EST Innovation Model and Incentive System in China: Waste Water Reduction Technology as a Case Study

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INTRODUCTION

At present, the water pollution issue has been becoming more and more serious for China, the number of cities suffering from water laciness in China has increased form 154 in 1979 to 300 in 1995. And also according to statistics, the direct economic loss due to water pollution amounts to about 27,300 million RMB Yuan in China in 1993, which is nearly equal to 1.33 per cent of GNP in 1993. Some authorities also claim that the water resource will be the key bottleneck influencing the rapid economic growth for China in the next century.

As to China, although Government has adopted some measures for reduction and control of water pollution, there still exist some problems:(i)the main measure in existing incentive system for water pollution reduction is emission charge, this will result in the uncertainty in unit charge of waste water emission[1].(ii)The charge standard for water pollution emission is much lower than its treatment fee. As a whole, the ratio of total industrial waste water emission charge to GNP has showed a declining trend from 1986 to 1992 while the pollution situation has become more and more serious.(iii)The investment in waste water pollution treatment is far less than the urgent demand.(iv)For most of Chinese firms, they still adopt some simple methods for water pollution reduction and treatment, and lack some advanced environmentally sound technology.

DIMENSIONS OF EST INNOVATION

In fact, environmentally sound technology is a key factor to sustainable development for China. As a widely accepted concept, environmentally sound technology was first advanced by E. Brawn and D. Wield in 1994[2]. It almost includes all the technologies related to environmental protection. In our opinion, the EST innovation can be divided into three dimensions as end-of-tipe technology oriented dimension, ecological process oriented dimension, and ecological product oriented dimension[1].

MODEL STRUCTURE & CAUSE-EFFECT DIAGRAM

In this model. it will include six subsystem: water environment subsystem; science and technology subsystem; economy subsystem; population subsystem; education subsystem; and incentive subsystem (See Fig.1).

(1)**Water environment subsystem.** In this subsystem, natural desolution capacity (NDC) is considered. It should be pointed out that the NDC is a dynamic variable, and has a adverse relation with pollution situation[3].
(2)**Science & technology subsystem.** The adoption of EST will greatly reduce pollution emission and improve the treatment quality of water pollution[4].
(3)**Economy subsystem.** There exist mutual interaction between economy and environment protection. The pollution will induce resources scarcity, which will result in economic loss and efficiency decrease. On the other hand, the development of economy will often raise pollution treatment investment, which will result in the increase of NDC.
(4)**Population subsystem.** It includes two factors, population amount and population structure. Under a certain environmental capacity, the unrational population increasement will inevitably cause the resources scarcity more intensified[5].
(5)**Education subsystem.** Education can play important role in improving people's environmental consciousness, and enhancing the opportunity of EST development. Moreover, it can make desicion-makers take environmental issues into their policy making and enforcement process.
(6)**Incentive subsystem.** There is a close interaction between economy subsystem and incentive subsystem. It is a common problem in developing countries that no enough investment in environmental protection technology especially EST is available[6].

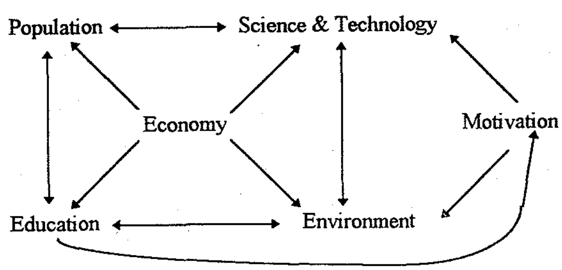


Fig.1 The EST Innovation Model
for Waste Water Reduction Technology

And also, by considering the interrelation between subsystems and the internal interaction in each subsystem, we form the cause-effect diagram (See Fig.2).

BASIC BEHAVIOR OF EST INNOVATION MODEL

According to the government's development planning of society and economy in China, we choose following basic parameters:(i)The GNP of year 2010 will be doubled on the basis of year 2000, then the average annual economy growth rate will be about 10%.(ii)The investment in EST developing remain the same level of 1995.

Then we get the model basic behavior as Fig.3. By year 2010, the environmental loss caused by water pollution will rush to 275.7 billion Yuan which is 9.1 times more than 1990, which will be a serious problem for the future economy growth of China.

