129	0.129	0.129	0.129	0.129
$\alpha_{X\eta}^B(t) = \alpha_{XS}^B(t)$		0.138	0.138	0.138	0.138	0.138	0.138	0.138	0.138	0.138
$\alpha_{Y\eta}^B(t) = \alpha_{YS}^B(t)$		0.552	0.552	0.552	0.552	0.552	0.552	0.552	0.552	0.552
η_{t+1}^A	0.55	0.55	0.874	0.763	0.954	1.037	0.935	0.8	0.613	1.278
η_{t+1}^B	0.45	0.45	0.927	0.805	0.919	0.667	0.927	0.941	1.204	0.515
PV $\{U^A(t)\}$		-0.32	0.675	1.996	2.95	4.1	5.02	5.957	6.993	8.007
PV $\{U^B(t)\}$		-0.32	0.675	2.036	2.901	3.983	4.957	6.108	6.992	7.868
Total util_A (join)	35.37			Total util_A (disjoin)		30.52				
Total util_B (join)	35.2			Total util_B (disjoin)		30.52				

Figure 3: Simulation of Cooperation Cycle (small difference in cooperation attitude: A(0.55, B(0.45))

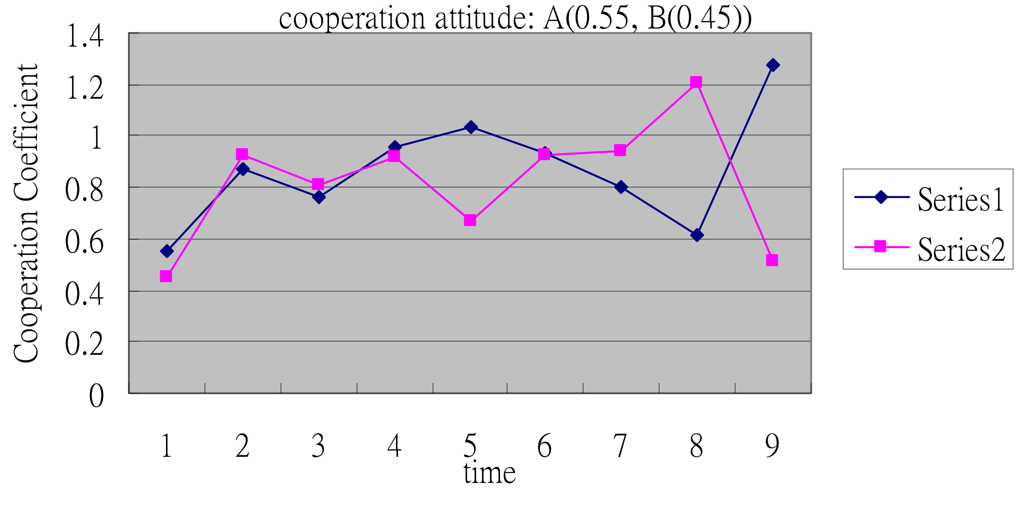

Figure 4: Simulation of Cooperation Cycle (perfect in tandem: A(0.5), B(0.5))

