

# Development Power and Derivative Process: A Model and Theory for Macroeconomy Analysis

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**Abstract** *Stating from the basic characteristics of economic development process and based on the partial distribution [F.Dai, 2001], this paper advance the concept of development power, give its basic models, and try to establish a theory of describing and analyzing the macroeconomy — the development power and derivative process. By means of the development power theory, we can explain and solve some important problems in macroeconomic researches, such as how the economic cycle be formed, what is the reason that economic outputs vary violently, etc. And by the derivative process model, we can give out the indexes of valuating development power and development vitality in economic process, analyze the macroscopic course of economic development, and compute the beginning time and ending time of the economic cycle depending on the accumulating and releasing development power. Finally, we analyze emphatically the DP movement in economic development of China and USA in recent several decades, in order to show the realistic background and the creditability of development power and derivative process.*

**Keywords** *partial distribution, macroeconomy, development power (DP), derivative process, analytic model*

## 1. INTRODUCTION

There are many of the important studies in the economic theory, such as R. E. Lucas's business cycle theory [1981], Prescott's real business cycle theory [1982], P. M. Romer's new growth theory [1986], and D. Kahneman's prospect theory [1979], etc. These theories has availably propeled forward the economic development of world.

### 1.1. The important economic theories

After World War II, Keynesian once obtained a lot of glorious researches, as for the some economist think the economic cycle to be dead already, and the role of government is to adopt some measures timely to eliminate the economic cycle. But, R. E. Lucas used the time series analysis based on the theory of rational prospect, and demonstrated the Philips curve (so the economic development follows a equilibria cycle), at the same time, this also mean the Philips curve to be unsteady, and it would vary along with the variety of the government policy. So the economic cycle is ineluctable, and the governmental intervention will finally be out of order.

The new classical school quickly grew up at 20th century 80's, Prescott, Kydland, King and others bring forward the real business cycle theory. The real business cycle theory still completely taken the way of the Lucas' research route in the economic cycle research, and used a persuasive complete Economic person as a basis, and designed the economic system laboratory in order to avoid too expensive experimental fee for actual economic policy. Therefore, Lucas is still the most important person to the real business cycle theory. Another famous research from Lucas is his proposition about policy invalidation, i.e., the famous Lucas' "A Critique" [1976].

Lucas pointed out: only if the construction of quantitative economic model is consistent with the optimal decision rule of economic individual, and the optimal decision rules change systematically along with the variety of the related environment around the decision maker, then the economic policy's variety would change systematically the construction of quantitative economic model. This proposition is a rigorous challenge to the foundation of

quantitative model of macroeconomy prevailed at that time.

In 20<sup>th</sup> century 90's, another important progress in the field of macroscopic economics is the new growth theory. Romer and Lucas established a theoretical foundation of the new economic growth theory. They think that the market condition of realistic economy is incompletely compete, thus the scale income gradually increase, this kind of result is obtained depended on the accumulation of manpower capital. And then, they regarded the endogenesis, accumulation and growth of manpower capital as the headspring and the power for economic growing. In other words, knowledge accumulating, technique creating and professional manpower capital can not only make themselves growing, and make the economic growth dynamic and protracting. Prescott and Kydland think, that the economic fluctuation is just nature action of real output level, the reason that economic fluctuate is a technique advance, and put forward the real business cycle theory. But others think: in short-term, there is no certainly causality between the fluctuation of economic output and a technique advance; at the economic crisis, that the productivity and output are all dropping can't be explained by technique retrogress; also there is no a consideration about the bigness influence of monetary policy changing to economic output fluctuation. Therefore, most economists does not think that theory can sufficiently explain the reason for economic output fluctuating.

The traditional economics thinks that a "rational economic person" [Simon, 1954] can estimate the emergence possibility of different future results, and then maximize its expectation utility. This kind of "expected utility theory" is widely applied in the economics field. But D.Kahneman and others completed a lot of experiments and investigations, all the results indicate: the assumption about "rational economic person" deserve a doubt. Thus the "prospect theory" is established and the assumption about "non-rational economic person" is put forward, and by the comparison experiments, majority of individual is not always rational and aversion of risk.

### 1.2.Problems and considerations

Despite above economic theories all contain its real excellent contents, but there still are some problems which are difficult to explain. Such as:

1) Whether there are the cycles in the economic development or not. If there are cycles in economic development, we may ask:

- What is the reason that cause the cycle in economic development?
- What are the characteristics of each stage in cycle of economic development?
- What kinds of characteristics of promoting power and economic vitality are there at each stage inside the cycle of economic development?
- How we estimate the time period of each cycle.

2) The government intervene to economy will finally be out of order or not.

3) Economic output is an objective esse, but what is the real reason for fluctuation in output of economy.

4) The assumption and the behavior of "rational economic person" are in conflict with that for "non-rational.

Aiming at some current perplexities in economic theory, this paper bring forward an mode of development power (*DP*) movement about economic development, i.e. an accumulating and a releasing process of economic *DP* (*EDP*)constitute a whole process of economic development, and try to establish a theory of macroeconomy development —*DP* and derivative process.

Main standpoints *DP* theories are

- The development of the economic society is basically propelled by the latent promoting power, namely the *DP*.
- The *EDP* is scale by economic development energy, and economic energy for short.
- In the process of economic development, the *EDP* need to be accumulated first, and will be released out later,

then the economy were naturally propelled to develop by the movement of *DP*. The movement process that *EDP* is accumulated and then is released is called a full process.

- After a full process of *DP* movement is over, another full process of *DP* movement starts, namely a new process of *DP* movement, is derived. It is the continuously derivative process of *DP* propels the economic production to keep on developing, until human's economic society is thoroughly perished.

- In economic development, the economic growth follows the derivative process, and the economic recession also follows the derivative process, and generally, a economic growth process may be interlaced with another economic recession process.

By the *DP* movement and derivative process theory, we can explain and solve some important problems in economic cycle, such as, whether the government intervenes to economy will finally be out of order or not, what are the real reasons that economic output fluctuates, and other problems in macroeconomic theory, and can interpret the conflict and coexistence of "rational economical person" and "non-rational economical person" in macroeconomic development. Also, by the *EDP* accumulating or releasing process, *DP* theory can help government to analyze and control the economic course, to know what position we are at in the whole economic development process, and can provide consultable basis for opportune moment of announcing of related economic policy. So the *DP* and derivative process theory is very important to deeply understand the rule of economic development.

## **2. THE BASIC THEORIES OF THE DEVELOPMENT POWER**

Here, we shall elucidate that *DP* is really existent by some fundamental models, elucidate the definition of *DP*, and explain the core contents of the *DP* theory from the fundamental assumptions and basic conclusions.

### *2.1. The basic models*

#### 1) *DP* movement model in the process of learning knowledge.

If an individual wants to make a living or become successful in the modern society, he (or she) needs to learn many necessary knowledge (or hold the technical ability and skill, Neglect below), namely accumulates the necessary knowledge power. When controlled the related knowledge, he can use this knowledge to solve the problems met in his work, namely release the knowledge power accumulated already. Later, three kinds of processes that knowledge power is accumulated and released would come to the man:

- If met the new problem demanded to resolve in his work, he must learn new knowledge and use them.
- If others also use the same knowledge to make a living, he has to learn and use another new knowledge further in order to win the competition advantage.
- If the individuals whose knowledge is the same are too many to the economic society, he has to learn other new knowledge and use these knowledge.

If we take the impelling force that knowledge help the people to form the ability to live or become successful in the society as a knowledge development power, and then, it is this kind of accumulation and release movement of the knowledge development power (*DP*) to propel people to learn and work continually.

One accumulation process and one release process of knowledge *DP* constitute one movement cycle of knowledge *DP*. There are the different *DP* movement process in learning different knowledge and concentrating on the different economic activities. The same knowledge *DP* has a varying movement characteristic at the different stage of learning knowledge. Therefore, the each of knowledge *DP* has a varying movement cycle, and the accumulating and releasing process of different knowledge *DP* may be mutually interlaced one with another. In addition, any of peoples needs to learn and apply the new knowledge continually in their living and working, so the

rolling phenomenon that the knowledge *DP* is accumulated and released continuously comes into being.

2) *DP* movement model in the process of operating an enterprise.

If trying to exist or become successful in the modern economic society, it is necessary for a business enterprise to hold the producing technique and own the producing bankroll first, namely accumulates the necessary economic power. When it got the related producing technique and producing bankroll, it can convert them to the actual production ability (include purchasing the equipments, recruiting the employees, and using the techniques), and can produce the merchandises and sell them, namely release the economic power accumulated already. Later, three kinds of processes that economic power is accumulated and released would come to the enterprise:

- If there are new need for merchandises in market, the enterprise must hold the new producing techniques and own the new producing bankroll, and use them.

- If other enterprise also use the same techniques to produce the same merchandises, it has to hold another new technique and use them in order to win the competition advantage.

- If the enterprise whose producing technique is the same are too many to the economic society, he has to hold other new techniques and use the techniques.

If we take the impelling force that technique and bankroll help the enterprise to form the ability to produce merchandises as the technique development power and bankroll development power of the enterprise, and then, it is this kind of accumulation and release movement of the technique development power (*DP*) and bankroll development power (*DP*) to propel the enterprise to produce and sell its merchandises continually.

One accumulation process and one release process of technique *DP* or bankroll *DP* constitute one movement cycle of technique *DP* or bankroll *DP*. There are the different *DP*'s movement process in setting up and operating different enterprise. The same technique *DP* or bankroll *DP* has a varying movement characteristic at the different stage of operating enterprise. Therefore, the each of technique *DP* or bankroll *DP* has a varying movement cycle, and the accumulating and releasing process of different technique *DP* or bankroll *DP* may be mutually interlaced one with another. In addition, the any of enterprises needs to hold the producing technique and own the producing bankroll and apply them continually in their operating, so the rolling phenomenon that the technique *DP* and bankroll *DP* are accumulated and released continuously comes into being.