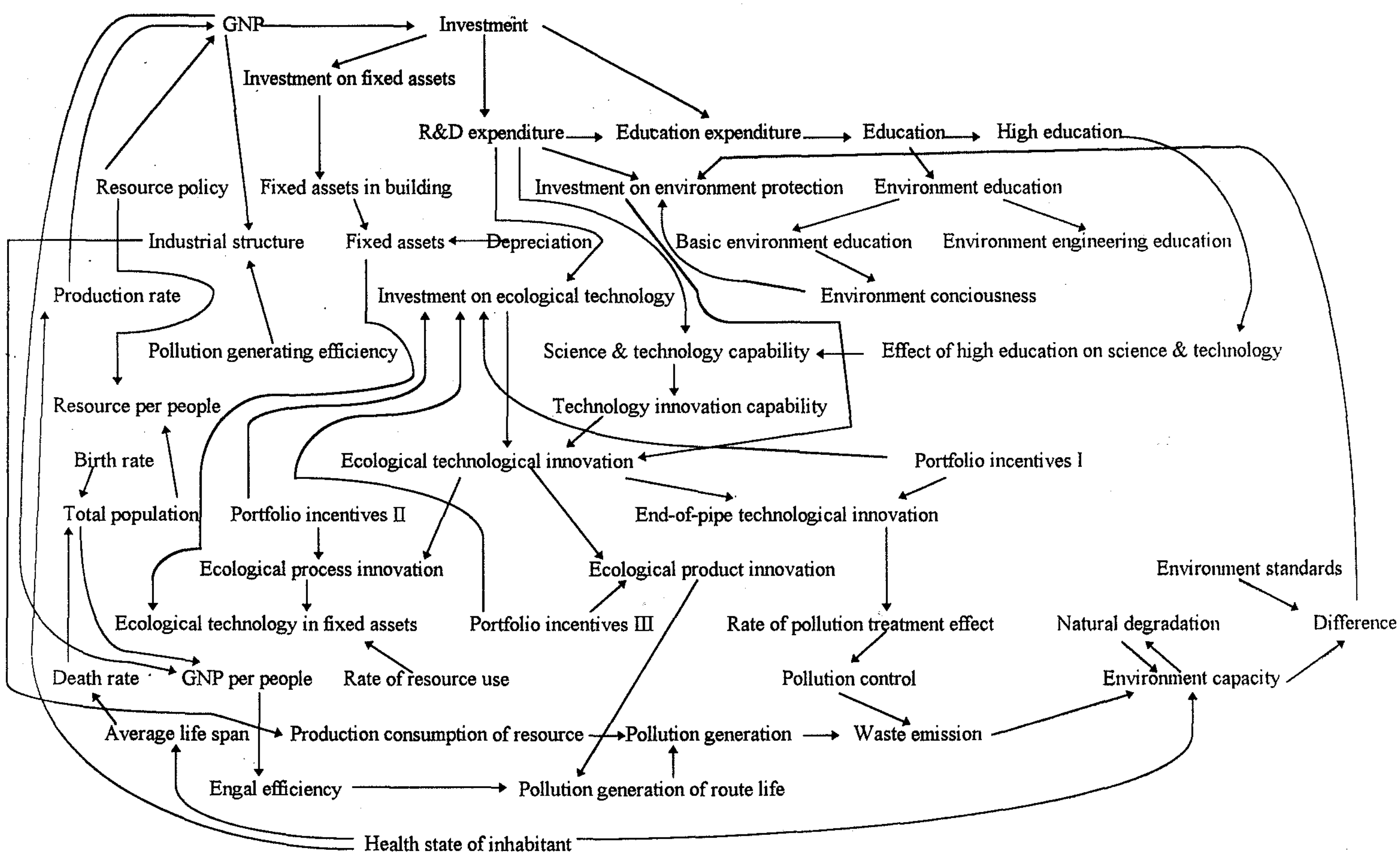
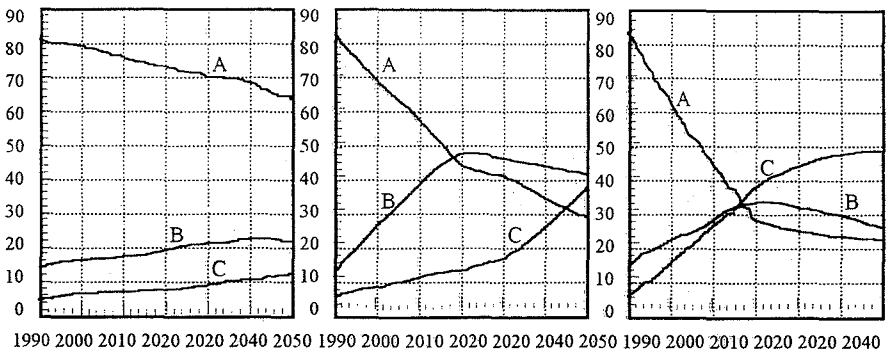