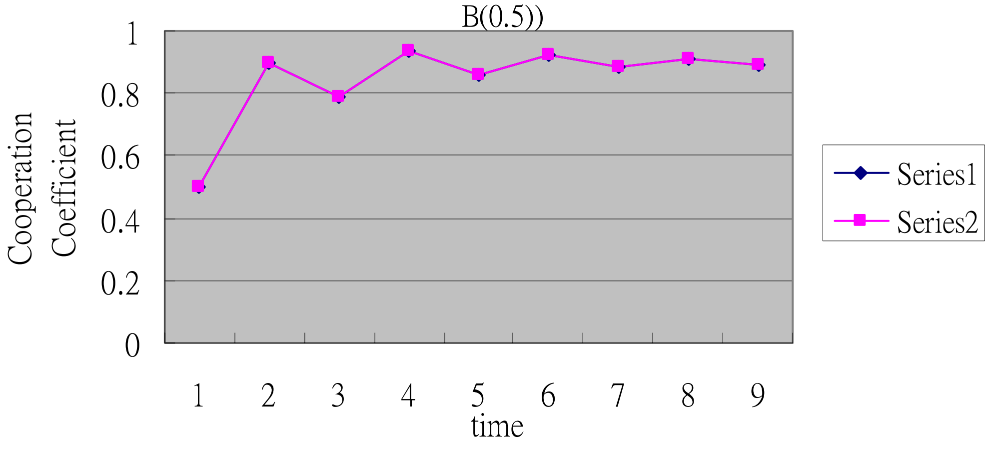

Table 4: Simulation of Cyclical Cooperation - perfectly in tandem										
Basic Assumptions:		β	0.5		η_0^A	0.5		η_0^B	0.5	
		γ	1		$\alpha_X^A(0)$	0.8		$\alpha_X^B(0)$	0.2	
		δ	0.9		$\alpha_Y^A(0)$	0.2		$\alpha_Y^B(0)$	0.8	
Time Period (t):	0	1	2	3	4	5	6	7	8	9
$\alpha_X^A(t)$	0.8	0.533	0.533	0.747	0.686	0.766	0.724	0.759	0.737	0.753
$\alpha_Y^A(t)$	0.2	0.133	0.133	0.187	0.171	0.191	0.181	0.19	0.184	0.188
$\alpha_X^B(t)$	0.2	0.133	0.133	0.187	0.171	0.191	0.181	0.19	0.184	0.188
$\alpha_Y^B(t)$	0.8	0.533	0.533	0.747	0.686	0.766	0.724	0.759	0.737	0.753
S_t^A	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
S_t^B	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
$dS_t^A / d\alpha_X^A(t-1)$		0.313	0.469	0.469	0.335	0.365	0.327	0.345	0.329	0.339
$dS_t^A / d\alpha_Y^A(t-1)$		1.25	1.875	1.875	1.339	1.458	1.306	1.38	1.318	1.357
$dS_t^B / d\alpha_X^B(t-1)$		1.25	1.875	1.875	1.339	1.458	1.306	1.38	1.318	1.357
$dS_t^B / d\alpha_Y^B(t-1)$		0.313	0.469	0.469	0.335	0.365	0.327	0.345	0.329	0.339
$\alpha_{X\eta}^A(t) = \alpha_{XS}^A(t)$		0.533	0.533	0.533	0.533	0.533	0.533	0.533	0.533	0.533
$\alpha_{Y\eta}^A(t) = \alpha_{YS}^A(t)$		0.133	0.133	0.133	0.133	0.133	0.133	0.133	0.133	0.133
$\alpha_{X\eta}^B(t) = \alpha_{XS}^B(t)$		0.133	0.133	0.133	0.133	0.133	0.133	0.133	0.133	0.133
$\alpha_{Y\eta}^B(t) = \alpha_{YS}^B(t)$		0.533	0.533	0.533	0.533	0.533	0.533	0.533	0.533	0.533
η_{t+1}^A	0.5	0.5	0.9	0.786	0.936	0.858	0.923	0.882	0.912	0.892
η_{t+1}^B	0.5	0.5	0.9	0.786	0.936	0.858	0.923	0.882	0.912	0.892
PV{ $U^A(t)$ }		-0.32	0.678	2.015	2.93	4.04	4.984	6.031	7.002	8.023
PV{ $U^B(t)$ }		-0.32	0.678	2.015	2.93	4.04	4.984	6.031	7.002	8.023
Total util_A (join)	35.38			Total util_A (disjoin)		30.52				
Total util_B (join)	35.38			Total util_B (disjoin)		30.52				

Table 5: Distribution of Incorporated Enterprises by Size of Regular Employees

Size of regular employees\Time	1975-6	1980-1	1985-6	1990-1	1995-6	2000-1
4 persons and under	0.438486	0.461544	0.474015	0.500319	0.493959	0.512874
5—49 persons	0.498525	0.474301	0.465769	0.441473	0.447074	0.430994
50—99 persons	0.034287	0.035544	0.03293	0.031529	0.031893	0.029763
100—999 persons	0.026867	0.026893	0.025689	0.024999	0.025285	0.02461
1,000--1,999 persons	0.000983	0.000922	0.000879	0.000935	0.000997	0.001018
2,000 persons and over	0.000852	0.000797	0.000719	0.000744	0.000791	0.000742
Total establishments	1	1	1	1	1	1
(4 and under) minus (2,000+)	0.437634	0.460747	0.473297	0.499575	0.493168	0.512132