3) *DP* movement model in the process of policy applications.

In the process of economic development, mankind need to establish many policies (include the laws and regulations) and make use of them. When some economic problems emerge and become more serious gradually, or some kind of economic demands come into being, thus the related policies are being established and will be set, the policy power has already being started accumulating. If the policy can push the economy in positive development, and then the policy power being released. Along with the economic development, some bad economic tendencies and new economic problem may appear, another new policies need to be established and set at this time, and then the policy power is accumulated again. When the economic development follows the positive orbit again, the new policy power starts gradually release again. This kind of process will continuously repeat.

If we take the impelling force that policy impels the economy to be positively developed as a policy development power (*DP*), and then, it is this kind of accumulation and release movement of the policy *DP* to propel economic development exuberantly and continually.

One accumulation process and one release process of economic policy *DP* constitute one movement cycle of economic policy *DP*. There are the different *DP*'s movement processes in formulating different policies.

The same policy *DP* has a varying movement characteristic at the different stage of economic development.

Therefore, the each of policy *DP* has a varying movement cycle, and the accumulating and releasing process of different policy *DP* may be mutually interlaced one with another. In addition, policies need to be established and set continuously in the whole process of economic development, so the rolling phenomenon that the policy *DP* are accumulated and released continuously comes into being.

4) *DP* movement model in the process that the enterprise employs the employees.

Suppose a business enterprise advertise for the employee. There are two men who accept the appointment, one is a graduate student, another one is a university student, and other terms of them are equal completely. In general,

- the inviter would like to choose the graduate student usually. Why the inviter would like to choose the graduate student? The direct explanation is that a graduate student controls more knowledge than a university student. According to the standpoint of *DP* movement, the graduate student has accumulated more *DP* of knowledge in his study process, and this kind of knowledge *DP* may be released to form more productivity in his work.

- if the term of a personnel who accepts the appointment surface is not very good, and he want to acquire the good employment opportunities, he must show his special ability differed from others in accepting the appointment. In this process, not only he needs to show his accumulating condition of knowledge *DP*, but also to show his releasing ability of his knowledge *DP*.

- an enterprise would like to employ the employees because they have accumulated the knowledge *DP*. There is probation to each of employee, for enterprise to observe whether he or she can be very competent for the job or not. The employee whose ability is outstanding in probation would be stayed to use. According to the standpoint of *DP* economics, the employee, whose work ability is outstanding in probation, can be able to release his knowledge *DP* which have been accumulated, and form the actual productivity.

- in the process of enterprise operating, a hired employee may be dismissed because the enterprise thinks that the employee is no longer competent for his job. According to the standpoint of *DP* economics, the basic reason is that the employee's ability to accumulate or release knowledge *DP* constantly and continuously is weak or not strong.

Various needs to make a living or become successful, various ways to hold the producing technique and own the producing bankroll, and various problems of economic development will cause the *DP* to accumulate or release in various cycle and various characteristic, these various processes cause the synthesis of *DP* movements.

In reality, there are *DP* accumulating and releasing in many activities, such as need and consumption in living, prospect and actuality, consciousness and behavior, leisure and work, association and achievement in career, merge and development in economic field, etc., or say that we can use *DP* accumulating and releasing to explain the latent mechanism of those activities.

## 2.2. *The basic concepts*

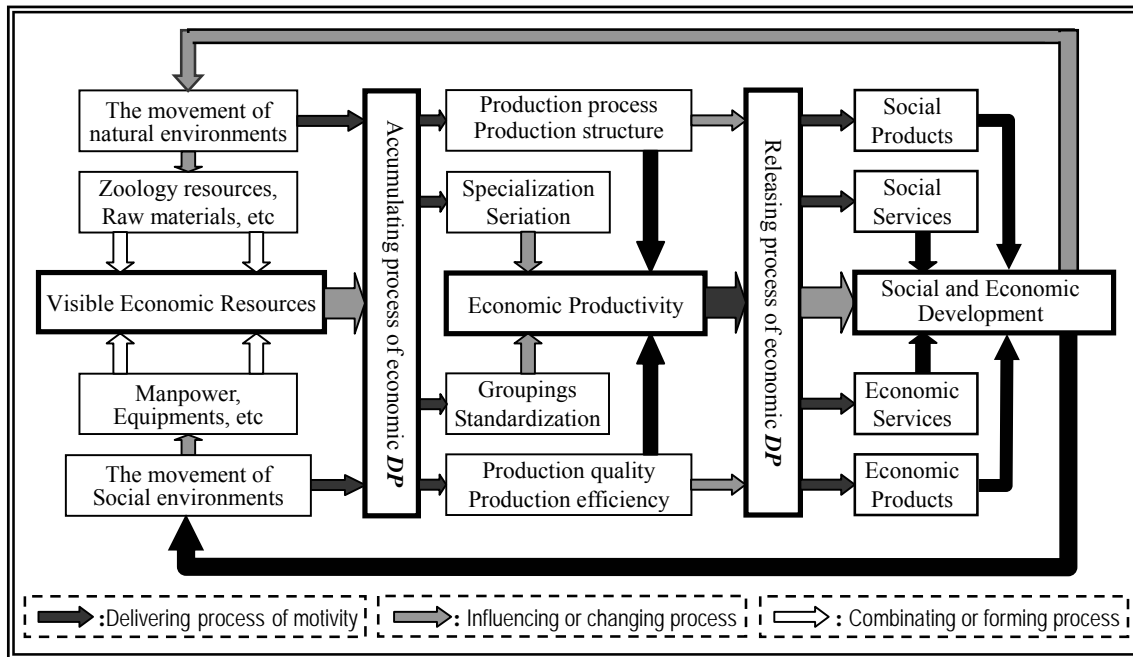
**Definition 1.** The development power (*DP*) is the potential motivity which can impel visible resources to convert to the visible productivity or social and economic products.

The development power includes the social and economic need, bankroll, policy, technique, knowledge, information, consciousness, idea, management, cultural, spirit and other invisible social and economic elements.

The productivity is the visible behavior ability for mankind to improve the nature, and the development power (*DP*) is the invisible behavior motivity for mankind to improve the nature. In the economic society, *DP* is the behavior motivity to develop economy, and we also call it the economic *DP*. The emergence of a new technique is the inevitable outcome of technique *DP* being accumulated, and the application to the new technique is the beginning of technique *DP* being released. Also, Establishment of a policy is an inevitable outcome of policy *DP* being accumulated, and putting a policy into practice is the beginning of policy *DP* being released. The production level is

a measurement of productive ability, similarly, the development energy is the measurement of  $DP$ , for example, the measurement of economic productivity is the level of economic development, and economic development energy is the measurement of economic  $PD$ .

We divide the visible economic resources in the visible nature resources (such as zoology resources like forest, river land etc, and raw materials like mines, coal, petroleum etc.) and the visible social resources (such as the manpower, workshops, equipments, surplus product of society, etc.), so the correlation of the economic  $DP$  to the visible economic resources and productivity and can be shown by figure 1. We call the economy productivity the object of Economic  $DP$ .



**Figure 1.** The relation of economic  $DP$  to Economic productivity and visible economic resources

In figure 1, depended on economic  $DP$ , the visible economic resources are converted to the visible economic productivity and visible social and economic products and services. Part of products is used to satisfy social and economic needs and part of products become the new social and economic resources.

**Definition 2.** Accumulation of development power ( $DP$ ) is the process in which  $DP$  becomes stronger and stronger, release of development power ( $DP$ ) is the process in which  $DP$  is converted to other kind of power, and becomes weaker and weaker.

$DP$  accumulating can be described by development energy becoming larger, and  $DP$  releasing can be described by development energy becoming smaller. There are four basic ways in  $DP$  movement, i.e. slowly accumulated and slowly released, slowly accumulated and quickly released, quickly accumulated and slowly released, and quickly accumulated and quickly released.

**Definition 3.** The derivative process is the process in which  $DP$  is accumulated, released, re-accumulated, and re-released, so that the society and economy is continuously pushed to develop.

### 2.3. The basic assumptions

According to the basic models and basic definitions, here we give the basic assumptions about the  $DP$  and derivative process. For the sake of convenience, we do not strictly distinguish  $DP$  from development energy in the following

description, namely see them as the same.

**Assumption 1.** The assumptions about *EDP*:

- 1) *EDP* is a primitive and natural force to impel economic development. Any development and change in economic field are the results of the *DP*'s varying.
- 2) *EDP* is always in the variety of being stronger or weaker. The movement of *EDP* is the emblem that economic society is existent. An economic society of no *EDP* is an obituary economic society.
- 3) The aim to which *EDP* moves is the looking for its optimal existence. The optimal existence of *EDP* means the minimum depletion and maximum income of economic development at the same time. If the object and the environment are different, the optimal existence of *EDP* may not be the same. If the object and the environment are same, and then the targets of the optimal existence of *EDP* are same.