Fig.2 The Cause-Effect Diagram of EST Innovation Model



Note: A: End-of-pipe B: Process C: Product

Fig.3 The Basic Behavior of EST Innovation Model

POLICY SIMULATION & ANALYSIS OF WASTE WATER REDUCTION EST INNOVATION

(1)EST Innovation Mode Selection

Technological progress has a essential act on the improvement of environmental quality and development of economy[3]. In order to analyze the impact of different type of EST innovation on the coordinate development of economy and environment, we will use three different investment mode as end-of -tipe oriented, ecological process oriented and ecological product oriented mode. We get following results (See Tab.1). It shows that for China, it should be better to choose ecological process oriented innovation mode at present stage, then after 2030 transfer to ecological product oriented innovation mode.

Tab.1 Simulation Results of EST Innovation Modes

Parameters	End-of type Oriented Mode				Ecological Process Oriented Mode				Ecological Product Oriented Mode			
	2000	2010	2020	2050	2000	2010	2020	2050	2000	2010	2020	2050
GNP	5.04	10.1	16.5	25.1	6.50	13.5	21.5	36.9	5.10	9.08	19.7	28.5
Environmental Loss	3380	7250	9530	15100	3290	66700	9800	8280	3540	8530	9650	12900
Water Pollution Cost	920	2130	3250	5500	730	1670	2940	3360	1050	2380	3160	3950
Innovation Results	670	820	1920	2540	360	420	750	1210	240	370	560	940

(2)Policy Analysis of Waste Water Emission Charge

We Select three charge policy to simulate the results:(i)Mode I, first low speed then high speed S-type growth mode. In this mode, the ratio of waste water emission charge to GNP increases from 0.05% at a low speed to 0.07% in 2010, then a high speed to 0.12% in 2050. (ii)Mode II, first high speed then low speed S-type growth mode. In this mode, the ratio increases from 0.05% at a high speed to 0.09% in 2010, then a low speed to 0.12% in 2050. (iii)Mode III, the ratio of emission charge to GNP increase at a same annual rate from 0.05% in 2000 to 0.12% in 2050.We found that the mode I is more appropriate for China, because that for China, the enterprises' internal economic mechanism is still under establishment, so an appropriate high growth rate in emission charge will inevitably hamper the process of externality internalization process. This also will result in the low enthusiasm for enterprises to invest in EST innovation.

CONCLUSION

By using the waste water reduction technology as an case, this paper establishes a system dynamic model to stimulate the impact of EST innovation mode on economy growth, as well as the influence of incentive system on the EST innovation. We found following results.

● At present, China should choose the ecological process oriented innovation mode, then after 2030 transfer to ecological product oriented innovation mode.

● As to waste water emission charge policy, it is appropriate for China to take the "first low speed then high speed S-type growth mode". In this mode, the ratio of waste water emission charge to GNP increases from 0.05% at a low speed to 0.07% in 2010, then a high speed to 0.12% in 2050.

● When the ratio of investment in waste water treatment to the whole environmental protection investment increases from 35% to 45%, then the loss caused by water pollution and the whole environmental loss will both decrease. And when this ratio increase from 45% to 50%, the loss by water pollution will decrease while the whole environmental loss will increase.

MAIN REFERENCES

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