THE COORDINATIVE DEVELOPMENT BETWEEN R&D AND TECH-ACQUISITION IN CHINA

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Abstract

This paper studies the coordinative development of R&D and tech-acquisition in the industrialization process of China,dealing with the mechanism of interaction between R&D and tech-acquisition.It also deals the mechanism of limited resources allocation in capital investment to R&D and tech-acquisition areas.A system dynamics model about coordinative development of R&D and tech-acquisition is developed.

1. Basic Structure of the System

As the development of science and technolog, we have more and more clearly recognized the close relationship between S&T (science and technology) and the economy. On one hand, demands are required continually from the economy for S&T; In addition, financial support is given to S&T by the economy. On the other hand, enormous potential promotion is delivered to the growth of the economy from S&T. In short, they have mutual reliance and promotion. But as for S&T itself, there are unilateral recognitions in some people's minds; Furthermore, because of this kind of unilateral recognition, the promotion of S&T on the economy is limited, and the resources are being wasted at the same time. In fact, the development of S&T in any country, especially in developing countries, should be promoted through two ways--R&D and tech-acquisition. Both of them have significant effects on the development of S&T for the nation. But it should be emphasized that the effects are not unilateral. That is to say ,neither national R&D nor tech-acquisition can play the complete role of S&T in the promotion of economic growth. The level of S&T in the nation can be raised as quickly as possible only through the coordinative development of national R&D and tech-acquisition. Therefore,the basic structure of the system that this paper deals with is described in Fig 1.

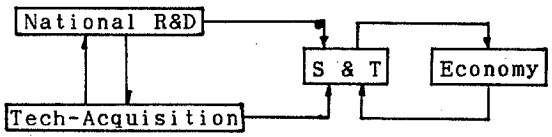

Fig 1 Basic Structure

There are a lot of factors which have, directly or indirectly ,notable impacts on the growth of the economy .But the impacts caused by different factors may differ .Furthermore, the relative power of the impacts caused by

different factors may change if the situations are considered from different points of view,so the interaction between education and economy, education and S&T are simplified in the system,and the boundary of the system is limited only to the areas of economy and S&T.It should be mentioned that the simplification doesn't mean that education is unimportant,but to concentrate on the foundamental points of the system.Similarly,although national R&D and tech-acquisition are related to many factors,it is impossible and unnecessory to discuss all the influencial factors due to the limitation of this model.

To be prudent,some hypotheses that run through the paper are related as follows: 1)There are two meanings bestowed on R&D in the paper.the first is the self-development of R&D.The second is the absorption and innovation of the acquired technology.Both are supposed to promote the development of S&T and the growth of the economy.2)It is well known that the output of scientific research not only depends on capital investment,but also depends on the match degree of the all imput factors.This paper probes into the coordinative development of national R&D and tech-acquisition relating to the whole process of economic growth.The effects of the labor force on the output of scientific research is simplified.

The definition and classification of R&D and tech-acquisition can be found in the reference.

2.The Subsystem of S&T

In accordance with the characteristics of research,national R&D can be classified into two groups.One is the self-development of R&D.Another is absorption and innovation of acquired technology. However,these two aspects are not separate.They are mutually promoted as the S&T level is improved.On one hand,output products of the investment of the self-development R&D signifies that the level of national scientific research has been increased.Meanwhile, the increasing level of scientific research improves the ability of absorption and innovation of acquired technology.As a result,the output of absorption and innovation of acquired technology is increased.On the other hand,the gained output products of absorption and innovation of acquired technology raises the S&T level.As a result,more self-development R&D output will be obtained at the same scale as the self-development R&D investment by shortening the research cycle and the improving research efficiency.

In accordance with the definition and the classification that we mentioned before.The structure of the S&T subsystem can be described as in Fig 2.