Source: Japan Statistical Yearbooks

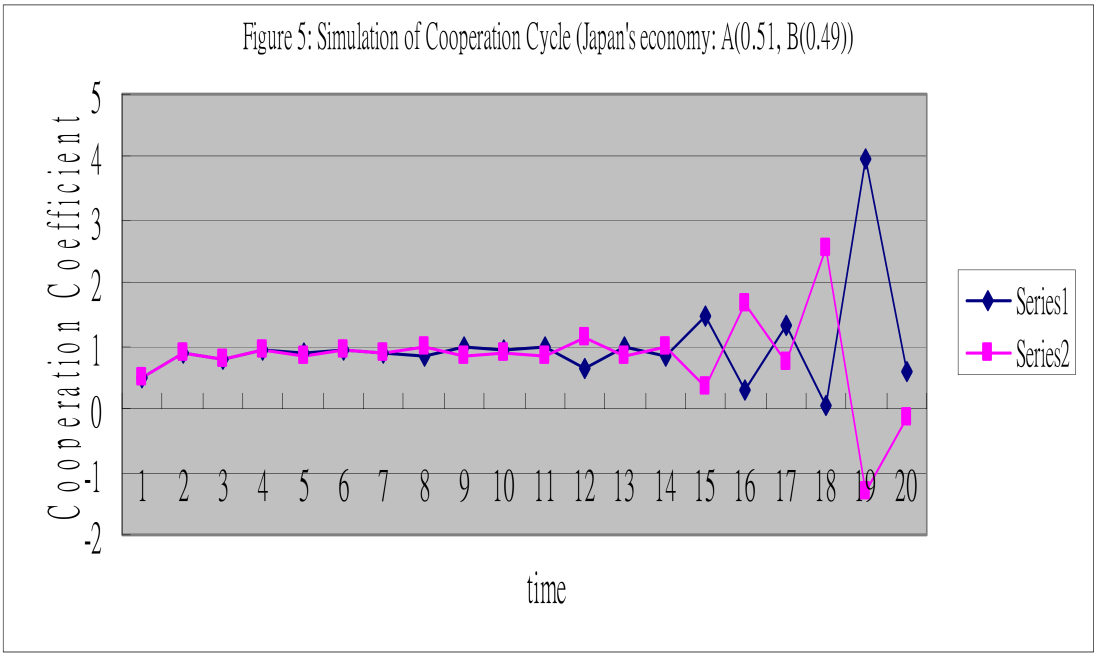

Table 6: Compensation to Management (Mgmt) and Non-management (Non-Mgmt) Employees (value in billions of yen)

Compensation \ Time	1975-6	1980-1	1985-6	1990-1	1995-6	2000-1
Compensation to Mgmt	7608	13206	18269	24913	31413	31446
Compensation to Non-Mgmt	43722	69011	93988	122101	146830	146637
No. of Mgmt employee (1,000)	2939	3872	4425	4849	5716	5957
No. of Non-Mgmt employee (1,000)	25281	27965	31447	34537	37891	39412
Compensation per 1000 Mgmt	2.588636	3.41064	4.128588	5.13776	5.495626	5.278832
Compensation per 1000 Non-Mgmt	1.729441	2.467763	2.988775	3.535368	3.875063	3.720618
Comp. ratio of Mgmt to Non-Mgmt	1.496805	1.382078	1.381365	1.453246	1.418203	1.418805

Source: Japan Statistical Yearbooks

Table 7: The Relative Performance of Japan's Economy vs. U.S.'s Economy

GDP growth rate(in 1991 price)	1977	1982	1987	1992	1997	2002
GDP growth rate in Japan	4.39	3.18	4.38	1	1.83	0.14
GDP growth rate in U.S.	4.7	-2.07	3.36	3.06	4.47	2.43
GDP grow(Japan-U.S.)	-0.31	5.25	1.02	-2.06	-2.64	-2.29

Source: the United Nations

Table 8: The Correlation Matrix

	Row 1	*Row 2*	*Row 3*
Row 1	1		
Row 2	-0.59048	1	
Row 3	-0.47947	-0.27209	1

Row 1: GDP growth rate difference between Japan and U.S.

Row 2: percentage difference between small and big enterprises

Row 3: per capita compensation ratio between management and non-management

Table 9: Regression of Japan's Relative Economic Performance

Dependent variable: Japan's GDP growth rate – U.S. Growth rate (one year lag)

Explanatory Variables	Coefficient Estimates
Constant	18.17
	(1.15)
% difference between small and big enterprise	-31.98
	(-2.08)**
Compensation ratio between management	-2.23
and non-management employee	(-0.31)
N	30
R^2	0.41

** Significant at the 5 percent level.