**Assumption 2.** The assumptions about the process of *EDP* movement:

- 1) Accumulation of *EDP*. The formation and increase of *EDP* depend on the proper process in which it is accumulated. When *EDP* is small to a certain degree, it naturally requires to be accumulated. The size of development energy is decided by the time and efficiency of *EDP* being accumulated. The longer the *EDP* is accumulated, the stronger the actual economic impetus of *EDP* is.
- 2) Release of *EDP*. When *EDP* is accumulated to a higher degree, it will be released out in a certain way. That the release of *EDP* is stronger or weaker and quicker or slower is determined by the degree of *EDP* being accumulated, and the related economic environment. To the same degree of *EDP* being accumulated, the quicker the release is, the shorter the time of release should be; whereas, the slower the release is, the longer the time of release should be.
- 3) The moving cycle of *EDP*. A standard cycle of *EDP* moving includes a process of *EDP* being accumulated and a process of *EDP* being released. If both the processes of *EDP* being accumulated and released are all shorter, then the moving cycle of *EDP* would be shorter, and if both the processes of *EDP* being accumulated and released are all longer, then the moving cycle of *EDP* would be longer.
- 4) The structure of *EDP* moving. To *EDP* moving, a longer cycle will include many shorter cycles. Whether the cycles of *EDP* moving are longer or shorter, they are alike in construction, namely each of them includes a processes of accumulating *EDP* and a process of releasing *EDP*.

What we need to indicate is, that the *EDP* is efficiently accumulated and released should match with the appropriate and reasonable way. If the way is not appropriate and reasonable, the *EDP* can not be efficiently accumulated. Also, if the way is not appropriate and reasonable, the *EDP* can not be efficiently released. For example, if the knowledge learned does not conform to the actual demand, the knowledge *DP* can't be efficiently accumulated, and if the knowledge learned does not be applied appropriately, the knowledge *DP* can't be efficiently released. Again for example, if the policy formulated does not conform to the actual circumstance, the policy *DP* can't be efficiently accumulated, and if the policy formulated can't be accurately understood and used, it is difficult for policy to produce ideal effect, namely the policy *DP* already accumulated can't be efficiently released.

**Assumption 3.** The assumptions about the level of economic development:

- 1) The level of economic development is the synthesis status of development in all economic fields, and includes the basic economy level and the actual economy level. The basic economy level is average level of economic development. The actual economy level is the actual level that economic development reaches finally.
- 2) Both the basic economy level and the actual economy level are all nonnegative. Namely in theoretical, the lowest values of the basic economy level and the actual economy level are the zero.
- 3) The actual economy level should fluctuate around its basic level, and the fluctuation range is positive, namely

lowest value is larger than zero.

4) The possibilities that the actual economy level is much lower than the basic economy level, or is much higher than the basic economy level, will be very small.

5) The actual economy level can't be accurately foreknowledge, so it is a stochastic variable.

Here, we give the rules about the measurement of the level of economic development and *DP* as follows:

1) The basic measuring index of the level of economic development is the statistic results of the integrated status of economic development. We can generally take the *GDP* (Gross Domestic Product) as a basic measuring index of the level of economic development.

2) The basic measuring index of the *EDP* is the development energy (*DE*), which is the fluctuating range of the level of economic development, namely standard variance of the level of economic development.

3) In particular, we can measure *DP* with the relative development energy. The relative development energy also called the development vitality (*DV*). The economic *DV* is the ratio of standard variance of the level of economic development to the actual economy level, namely

$$\text{The economic } DV = \frac{\text{The standard variance of the level of economic development}}{\text{The actual economy level}}$$

If *EDP* is continually accumulated when the basic economy level increases gradually, namely economic development energy (*EDE*) or economic development vitality (*EDV*) continuously strengthen, and we call this kind of process of economic development the growth process with *DP* accumulation. And if *DP* is continually released when the basic economy level increases gradually, namely *EDE* or *EDV* continuously weaken, and we call this process of economic development the growth process with *DP* release. To the circumstance that the basic economy level declines gradually, we have the recession process with *DP* accumulation and the recession process with *DP* release. If the basic economy level is stable, we have the stable process with *DP* accumulation, or the stable process with *DP* release.

#### 2.4. The basic inferences

According to the theory of *EDP* and derivative process, and we can get the following inferences:

1) The efficient economic development depends on the efficient release of *EDP*. When the *EDE* or *EDV* is higher, the key to decide the efficiency and speed of economic development is that the economic productivity is efficiently stirred up. In basically, that the economic productivity is efficiently stirred up depends on releasing the *EDP* reasonably. The incitement factors which are usually considered by peoples, such as the policy, economic data, war, nature disaster, etc. are substantially converted to *EDP* to influence the economic development.

2) The process of economic development is a derivative process. The process of economic development is essentially a movement process that *EDP* becomes stronger or weaker. It is the *EDP* movement causes the variety of production ability and the change of market require, and finally causes the variety of economic development. So the process of economic development is a derivative process. Both the growth process and the recession process in economic development are the derivative process in which accumulation and release of *EDP* are interlaced. In the growth process of economic development, accumulation of *EDP* is a process in which economic level increase by degrees and *EDV* becomes stronger more and more, and release of *EDP* is a process in which economic level increase by degrees and *EDV* becomes weaker more and more. In the recession process of economic development, accumulation of *EDP* is a process in which economic level decrease by degrees and *EDV* becomes stronger more and more, and release of *EDP* is a process in which economic level decrease by degrees and *EDV* becomes weaker more and more. All kind of economic development, no matter how its scale is large or small, is the alike derivative process in



structure.

3) The economic development causes derivative process more efficient. Along with the advance in economy level, the production will gradually incline to more standardization, namely more specialization, larger scale, more collectivization, more legal system, and more technological process. The standardization in economic production is beneficial to accumulate or release *EDP*, so the efficient derivative process is easy to come into being. On the other hand, the standardization in economic production will cause *EDV* to weaken or disappear more quickly. At this time, the main way to increase *EDV* is to make the standardization in economic production move forward to new higher level, and to form the more high-efficient derivative process.

4) The macroeconomic development is a cyclical process. To all kind of economic behavior individual, such as individuals, enterprise, consumer, economic society), they have their own cycle of *DP* movement, and the cycles may be not completely synchronous. It is the compositive *DP* from all kind of economic individuals impels the macroeconomic development.

At a certain period, the main economic development will influence the majority of individuals in economic society, and make them act in consistent behavior, so the cycle of economic development is formed. Because this cycle is essentially caused by *EDP*, the cycle of economic development should be similar to the movement cycle of *EDP*. The length of the cycle of economic development is decided by the status of accumulation and release of *EDP*. If the whole *EDP* is exhausted, and can not be accumulated again, thus the economic development may go to its end.

5) The validity of economic policy. In fact, the government's policy is effective to economic development in the many circumstance. Whether the interfering result of economic policy is good or not is determined by the movement of policy *DP*. If policy *DP* and *EDP* is sufficiently accumulated, the influence of policy will be very obvious, and if policy *DP* and *EDP* is sufficiently released or is not accumulated yet, the influence of policy will be very feeble, and even invalid.

6) Imbalance of economic development. For different country or different region, their economic backgrounds (economic level, economic consciousness, cultural environment, technical level and economic system) are different, and the abilities to accumulate or to release *EDP* are also different, so there is a big difference in their economic level. In the developed countries or regions, there are the good economic backgrounds to insure *EDP* to be accumulated or released, that certainly cause its higher level of economic development.

7) The fluctuation of *EDP* decides the fluctuation of economic output. The fluctuation of *EDP* directly reflects the synthesis status of economic require, and also directly decides the ability of economic production. The fluctuation of the economic output is caused by *EDP*, and also lags the fluctuation of *EDP*. Therefore, the fluctuation of *EDP* decides the fluctuation of economic output, the fluctuation of *EDP* is a real reason for fluctuation of economic output.

8) Modern economic development is more beneficial to new arisen industry. The economic development which is impelled by accumulation or release of *EDP* can bring many industries the benefits and the opportunities, also can bring some industries the risk. The industries that acquire the benefits are usually the new arisen industries, and the traditional industries may suffer the loss. Because *EDP* of the traditional industries have been accumulated and released again and again, the promoting space of their *EDV* is very limited.

9) *DP* decides the individual economic behavior. In economic society, whether is a "rational economic person" or "non-rational economic person", his economic behavior is decided by his economic need, consciousness, idea, knowledge, experience and other elements. That the consciousness, idea, knowledge, experience are different causes the tropism of their *DP* difference, and show their conflicting behavior characteristic further. According to the *DP*

theory, the assumptions of “rational economic person” and “non-rational economic person”, which both see conflicting, are actually the reasonable results of the different tropism of *DP*.

10) The actual economic level may be the zero, *EDE* can't be the zero. If a country or a region suffers a fatal stroke because of the war or nature disaster, all of its visible economic establishments and throughput lose, and then its actual economic level may be the zero in a short time. At this time, if there are peoples, and their experience, consciousness technique exist, *DP* level is higher than zero. The lower the level of economic development of a country or a region is, the bigger the possibility that its actual economic level is the zero after a fatal stroke from the war or nature disaster is. This inference can be clearly described by the partial distribution behind.

### 3. PARTIAL DISTRIBUTION AND RELATED RESULTS

According to the theory of *EDP* and derivative process, we can explain better the inherent reason that the cycle of economic development forms; and by means of the accumulation and release of *EDP*, we can approximately estimate the length of economic cycle. If we want do all of that, an appropriate analytic model is necessary based on the partial distribution. Now we give the definition of the partial distribution and some related results underneath.

#### 3.1. Basic definitions

**Definition 4** (partial distribution) Let  $X$  be a non-negative stochastic variable, and it follows the distribution of density

$$f(x) = \begin{cases} e^{-\frac{(x-\mu)^2}{2\sigma^2}} / \int_0^{\infty} e^{-\frac{(x-\mu)^2}{2\sigma^2}} dx & x \geq 0 \\ 0 & x < 0 \end{cases} \quad (1)$$

then  $X$  is called to follow a Partial Distribution, and note as  $S \in P(\mu, \sigma^2)$ . The partial distribution is a kind of truncated normal distribution.

