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市場構造、技術革新とインスティテューションの共進化ダイナミズムの分析

—中国の経済改革による成長・教育・情報化の共進

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Abstract

Chinese government endeavors to create a "socialist market economy with Chinese characters," this economic system's reform from planning-oriented economy to market-oriented economy accelerated remarkable growth in economic development. In line with rapid economic development, China's education level and PCs diffusion developed significantly. Number of college students per 1000 people and number of PCs per 1000 people increase 3.7 and 103.5 times from 1988 to 2002, respectively. Patterns of Education and PCs diffusion trajectories demonstrate a parallel path with GDP per Capita in China.

These characters in China prompt us to demonstrate dynamic co-evolution between GDP, education and PCs diffusion focusing on its unique institutional systems by diffusion theory.

1. Introduction

China's rapid economic development draws the increasing attention of the world, which is not only attributed to China's unique natural situation, but also attributed to her successful reform of economic system. In China, economic system is transited from a planned economy to market economy from the end of 1978. This process is characterized as piecemeal, partial, incremental, and often experimental (Justin et al., 1996), which matches China's unique initial condition, such as large population, great ratio of which live in urban areas, imbalance of local economy. China's reform in the micro-management institution can be divided into four stages: Enterprises autonomy and the role of finical incentives with the traditional economic systems was enlarged during the first stage (1979-83); shift to a formalization of the finical obligations of the state enterprises to the government and exposed enterprises to market influences during the second stage (1984-86); The contract responsibility system, which attempted to clarify the authority and responsibilities of enterprise managers, was formalized and widely adopted during the third stage (1987-92); and during the fourth stage (1993- present), the modern corporate system was introduced to the state enterprises (Justin et al., 1996). Because of these reforms were performed in China step by step, China's economy, education and PCs diffusion have developed significantly and their development patterns demonstrate very similar as illustrated in **Figs. 1-3**.

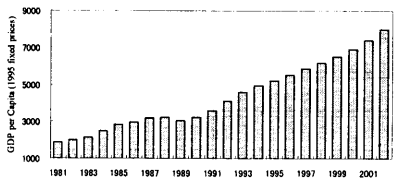


Fig. 1. Trends in China's GDP Per Capita ***(1981-2002) -1995 fixed price.***

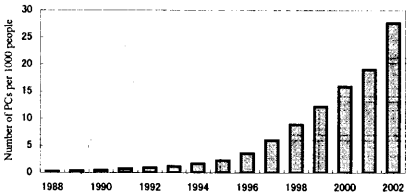


Fig. 2. Trends in Number of PCs per 1000 People in China ***(1988-2002).***

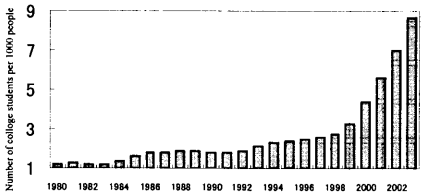
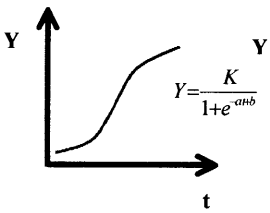


Fig. 3. Trends in Number of College Students per 1000 People in China ***(1980-2003).***

2. Analytical Framework

In this research, the relationship between GDP, education and PCs diffusion are analyzed with the theory of diffusion. Therefore, simple logistic model and Bi-logistic model are utilized as illustrated in **Fig. 4-5**.



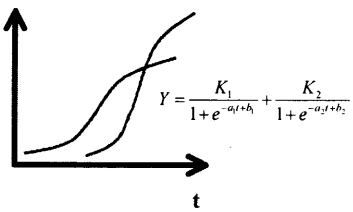
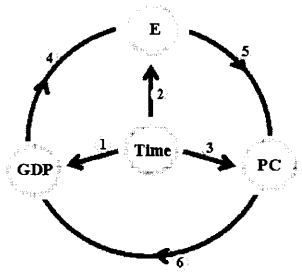


Fig. 4. Simple Logistic Model.　**Fig. 5. Bi-logistic Model.**

The analytical framework of this research is illustrated in **Fig. 6**.



E: number of college students per 1000 people;
PC: number of PCs per 1000 people

Fig. 6. Analytical Framework

As shown in Fig. 6, first, patterns of GDP, education and PCs diffusion by time t are analyzed by means of simple and bi-logistic models (Steps 1-3), and then, the relationship between them are analyzed by the foregoing two models (Steps 4-6).

3. Empirical Analysis

Estimation results of the development trajectories of China's GDP over the period 1981-2002 by simple and bi-logistic models are summarized in **Table 1**.

Table 1 Estimation Results for the Development Trajectories of China's GDP per Capita *(1981-2002)*

$$GDP = \frac{K_1}{1+e^{-a_1 t+b_1}} \qquad GDP = \frac{K_1}{1+e^{-a_1 t+b_1}} + \frac{K_2}{1+e^{-a_2 t+b_2}}$$

	K_1	a_1	b_1	K_2	a_2	b_2	adj. R^2	AIC
GDP								
Simple	46420	0.074	-3.20				0.994	10.44
	(1.02)	(8.62)	(-3.26)					
Bi-	4458.7	0.093	-0.52	8047.0	0.177	-3.81	0.997	10.23
logistic	(4.35)	(2.00)	(-1.65)	(2.12)	(2.56)	(-3.21)		

By means of AIC, the regression results of bi-logistic model are identified statistically more significant. Based on this result, trends in China's GDP per Capita are illustrated in Fig. 7.

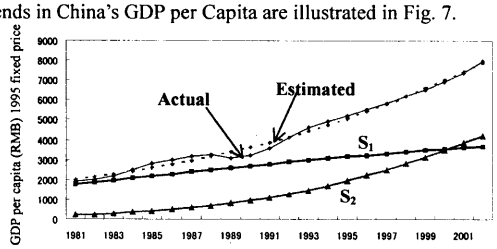


Fig. 7. Trends in China's GDP per Capita with Bi-logistic Growth Model with Time *(1981-2002)*.

From this figure, we note that China's GDP per capita develops in double trajectories, the first trajectory develops in almost a certain level, on the contrary, the second trajectory develops from the low level, and overcame the first one after 1999.

Similarly, education pattern are examined by utilizing number of college students per 1000 people over the period 1980-2003. Estimation results are summarized in **Table 2** and **Fig. 8**.

Table 2 Estimation Results for the Development Trajectories of China's Education Level *(1980-2003)*

$$E = \frac{K_1}{1+e^{-a_1 t+b_1}} \qquad E = \frac{K_1}{1+e^{-a_1 t+b_1}} + \frac{K_2}{1+e^{-a_2 t+b_2}}$$

	K_1	a_1	b_1	K_2	a_2	b_2	adj. R^2	AIC
Education								
Simple	1228.9	0.118	-7.97				0.999	-3.77
	(0.85)	(8.07)	(-6.43)					
Bi-	2.73	0.123	-0.50	8.47	0.737	-16.76	0.996	-3.75
logistic	(4.89)	(2.67)	(-2.01)	(7.41)	(7.87)	(-8.66)		

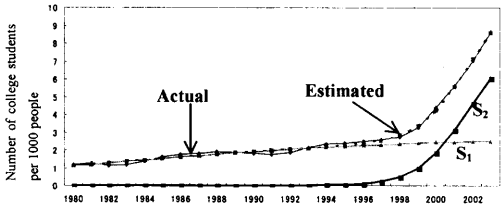


Fig. 8. Trends in China's Education Level with Bi-logistic Growth Model with Time *(1980-2003)*.

From these results, it is identified that number of college students per 1000 people grows in two trajectories, after 1995, the second trajectory grows very rapidly.

By means of the same method, patterns of PCs diffusion in leading 9 countries are analyzed. The results are summarized in **Table 3**.