**Definition 5** (The Partial Process). If stochastic variable  $X$  is related to time, i.e.  $\forall t \in [0, \infty)$ , we have  $S(t) \in P(\mu(t), \sigma^2(t))$ , then the  $\{S(t), t \in [0, \infty)\}$  is called a partial process.

**Definition 6** (*DF* Process) if  $T$  is appositive number, and  $\forall t \in [0, T]$ , have

$$W(t) \in P(\mu(t), \sigma^2(t)(T-t)),$$

then  $\{W(t), t \in [0, T]\}$  is called a *DF* process, here we rule:  $W(T) = \mu(T)$ .

If note:

$\mu$ —the basic economy level.

$\sigma$ —the fluctuation scope of the basic economy level, i.e. the standard variance of the basic economy level. The level of *EDP* of basic economy, the basic *EDE*, can be described by  $\sigma$ , and the development vitality of basic economy, the basic *EDV*, can be described by  $\sigma/\mu$ .

$X$ —the actual economy level.

Depending on assumption 3, definition 4 and ([28]), thus the actual economy level follows the partial distribution, i.e.  $X \in P(\mu, \sigma^2)$ .

If what we consider is related to time, then the definition 5 and definition 6 can be used. The above notations and meanings about  $\mu, \sigma, X$  (or  $\mu(t), \sigma(t), X(t)$  if time is related) will no longer repeat underneath.

#### 3.2. The Related Results

According to the basic definition above, if  $\mu(t), \sigma(t)$  and  $X(t)$  denote separately the basic economy level, the

fluctuation of the basic economy level and the actual economy level at time  $t \in [0, T]$ , then  $X(t) \in P(\mu(t), \sigma^2(t))$ . And refer to ([25]-[27]), have

1) The expectation value of  $X(t)$ , i.e. the average value of the actual economy level at time  $t$ , is

$$E[X(t)] = \mu(t) + \sigma^2(t) \times e^{\frac{[\mu(t)]^2}{2\sigma^2(t)}} \left/ \int_0^\infty e^{-\frac{(x-\mu(t))^2}{2\sigma^2(t)}} dx \right. \quad (2)$$

where,  $R[X(t)] = \sigma^2(t) e^{\frac{[\mu(t)]^2}{2\sigma^2(t)}} \left/ \int_0^\infty e^{-\frac{(x-\mu(t))^2}{2\sigma^2(t)}} dx \right.$  can express the average increment of the actual economy

level to the basic economy level. And

$$\int_0^\infty e^{-\frac{(x-\mu)^2}{2\sigma^2}} dx = \sqrt{\frac{\pi}{2}} \sigma \left( \sqrt{1 - e^{-\frac{2(\mu)^2}{\pi \sigma^2}}} + 1 \right).$$

2) The variance of  $X(t)$  is

$$D[X(t)] = \sigma^2(t) + E[X(t)](\mu(t) - E[X(t)]) \quad (3)$$

Notice:

$\sqrt{D[X(t)]}$  — actual *EDE* at time  $t \in [0, T]$ .

$\sqrt{D[X(t)]}/E[X(t)]$  — actual *EDV* at time  $t \in [0, T]$ .

## 4. THE BASIC MODELS FOR DERIVATIVE PROCESS

The processes of economic development primarily include the growth process and recession process. An economic process that the basic economy level increases gradually is called a growth process; an economic process that the basic economy level declines gradually is called a recession process. If a process of economic development does not show obvious increase or decline, we call it a stable process. A stable process substantially includes many growth process and recession process which scales are very small. So we do not discuss the stable process alone.

There are three ways to describe the economic development by means of derivative process: they are the derivative process model on mathematics expectation, the derivative process model on optimal choice, and the derivative process model on time series. Based on the partial distribution and *DF* process [25]-[27], we give the derivative process models as follow.

### 4.1. The derivative process model on mathematics expectation

The derivative process model on mathematics expectation, is also called the natural process, describes mainly the natural process of economic development by means of the average value of the actual economy level and the *EDE* or *EDV* of the actual economy. If the initial variable of actual economy level is  $X_0$ , and  $X_0 \in P(\mu, \sigma^2)$ , we use the notations in Table 1.

Then, according to (2) and (3), have

$$E(X_i) = E(X_{i-1}) + R(X_i) \quad (4)$$

$$D(X_i) = D(X_{i-1}) - E(X_i)R(X_i) \quad (5)$$

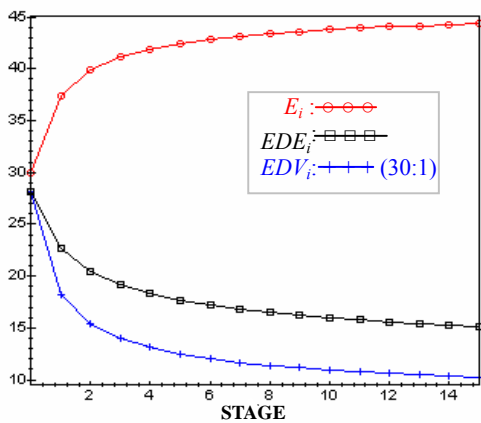
Because  $E(X_i) > 0$ ,  $R(X_i) > 0$ , according to (4) and (5), we get the following inequalities for  $i=1, 2, \dots, n$ :

$$E(X_i) > E(X_{i-1}) \text{ and } D(X_i) < D(X_{i-1})$$

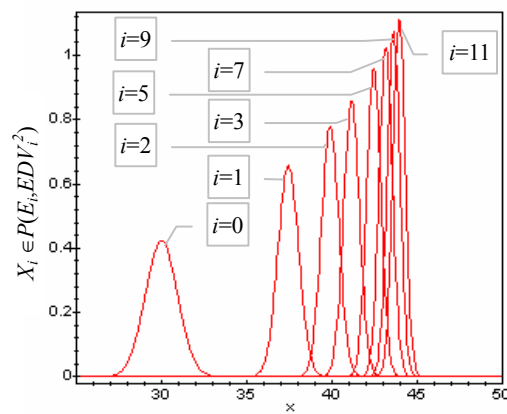
Where,  $n$  is the total number of development stages.  $E(X_i) > E(X_{i-1})$  means that the average value of the actual economy level becomes higher gradually, and  $D(X_i) < D(X_{i-1})$  means that the  $EDE$  becomes lower gradually, namely the  $EDV$  becomes weaker gradually. So the derivative process model on mathematics expectation is a growth process with  $EDP$  release. Sometimes, we use  $X_i \in P(E(X_{i-1}), EDV_{i-1}^2)$  instead of  $X_i \in P(E(X_{i-1}), EDE_{i-1}^2)$  in order to describe the variety of  $EDP$  more clearly and more evidently. Suppose that the initial level of basic economy is  $\mu=30$ , the initial  $EDE$  is  $\sigma=28.2$ , and the total number of development stages is  $n=15$ . According to the formula (4) and (5), we can get calculating results in Table 2, and the varying process of the related indexes in figure 2 and the distributions of actual economy level in figure3.

**Table 1.** Main notations and its meanings

Notations	Meanings ( $i=1,2, \dots, n$ )
$X_i$	The actual economy level for stage $i$ , $X_i \in P(E(X_{i-1}), EDE_{i-1}^2)$ or $X_i \in P(E(X_{i-1}), EDV_{i-1}^2)$ .
$E(X_i)$	The actual economy level for the end of stage $i$ , Also the basic economy level for the beginning of stage $i+1$ ( $i \leq n-1$ ), $E(X_i)$ is determined by (2).
$EDE_i = \sqrt{D(X_i)}$	The actual level of $EDP$ for the end of stage $i$ , Also the basic level of $EDP$ for the beginning of stage $i+1$ ( $i \leq n-1$ ), $D(X_i)$ is determined by (3).
$R(X_i)$	The average increment level of economic development for the end of stage $i$ .
$EDV_i = \sqrt{D(X_i)} / E(X_i)$	The average vitality of actual economy development for the end of stage $i$ , Also the vitality of basic economy for the beginning of stage $i+1$ ( $i \leq n-1$ ).



**Figure2.** The indexes varying process of economy developing (on the natural process)



**Figure3.** The partial distributions of actual economy level in different stages (on the natural process)

In figure 2, the proportion of the real calculating values of  $EDV_i$  (Table 2) to shown values is 30:1. The

probability distribution functions of variables of the actual economy level,  $X_i \in P(E(X_{i-1}), EDV_i^2)$  ( $i=0, 1, 2, 3, 7, 11, 15$ ), are shown in figure 3. Here list only the stage  $i$  ( $i=0, 1, 3, 7, 11, 15$ ) in all of 16 stages.