Table 3 Estimation Results of the Development Trajectories of PCs in the World

	K_1	a_1	b_1	K_2	a_2	b_2	adj. R^2	AIC	Period
China									
Simple	77.82	0.375					0.987	-0.600	1988-
	(2.71)	(11.32)							2002
Bi-	2.58	13.347	-133.48	472.28	0.339	-7.98	0.999	-1.622	
logistic	(4.77)	(3.11)	(-3.11)	(2.90)	(28.35)	(-21.03)			
India									
Simple	33.50	0.287	-5.59				0.999	-2.765	1988-
	(3.62)	(26.96)	(-27.70)						2002
Bi-	2.32	1.319	-18.30	8.69	0.321	-4.38	0.999	-5.012	
logistic	(2.15)	(4.39)	(-4.66)	(3.04)	(15.09)	(-16.45)			
Indonesia									
Simple	12.68	0.390	-3.54				0.999	-2.765	1988-
	(34.26)	(19.90)	(-29.04)						2002
Bi-	5.05	0.808	-6.21	25.44	0.184	-3.77	0.998	-3.399	
logistic	(7.84)	(6.98)	(-7.24)	(2.36)	(11.06)	(-8.52)			
Phillipines									
Simple	79.76	0.193	-3.59				0.999	-3.225	1988-
	(2.34)	(10.16)	(-10.27)						2002
Bi-	29.16	0.266	-2.84	275.06	1.600	-27.43	1.000	-3.502	
logistic	(28.13)	(46.41)	(-102.4 5)	(10.46)	(8.72)	(-9.68)			
USA									
Simple	1581.7	0.137	-3.35				0.987	6.484	1981-
	(3.16)	(10.22)	(-13.59)						2002
Bi-	231.83	0.473	-2.73	577.51	0.387	-7.42	0.999	3.693	
logistic	(15.19)	(13.57)	(-21.21)	(16.30)	(11.24)	(-11.75)			
Japan									
Simple	680.31	0.243	-4.05				0.999	4.554	1981-
	(6.78)	(12.49)							2002
Bi-	116.28	0.912	-11.89	1003.0	0.159	-3.87	1.000	3.295	
logistic	(5.26)	(9.48)	(-10.45)	(4.13)	(17.41)	(-15.46)			
Canada									
Simple	771.86	0.204	4.15				0.999	4.344	1980-
	(15.40)	(26.09)	(-68.61)						2002
Bi-	232.24	0.710	-14.35	295.00	0.303	-3.90	1.000	2.382	
logistic	(8.32)	(8.78)	(-8.81)	(12.86)	(24.32)	(-65.33)			
France									
Simple	766.82	0.179	-2.82				0.999	3.815	1988-
	(4.67)	(11.62)	(16.70)						2002
Bi-	103.47	1.017	-11.82	314.80	0.204	-1.79	1.000	3.644	
logistic	(2.496)	(4.11)	(-4.27)	(3.38)	(7.34)	(5.38)			
UK									
Simple	816.34	0.159	-2.90				1.000	3.885	1985-
	(6.93)	(16.90)	(-26.30)						2002
Bi-	189.42	0.329	-1.78	333.04	0.407	-6.68	1.000	2.721	
logistic	(5.65)	(9.69)	(-12.94)	(3.83)	(4.26)	(-4.85)			

From Table 3, we note that all of results of Bi-logistic model demonstrate statistically significant, which indicates that PCs diffusion in these countries grows in double trajectories. However, comparing the ratio of the first carrying capacity and total carrying capacities illustrated in **Table 4** and **Fig. 9**, it is noted that the ratio of China is the lowest, which indicates the second trajectory plays very important role in PCs diffusion.

Table 4 Ratio of the First and Total Carrying Capacities

	China	India	Indonesia	Philippines
$K_1/(K_1+K_2)$	0.54%	21.07%	16.56%	9.59%

	USA	Japan	Canada	France	UK
$K_1/(K_1+K_2)$	28.64%	10.39%	44.05%	24.74%	36.28%

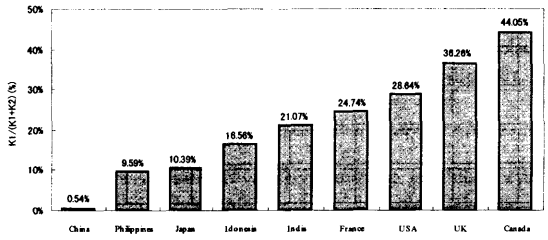


Fig. 9. Ratio of the First and Total Carrying Capacities.

Nation's education level chiefly depends on its economic development. Therefore, in this research simple and bi-logistic models analyze their relationship. The analytical results are summarized in **Table 5**.

Table 5 Estimation Results of the Development Trajectories of China's Education Level by GDP per Capita *(1981-2003)*

$$E = \frac{K_1}{1+e^{-a_1 GDP+b_1}} \qquad E = \frac{K_1}{1+e^{-a_1 GDP+b_1}} + \frac{K_2}{1+e^{-a_2 GDP+b_2}}$$

	K_1	a_1	b_1	K_2	a_2	b_2	adj. R^2	AIC
Education								
Simple	699.54	0.0003	-7.11				0.999	-3.80
	(1.26)	(11.32)	(-8.65)					
Bi-logistic	2.43	0.0008	-1.67	5.23	0.0024	-17.00	0.995	-4.17
	(16.34)	(4.99)	(-5.52)	(14.36)	(9.08)	(-9.49)		

Similarly, estimation result of Bi-logistic model is statistically more significant. Based on this result, trends in education level in line with GDP per capita are illustrated in **Fig. 10**.

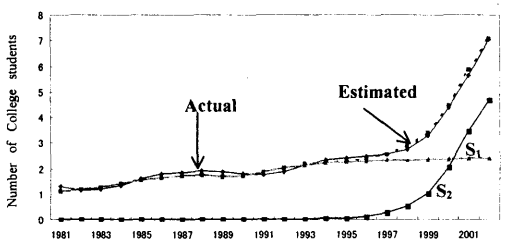


Fig. 10. Trends in China's Education Process with Bi-logistic Growth Model by GDP per Capita *(1981-2003)*.

Fig. 10 indicates that number of college students grows in double trajectories; the patterns of education level are very similar to that of GDP per capita (Fig. 7). However, the second trajectory of education level grows rapidly after 1995, because in China, reform of universities performed since 1995, many universities endeavor to build comprehensive universities instead of single colleges of social science or natural science, now local governments try to build university cities in order to meet large demand of high education in China.

PC's operation need a certain level of knowledge, therefore, the relationship between PCs diffusion and education level are similarly analyzed by simple and bi-logistic models. Analytical results are summarized in **Table 6**. By AIC, we also note that results of bi-logistic model are more significant. Based on these results, relationship between them is illustrated in **Fig. 11**.

Table 6 Estimation Results of the Development Trajectories of China's Number of PCs per 1000 People by Education Level *(1988-2002)*

$$PC = \frac{K_1}{1+e^{-a_1 E+b_1}} \qquad PC = \frac{K_1}{1+e^{-a_1 E+b_1}} + \frac{K_2}{1+e^{-a_2 E+b_2}}$$

	K_1	a_1	b_1	K_2	a_2	b_2	adj. R^2	AIC
PCs								
Simple	24.309	1.348	-4.96				1.000	-0.629
	(7.91)	(3.10)	(-4.92)					
Bi-logistic	11.17	8.118	-21.23	33.33	0.771	-5.45	0.995	-1.236
	(20.08)	(8.86)	(-9.08)	(3.96)	(9.81)	(-17.76)		

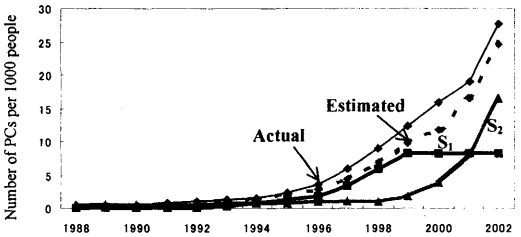


Fig. 11. Trends in China's Number of PCs per 1000 People with Bi-logistic Growth Model by Education Level *(1988-2002)*.

Fig. 11 shows strong relationship between PCs diffusion and education level in China, patterns of PCs grow in two trajectories, which are very similar to education level, which suggests education level strongly influenced PCs diffusion.

From an industrial society to an information society, IT plays very important role in accelerating nation's development. PCs are key tools of IT, therefore the relationship between GDP per capita and PCs diffusion is analyzed by the same method, and the estimation results are summarized in **Table 7** and **Fig. 12**.