**Table 2.** The calculating results of the related indexes (the natural derivative process)

Stage	Basic economy level	Economic development energy	Economic development vitality
	$E(X_i)$	$EDE_i = \sqrt{D(x_i)}$	$EDV_i = \sqrt{D(x_i)} / E(X_i)$
$i=0$	30	28.2	0.9399999999
$i=1$	37.44342600	22.72735421	0.6069784910
$i=2$	39.89124129	20.46671051	0.5130627639
$i=3$	41.14162872	19.16880966	0.4659224794
$i=4$	41.91629430	18.30224449	0.4366379423
$i=5$	42.45128941	17.67090606	0.4162631172
$i=6$	42.84734483	17.18403323	0.4010524642
$i=7$	43.15500237	16.79327353	0.3891385148
$i=8$	43.40256600	16.47025013	0.3794764146
$i=9$	43.60720069	16.19708595	0.3714314538
$i=10$	43.77996528	15.96189103	0.3645935059
$i=11$	43.92833160	15.75641077	0.3586844798
$i=12$	44.05754516	15.57471182	0.3535083892
$i=13$	44.17140672	15.41240484	0.3489226625
$i=14$	44.27274408	15.26616323	0.3448208045
$i=15$	44.36370903	15.13341327	0.3411214617

#### 4.2. The derivative process model on optimal choice

The derivative process model on optimal choice, is also called the optimal process, describes mainly the optimal process of economic development by means of the optimal choice of the actual economy level and the  $EDE$  or  $EDV$  of the actual economy. Noting:  $E_0=\mu$ ,  $D_0=\sigma^2$ ,  $X_0 \in P(\mu, \sigma^2)$ , according to [28]-[29], for positive integer  $n(n>0)$  and  $i=1, \dots, n$ , we have

$$\text{the basic economy level for stage } i: E_i = \frac{E_{i-1} + \sqrt{E_{i-1}^2 + 4D_{i-1}}}{2} \quad (6)$$

$$EDE \text{ of basic economy level for stage } i: \sqrt{D_i} = \sqrt{D(X_{i-1}) + [E(X_{i-1}) - E_i]^2} \quad (7)$$

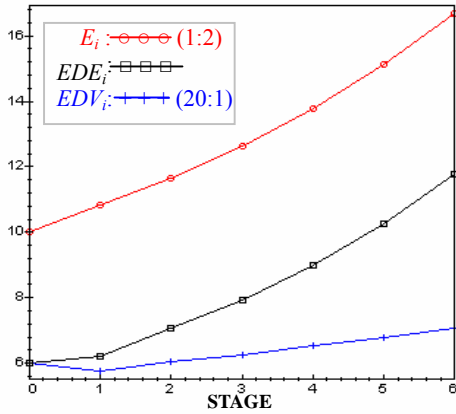
$$EDV \text{ of basic economy level for stage } i: EDV_i = \frac{\sqrt{D_i}}{E_i} \quad (8)$$

where,  $E(X_{i-1})$  is determined by (2), and  $X_i \in P(E_i, D_i)$  or  $X_i \in P(E_i, EDV_i^2)$ . Because  $E_i > E_{i-1}$ ,  $D_i > D_{i-1}$ , the optimal process is an growth process with  $EDP$  accumulation.

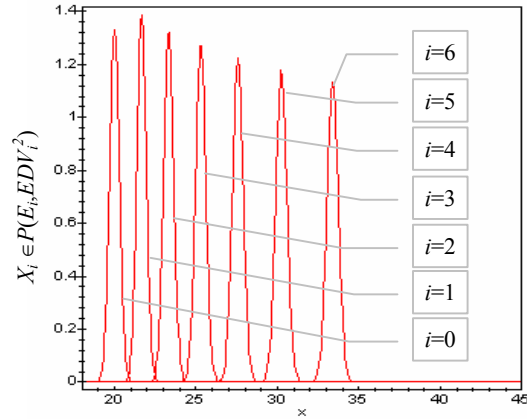
Suppose an initial basic economy level is  $\mu=20$ , and initial  $EDE$  is  $\sigma=6$ , and the total number of economic

development stages is  $n=6$ . According to formulas (6), (7) and (8), we have the calculating results as drawn in figure 4, figure5 and figure 6. In figure4, the proportion of the real calculating values of  $E_i$  to drawn values is 1:2, and the proportion of the real calculating values of  $EDV_i$  to drawn values is 20:1. In figure 5 are the partial distributions of  $X_i$  (the variable of actual economy level) on  $EDV_i$ , i.e.  $X_i \in P(E_i, EDV_i^2)$  ( $i=0, 1, \dots, 6$ ). In figure 6 are the partial distributions of  $X_i$  on  $EDE_i$ , i.e.  $X_i \in P(E_i, D_i)$  ( $i=0, 1, \dots, 6$ ).

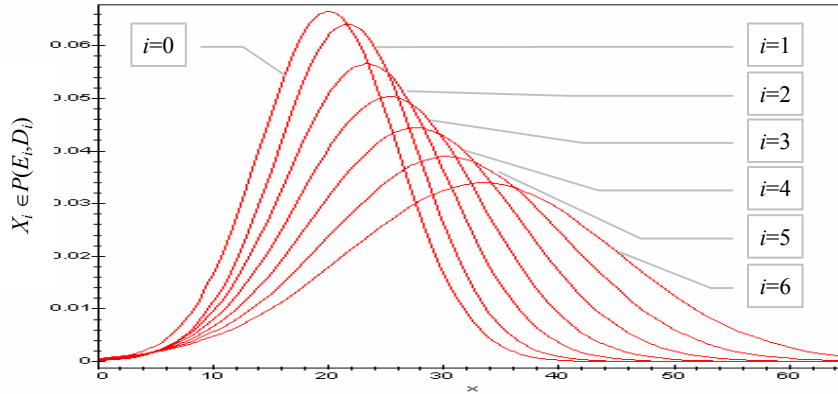
We can see, from figure 4 and figure 6, the derivative process model on optimal choice is an growth process with  $EDP$  accumulation. And from figure5, the vitality has a shorter drop before it longer rise, this means the startup.



**Figure 4.** The indexes varying process of economy developing (on the optimal process)



**Figure 5.** The partial distributions of actual economy level in different stages (on the natural process and  $EDV_i$ )



**Figure6.** The partial distributions of actual economy level in different stages (on the natural process and  $D_i$ )

#### 4.3. The derivative process model on time series

Suppose the process of economic development is divided as the period sections:  $[t_0, t_1)$ ,  $[t_1, t_2)$ ,  $\dots$ ,  $[t_{n-1}, t_n)$ , where,  $t_0 < t_1 < t_2 < \dots < t_{n-1} < t_n$ . And the time  $t_i$  ( $i=1, \dots, n$ ) is end time of the  $i$ th process, also the start time of  $i+1$ th process. For  $t \in [t_{i-1}, t_i)$ ,  $i=1, \dots, n$ . Note:

$X_i(t)$ —the actual economy level of  $i$ th process,  $X_i \in P(\mu_i(t), \sigma_i^2(t))$ .

$\mu_i(t)$ —the basic economy level of  $i$ th process.

$\sigma_i(t)$ —the basic *EDE* of  $i$ th process.

$\sigma_i(t)/\mu_i(t)$ —the basic *EDV* of  $i$ th process, i.e.  $EDV_i$ .

For the *EDP* with accumulation, *EDE* presents uptrend along with time propulsion, so *EDE* can be usually determined by expression (9):

$$\sigma_i(t) = \sigma_i(t_{i-1}) \sqrt{\frac{t}{t_{i-1}}}, t \in [t_{i-1}, t_i] \quad (9)$$

And for the *EDP* with release, *EDE* presents downtrend along with time propulsion, so *EDE* can be usually determined by expression (10):

$$\sigma_i(t) = \sigma_i(t_{i-1}) \sqrt{\frac{t_i - t}{t_i - t_{i-1}}}, t \in [t_{i-1}, t_i] \quad (10)$$

1) The model of economic growth process. The growth processes in economic development include the growth processes with *EDP* accumulation and with *EDP* release. If the basic economy level continuously increases, the basic economy level can be generally expressed as

$$\mu_i(t) = \mu_i(t_{i-1}) e^{a_i(t-t_{i-1})}, t \in [t_{i-1}, t_i] \quad (11)$$

or if there is a upper limit for actual economy level, have

$$\mu_i(t) = \mu_i(t_{i-1}) \frac{\lambda_i}{1 + (\lambda_i - 1)e^{-a_i(t-t_{i-1})}} \quad (12)$$

where,  $t \in [t_{i-1}, t_i]$ ,  $a_i (>0)$  is the growth rate of basic economy level,  $\lambda_i (>1)$  is the upper limit value of increase of basic economy level.

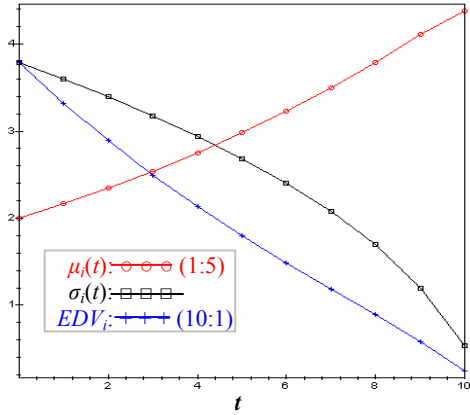
For  $X_i \in P(\mu_i(t), \sigma_i^2(t))$ , if the  $\mu_i(t)$  and  $\sigma_i(t)$  are separately determined by (11) and (9), the process of economic development is an growth processes with *EDP* accumulation; if the  $\mu_i(t)$  and  $\sigma_i(t)$  are separately determined by (11) and (10), the process of economic development is an growth processes with *EDP* release. An example of growth processes with *EDP* release is given as follow. The example of growth processes with *EDP* accumulation could be got by the reverse of the recession processes with *EDP* release.

The example of growth processes with *EDP* release. Suppose that the growth rate of basic economy level is  $a_i=0.10$ , the initial time and end time of  $i$ th process are separately  $t_{i-1}=0$  and  $t_i=10$ , and the time unit is 1. The basic economy level is  $\mu_i(t_{i-1})=10$ , and initial *EDE* is  $\sigma_i(t_{i-1})=1.2$ . According to formulas (9) and (11), we have the calculating results as drawn in figure 7 and figure 8. In figure 7, the proportion of the real calculating values of  $\mu_i(t)$  to drawn values is 1:5, and the proportion of the real calculating values of  $EDV_i$  to drawn values is 10:1. In figure 8 are the partial distributions of  $X_i(t)$  (the variable of actual economy level) on  $\mu_i(t)$  and  $\sigma_i^2(t)$ , i.e.  $X_i(t) \in P(\mu_i(t), \sigma_i^2(t))$ ,  $t=1, 5, 7, 8, 9, 9.8$ .

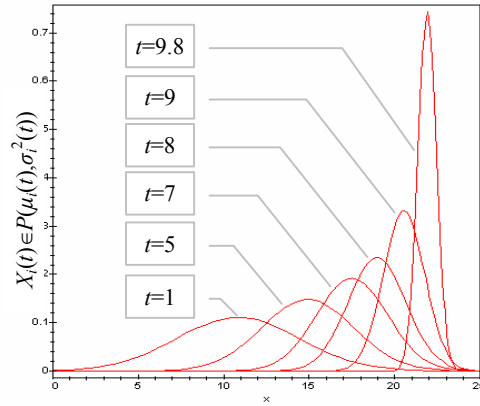
2) The model of economic recession process. The recession processes in economic development include the recession processes with *EDP* accumulation and with *EDP* release. If the basic economy level continuously decline, the basic economy level can be generally expressed as

$$\mu_i(t) = \mu_i(t_{i-1}) e^{-b_i(t-t_{i-1})}, t \in [t_{i-1}, t_i] \quad (13)$$

where,  $t \in [t_{i-1}, t_i)$ ,  $b_i (>0)$  is the declining rate of basic economy level.



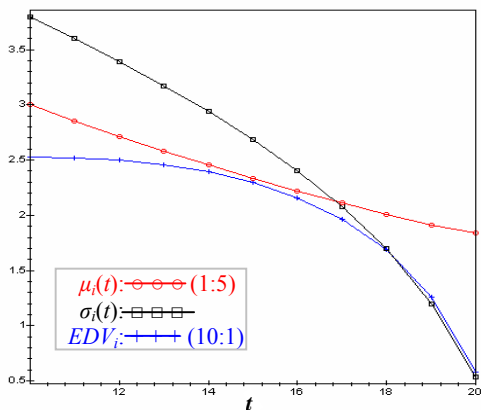
**Figure7.** The indexes varying process of growth processes with *EDP* release



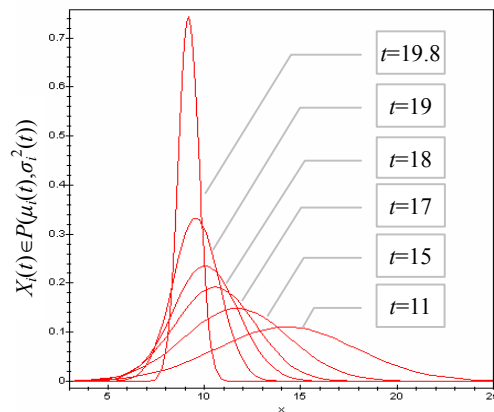
**Figure8.** The partial distributions of actual economy level in growth processes with *EDP* release

For  $X_i \in P(\mu_i(t), \sigma_i^2(t))$ , if the  $\mu_i(t)$  and  $\sigma_i(t)$  are separately determined by (13) and (9), the process of economic development is a recession processes with *EDP* accumulation; if the  $\mu_i(t)$  and  $\sigma_i(t)$  are separately determined by (13) and (10), the process of economic development is a recession processes with *EDP* release. An example of recession processes with *EDP* release is given as follow. The example of growth processes with *EDP* accumulation could be got by the reverse of the growth processes with *EDP* release.

The example of recession processes with *EDP* release. Suppose that declining rate of basic economy level is  $b_i=0.05$ , the initial time and end time of  $i$ th process are separately  $t_{i-1}=10$  and  $t_i=20$ , and the time unit is 1. The basic economy level is  $\mu_i(t_{i-1})=15$ , and initial *EDE* is  $\sigma_i(t_{i-1})=1.2$ . According to formulas (10) and (13), we have the calculating results as drawn in figure 9 and figure 10. In figure 9, the proportion of the real calculating values of  $\mu_i(t)$  to drawn values is 1:5, and the proportion of the real calculating values of  $EDV_i$  to drawn values is 10:1. In figure 10 are the partial distributions of  $X_i(t)$  (the variable of actual economy level) on  $\mu_i(t)$  and  $\sigma_i^2(t)$ , i.e.  $X_i(t) \in P(\mu_i(t), \sigma_i^2(t))$ ,  $t=11, 15, 17, 18, 19.8$ .



**Figure9.** The indexes varying process of recession processes with *EDP* release

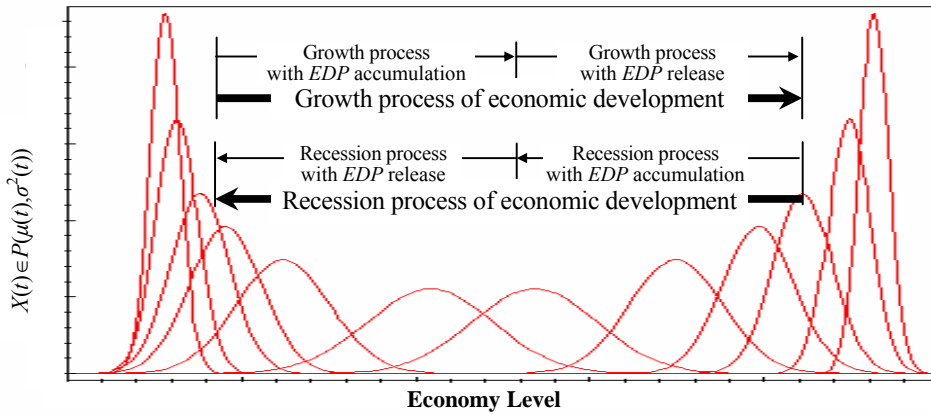


**Figure10.** The partial distributions of actual economy level in recession processes with *EDP* release

#### 4.4. The derivative process model on the complete cycle



A complete cycle of derivative process in economic development includes an accumulating process of *EDP* and a releasing process of *EDP*. Further more, a growth process includes an growth process with *EDP* accumulation and an growth process with *EDP* release, and a recession process includes a recession process with *EDP* accumulation and a recession process with *EDP*. A complete growth process is similar to a complete recession process in structure, but *EDP* moves in reverse direction. The processes of *EDP* being accumulated and being released in a complete cycle are shown in figure 11.



**Figure11.** The partial distributions of actual economy level in a complete cycle of derivative process

#### 4.5. *EDP* analysis and countermeasures in the process of economic development

In the general process of economic development, the keeping time or ending time of economic growth or economic recession are generally determined by the statuses of *EDP* movement. So we can make use of indexes, such as the economic develop level ( $E[X(t)]$ ) and  $EDV (\sqrt{D[X(t)]}/E[X(t)])$ , to analyze and estimate the possible course of economic developing as the following six aspects:

- 1) If the basic economy level start growing and *EDV* becomes high gradually from lower level, and higher than a certain degree, the economic development may enter into a growth process with *EDP* accumulation.
- 2) If passing through the former economic growth, the economic level is still in the exaltation. When the *EDV* becomes lower gradually from higher level, the economic development may enter into a growth process with *EDP* release.
- 3) If the growth speed of economic level becomes slow obviously and *EDV* is already lower than a certain degree, then the economic development may enter into a new growth process with *EDP* accumulation, or starts a recession process with *EDP* accumulation, because *EDP*, which impels the economy to increase, have already released sufficiently.
- 4) If the basic economy level start decreasing and *EDV* becomes low gradually from higher level, and lower than a certain degree, the economic development may enter into a recession process with *EDP* accumulation.
- 5) If passing through the former economic recession, the economic level is still in the fall. When the *EDV* becomes lower gradually from higher level, the economic development may enter into a recession process with *EDP* release.
- 6) If the decreasing speed of economic level becomes slow obviously and *EDV* is already lower than a certain degree, then the economic development may enter into a new recession process with *EDP* accumulation, or starts a growth

process with *EDP* accumulation, because *EDP*, which impels the economy to decline, have already released sufficiently.

For the above circumstance 1) and 2), the government departments should pay attention to adopting the related policies properly, and accumulate or release *EDP*, in order to impel the economy to develop further. For the circumstance 3), the government departments need to consider how to discover the new point of economic increase, or adopt measures in order to arrest the possible economic decline to happen. For the circumstance 4) and 5), the government departments should pay attention to adopting the related policies properly, in order to change the present condition of economic development, and to impel economy to recovery. For the circumstance 6), the government departments need to consider how to accumulate *EDP* efficiently, and adopt the related policies in order to impel the possible economic increase to happen.

Whether is the growth process or recession process in economic development, the derivative process models on time series or the complete cycle can be applied at any time, to calculate the basic economy level, *EDE*, *EDV*, and the probability distributions of actual economy level, and to analyze and predict the economic development in the next stage. Also, the analysis and the prediction for economic development can be completed according to the derivative process model on mathematics expectation or optimal choice.

## 5. ANALYSIS OF THE REAL CASES

Making use of *DP* and the derivative process theory, we shall analyze the development characteristics of Chinese economy and American economy in the past several decades, predict the future possibility in economic development of these two countries, and bring up the consultable policy suggestions.