Table 7 Estimation Results of the Development Trajectories of China's GDP per Capita by Number of PCs per 1000 People *(1988-2002)*

$$GDP = \frac{K_1}{1+e^{-a_1 PC+b_1}} \qquad GDP = \frac{K_1}{1+e^{-a_1 PC+b_1}} + \frac{K_2}{1+e^{-a_2 PC+b_2}}$$

	K_1	a_1	b_1	K_2	a_2	b_2	adj. R^2	AIC
PCs								
Simple	7127.5	0.336	-0.101				1.000	12.222
	(18.74)	(1.95)	(-0.72)					
Bi-logistic	1983.9	4.042	-3.72	6862.4	0.080	-0.282	1.000	8.807
	(11.52)	(4.81)	(-4.27)	(25.97)	(11.10)	(-3.71)		

Based on Table 7 and Fig. 12, we note that with great influence of PCs diffusion, GDP per capita grows in double trajectories, which are similar to PCs diffusion in China. Therefore, shifting from an industrial society to an information society, PCs diffusion influences nation's IT level, which chiefly influences nation's growth. Therefore, China's GDP grows significantly with rapid PCs diffusion.

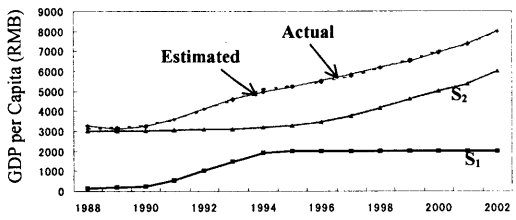


Fig. 12. Trends in GDP per Capita Process with Bi-logistic Growth Model by Number of PCs per 1000 People in China *(1988-2002)*.

From analytical results of Steps 1-6, it is identified that GDP per capita, number of college students per 1000 people and number of PCs per 1000 people in China grow in double trajectories, furthermore, a virtuous cycle between them exist. Why such special development trajectories and virtuous cycle exist in China? Is it an occasional phenomenon or not? From the development history of China's social and economical system, it should be noted that since 1979, China began to change economic system from planning-oriented economy to market-oriented economy, after 1992, market economy are widely performed, since this economic reform, China has great change in every field. Therefore, from the view of institutional theory, relationship between institutional reform and nation's development could be summarized in **Fig. 13**.

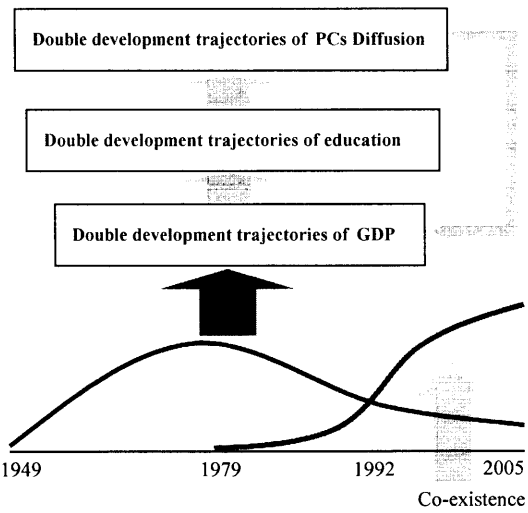


Fig. 13. Dynamism between Reform of Economy System, GDP, Education and PCs Development in China.

4. Conclusion

This research attempted to analyze the dynamism between GDP, education and PCs diffusion focusing on China's unique institutional structure. On the basis of an empirical analysis by simple and bi-logistic models, noteworthy finding obtained include:

(i) Co-evolutionary dynamism between GDP, education and PCs diffusion exists in China, that is, GDP effects education level, and education accelerated PCs diffusion, which induced GDP's increase. This virtuous cycle can be attributed to China's reform of economic system.

(ii) China's traditional economic system was itself a crystal of institutional innovation induced by the government. Self-propagating of institutional innovation accelerates remarkable nation's development including economy, educational level and PCs diffusion.

(iii) Simultaneously, China's unique institutional system decided development patterns of GDP, education and PCs diffusion in two double trajectories.

(iv) From China's case, it can be concluded that reform of socio-economic system is the nutrition of nation's institution, only when this reform is adaptable and match with nation's actual situation, nation's development in every field will grow dramatically, otherwise, the socio-economic reform will become the hell of the nation. China's economic reform matches the actual situation and changed step by step, which are different from Russia and other countries.

(v) Given the unique institutional systems driving China's successful development, elucidation of the role of institutional innovation in national, entrepreneurial and historical perspectives should be endeavored.

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