### 5.1. The process analysis for Chinese economic development (1949—2002)

In the past 50 years or more, there is a great development in Chinese economy. the China's **GDP** (gross domestic product) increases from the 408 hundred million Yuans (R.M.B) at 1949 to 3624.1 hundred million Yuans (R.M.B) at 1978, and to 102398 hundred million Yuans (R.M.B) at 2002. according to the exchange rate of homologous years, China's **GDP** increases from the 194.3 hundred million US\$s at 1949 to 2157 hundred million US\$s at 1978, and 12371 hundred million US\$s at 2002. From 1949 to 2002, Chinese economic development primarily experienced four periods. For each stage, the average rate of **GDP** growth, the standard variance of **GDP** and *EDV* are all shown in Table 3.

**Table 3.** Index results of Chinese economic development (1949—2002)

<b>Time stage</b>	<b>the average rate of GDP growth (%)</b>	<b>The standard variance of GDP (%)</b>	<b><i>EDV</i></b>
1949~1978	6.2	2.2	0.35
1979~1991	9.27	3.39	0.37
1992~1996	12.08	1.96	0.16
1997~2002	7.84	0.63	0.08

In the Table 3, we can see that there is a growth process with *EDP* accumulation for Chinese economic development in the period of 1949-1978. Making sure the reformation policy after the end of 1978, China entered a growth process with *EDP* release in the period of 1979-1996. The increase rate of Chinese **GDP** is decelerated in the period of 1997-2002, and *EDP* releases continuously, *EDV* declines to the lower level, *EDP* needs to be accumulated again for Chinese economic development.

The further development of the Chinese economic faces two kinds of possible results, one is a new growth process with *EDP* accumulation, and another one is a recession process with *EDP* accumulation. According to the current development level and the related conditions of Chinese economy, the possibility that former happens is larger than latter. So the Chinese government needs to perfect economic systems and economic environments completely, develop strongly economic foundation facilities, enhance economy safety efficiently, strengthen national economic consciousness, push forward basic science and applied technique, use all kind of social and economic resources, and impel *EDP* to accumulate and the economy level to increase. Both the success in application to hold the Olympic Game'2008 and the successes in launching and returning of spaceflight airship with person at 2003 are all the better ways to accumulate *EDP* for Chinese economic development.

### 5.2. Analysis for the process of U.S. economic development (1940-2002) and forecast

American economy has been increasing From World War II to 2002. According to *EDP* and derivative process theory, we can discover that there are many different characteristics at each of periods in that development process. Further more, we can predict approximately the US economic developing trend in next 4-8 years by means of *EDP* movements.

1) Data and models. Here, we analyze the U.S. economic development mainly according to American **GDP** in the period of 1940-2002. Because the absolute difference is too big between 1940 and 2002 in **GDP** price index on the U.S.\$, this does not benefit to objectively describe the undulating range on the same foundation, so we use the **GDP** (chained) price index (the **GDP** index for short) to give the empirical analysis (Fiscal Year 1996 = 1.000. Data resource: <http://www.whitehouse.gov>).

Taking the following notations and expressions:

The basic economy level:  $\mu(t)$  is the **GDP** index at the year  $t$ ,  $t=1940,1941,\dots,2002$ .

$EDE(t)$ :  $\sigma(t)=|\mu(t)-\mu(t-1)|$ ,  $t=1941,1942,\dots,2002$ .

$EDV(t)$ :  $|\mu(t)-\mu(t-1)|/\mu(t)$ ,  $t=1941,1942,\dots,2002$ .

The variable of U.S. actual economy level:  $X(t)\in P(\mu(t),[EDV(t)]^2)$ .

The basis to decide the above formulas about  $EDE(t)$  and  $EDV(t)$  is that the year is a time unit of sampling **GDP** indexes, the stability of indexes is higher, and the difference between **GDP** price index of one year and that of last year can nicely describe the economic fluctuation at that time. The calculating results are drawn in figure 12. In figure 12, the proportion of the real indexes of  $\mu(t)$  to drawn indexes is 1:10.

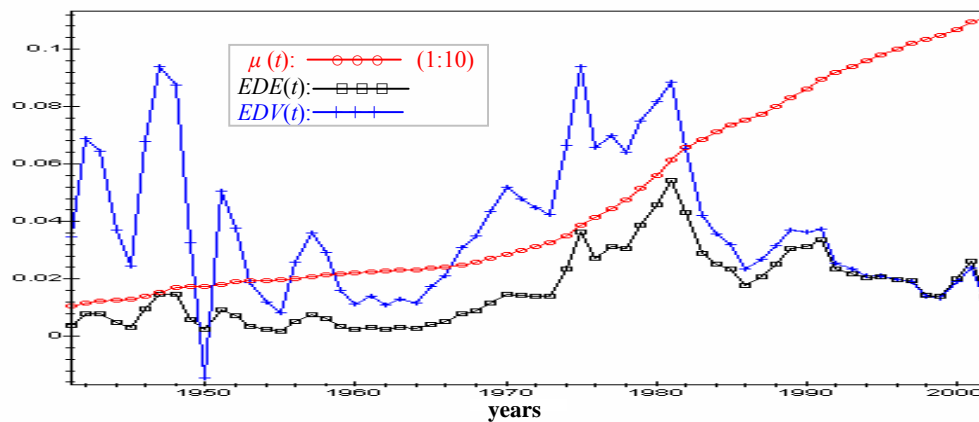
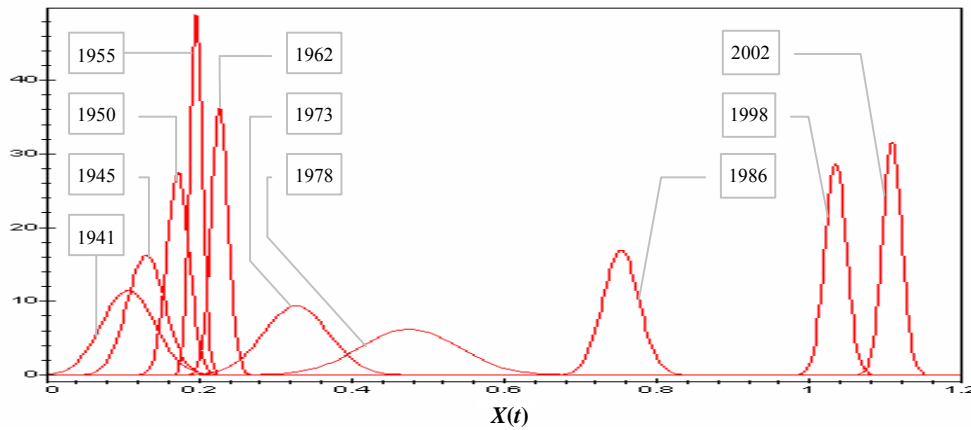


Figure12. The indexes varying process of US economic development (1941-2002)

2) Analysis of *EDP* movement. From figure 12, we have drawn the distribution curves of  $X(t)$  (the variable of U.S. actual economy level ) according to the years its values of  $EDV(t)$  is at the bottoms ( $t= 1941, 1945, 1950, 1955, 1962, 1973, 1978, 1986, 1998, 2002$ ), see also figure 13.



**Figure13.** The distribution curves of  $X(t)$  at the years of lower

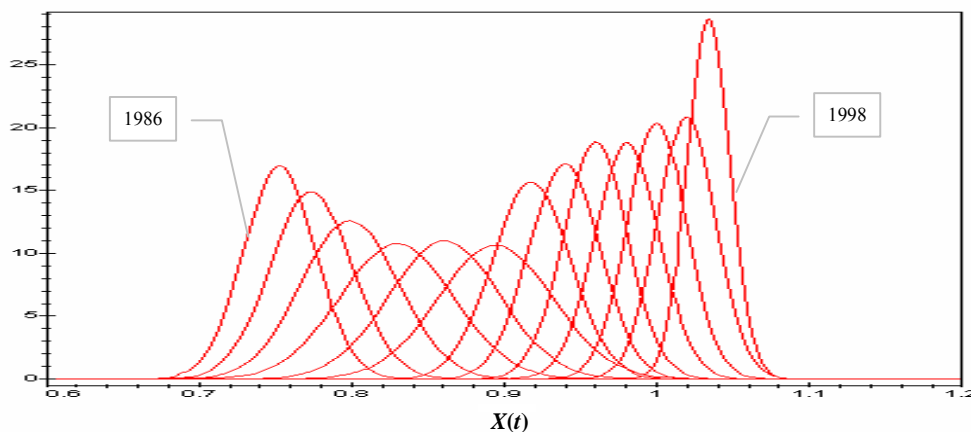
From figure 13, we see that the process of U.S. economic development from 1940 to 2002 can be divided as three stages.

First stage: 1940-1955, this is a growth process with *EDP* release.

Second stage: 1955-1978, this is a growth process with *EDP* accumulation.

Third stage: 1978-2002, this is a growth process with *EDP* release also.

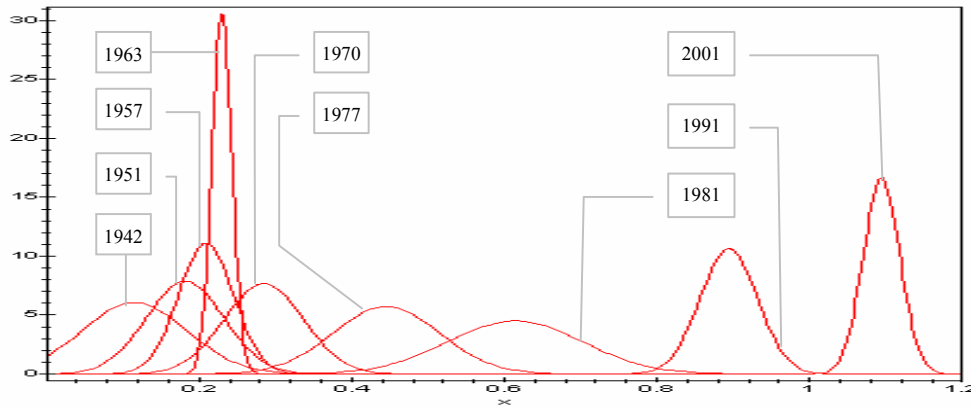
There is no marked  $EDV(t)$  between 1986 and 1998 in figure 13. If drawing the distribution curves of  $X(t)$  this 13 years, we get the results shown in figure 14. It is worthy to point out that, there is another whole derivative process in figure 14, includes a growth process with *EDP* accumulation and a growth process with *EDP* release. There are the similar characteristics between other two  $EDV$  values at the bottom.



**Figure14.** The distribution curves of  $X(t)$  between the year 1986 and 1998

In order to check the characteristic of derivative process that exists in the economic development, we have drawn the partial distributions of  $X(t)$  corresponding to the years its values of  $EDV$  is at the tops ( $t=1942, 1951, 1957, 1963, 1970, 1977, 1981, 1991, 2001$ ), see also figure 15.

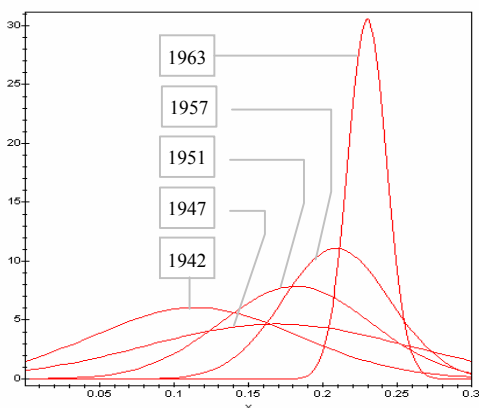
In figure 15, we also see that the process of U.S. economic development from 1940 to 2002 can be divided as three stages. First stage: 1942-1963, this is a growth process with *EDP* release, second stage: 1963-1981, this is a growth process with *EDP* accumulation, third stage: 1981-2001, this is also a growth process with *EDP* release.



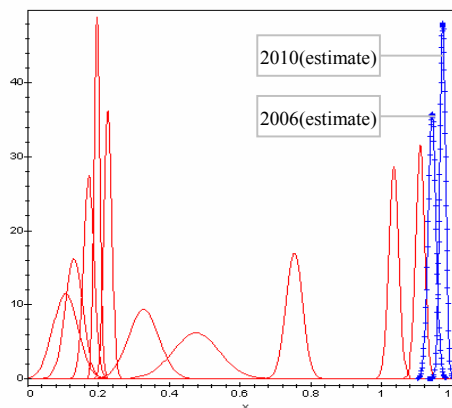
**Figure15.** The distribution curves of  $X(t)$  at the years of higher *EDV*

What we need to explain is that the top point year (1947) does not appear in figure 15. 1947 is the second year that the U.S. economy resumes to develop after World War II, and is a year of economic growth with *EDP* accumulation, see also figure 16. we also see from figure 15 that it is, as a whole, an growth process with *EDP* accumulation between 1942 and 1963, still come through a whole derivative process (see also figure 16). Because World War II brings on the *EDP* being accumulated in U.S., there is a growth process with *EDP* accumulation between 1942 and 1947. On the basis of improvement for economic environment, a growth process with *EDP* release is formed between 1948 and 1963.

Make a synthesis from above discussions, we get a conclusion that the *EDP* movement and derivative process always exist in the economic development. If analytic stance about derivative process is different, there may be a small difference in period of time, but the macroscopic structure is no essential difference.



**Figure16.** The distribution curves of  $X(t)$  at the years of higher *EDV* between 1942-1963



**Figure17.** The forecast about US economy development (2006 and 2010)

3) Forecast analysis. Suppose that the growth process with *EDP* accumulation, which started from 1978, will end by 2020. We forecast the developing trend of U.S. economy from 2002. According to figure 13 and four years between

1998 and 2002, and by means of expression (10), we have the following calculating formula for  $EDV$  of U.S.:

$$EDV(t) = EDV(2002) \sqrt{\frac{t_{2020} - t}{t_{2020} - t_{2002}}}, t_{2020}=2020; t=2006, 2010.$$

Taking the real  $GDP$  index,  $\mu(2002)=1.1080$  as the initial level, we have the following calculating formula of basic economy level of U.S. according to expression (11)

$$\mu(t) = \mu(t-4) e^{a_t \left( \frac{t-2002}{2020-2002} \right)}$$

where,  $a_t = 2[\mu(t) - \mu(t-4)] / \mu(t-4)$ , the coefficient 2 in  $a_t$  means the optimistic attitude towards U.S. economic development,  $t=2006, 2010$ .

The forecast results are shown in figure 17. Here, the forecast models for  $GDP$  price indexes and  $EDV$  are only the most basal and the simplest. If needed, the more complicated model could be used.

According to figure 17, we can see that when the U.S. economy develops until 2010,  $EDV$  will near to the low point of the 1955. So the  $EDP$  of U.S. may be released sufficiently until 2010. By the  $EDP$  and derivative theory, U.S. economic development should still have an growth process with  $EDP$  release, and this process is estimated mostly in 4-8 years, not over ten years. After this process, The U.S. economic development will faces two kinds of possible results, one is another growth process with  $EDP$  accumulation, and other one is a larger scale of recession process. If economic recession takes place, it should include a recession process with  $EDP$  accumulation and a recession process with  $EDP$  release at least. So it is a larger scale of recession process.

In order to avoid the economic recession, U.S. government needs to do a lot of works, such as technology innovation, extending the market need, etc., to accumulate the  $EDP$ . If like that, it may be not enough only depending on financial policy, and the workload should be very enormous and egregious.

### 5.3. Other examples of $DP$ movement in economic development

1) Accumulating and releasing  $DP$  by technology innovation. From the end of 19th century to beginning of 20th century, the gas engine and electronic power, as are the marks of technique inventions, caused the second revolution of industrialization, accumulated ample  $DP$  availably, and the  $DP$  releasing impelled the world economy to develop rapidly. After World War II, the new techniques such as A-energy, space navigation, electronic computer, biological engineering, etc., by its  $DP$  to be accumulated and released, caused the third technology revolution, and resulted in the unprecedented development of the social productivity.

2) Accumulating and releasing  $EDP$  by business merger and reorganization.

■ In recent years, the large-scale business merger and reorganization happen extensively in the scope of world. For examples, America Online procured Time Warner Inc at the beginning of the 2000, and involved 155 billions US\$; England Vodafone procured Germany Mannesmann, and involved 185 billions US\$;

■ Car industry. American General Motors and Italian FIATSPA constitute the alliance, Ford Motor Company procured the factory of Rover from German ion Bayerische Flugzeugwerke, Daimler-Chrysler becomes the Shareholder of Korean HYUNDAI after procuring 34% of share of Japanese MITSUBISHI CAR.

■ Communication industry. by means of merger, Three big business enterprises Lucent, NORTEL and Cisco partition the world market.

■ Financial field. Ubsag procured Paineweb-Ber, Creditsuisse Group procured DLJ (Donaldson, Lufkin& Jenrette), JP Morgan joins in Chase Manhattan Corporation.

■ Pharmacy. Glaxo amalgamates with Smithkline Beecham, Pfizer Pharmaceuticals Limited procured Warner-

Lambert.

■ Fashionable dresses field. Gucci Group Gucci and Louis-Vuitton (LV) constitute an alliance.

We can say that all of industries over the world are almost in the merger. This kind of merger is benefit for enterprises to accumulate its  $DP$  in the biggest limit, so it is essentially the results of  $EDP$  movement. The merger of enterprises can bring on resources more centralized, and make the using level of resources higher. by the merger of enterprises,  $EDV$  becomes higher rapidly, and  $EDP$  can be released more easily at the same time, so it is also the results of  $EDP$  movement.

The related cases are of plenty, owing to limited space, we do not say more here.

## 6. CONCLUSIONS AND REMARKS

In this paper, a new mode and theory for analyzing macroeconomy, the derivative process based on development power( $DP$ ), is bring forward. This theory thinks that the real force to impel the economy developing is the  $DP$  implicated in the economic society. Despite the  $DP$ , such as policy  $DP$ , technique  $DP$ , etc. does not have the actual ability to impel economic developing directly, but they can efficiently promote to improve the productivity, and impel economy to develop completely. Therefore, the basic premise of economic development is to own accumulated  $EDP$  and to release it. This shows that it is important to valuate  $EDP$  and to study how the  $EDP$  transforms to productivity.

In addition, by use of the model in this paper, we can availably describe  $EDP$  movement in the process of economic development, and analyze the beginning time and ending time of the economic cycle, establish the actual policies of economic development, and lead economic development in positive way.

What we need to know is, because the derivative process is an analysis model to macroeconomy, it may be not very accurate for the problems of micro-economy.

Some problems which are worth to study further about  $DP$  and derivative process are listed as follows:

- 1) The basic theories system needs to be developed and perfected further.
- 2) The empirical analysis and research need to be completely made.
- 3) The term and scope in which derivative process is effective need to be researched further.
- 4) The valuation research about  $EDP$  should be carried through further.
- 5) The research to confirm whether economic cycle ends or not by  $EDP$ ,  $EDE$  and  $EDV$  still need to proceed.
- 6) How to use the status of  $EDP$  being accumulated and released analysis to analyze and judge that the economic cycle is long-time, medium-time or short-time.
- 7) The accuracy of derivative process model need to be researched further.

In fact, besides economy, mankind, society, culture, family relation, etc., may be researched and analyzed by means of  $DP$  movement. Therefore, the theory of  $DP$  and derivative process, brought forward in this paper, could be applied after a revision.

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