As to the self-development of R&D ,when investments in each kind of research are given, output quantity of the corresponding research is decided by the research cycle and research efficiency.Here,the research efficiency refers to the output quantity under a certain investment while other influencial factors are relatively fixed.In general,research efficiency depends on the following factors.The first is the prerequisite possession of relative imformation for the research.E.g.one of the main factors that affects the AR and ED efficiency is the sufficient degree of the preceeding research products .The second is abundant research experience.In general, the accumulation of the research experience varies directly with the advancing of the research work.The research cycle refers to average time within which a research project can be finished.Research cycles of the three kinds of research mentioned before vary with the

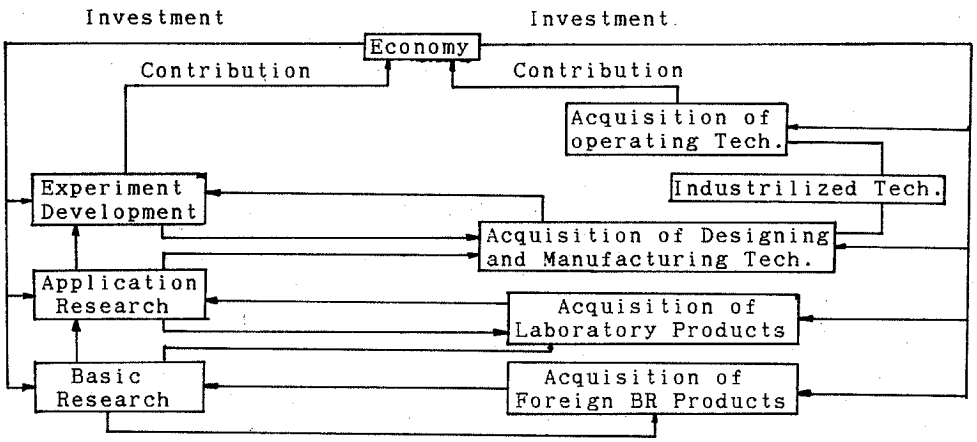

Fig 2 The Subsystem of S&T

characteristics of each kind of research.The length of the cycles still can be changed by other factors.E.g.as to AR and ED research cycle,they are related to the sufficient degree of the research resources.The more products accumulation of the preceeding research, the less roundabout courses,and the quicker the research output rate. Unlike AR and ED,the BR cycle is shortened with the increase of the BR level.The cause-effect relationship of AR input-output is described in Fig 3.

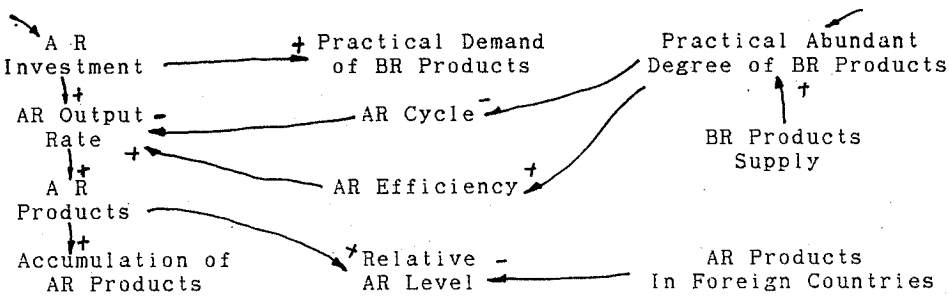

Fig 3 The Cause-Effect Relationship of AR Input-Output

In general,obtained research products can not be applied in the next link of the chain of self-development R&D immedialty.This is because scientific research activities,which are supposed to sovel the problems that are not solved or even touched previously, are exploratory. So to understand and apply the research products needs

some prerequisite knowledge and neccessary preparation.Therefore,it will last a period of time from output of products to application, i.e.the absorption delay of the products.Furthermore,the expansion of demand and the increase in the research level will be in favor of shortening the delay.

In terms of tech-acquisition, except the acquisition of operating tech.,designing and manufacturing tech.,and laboratory products,it will include the acquisition of foreign BR products.This enables us to study the problems objectively and all-sidedly.The acquisition of operating tech. mainly concentrates on expanding production.It affects the economic system directly.

Usually,the acquisition cost of foreign BR products is relatively low.So the provided foreign BR products which is suitable and helpful to the national scientific research will be acquired in most cases.In brife,the acquisition number of foreign BR products mainly depands on the amount of foreign BR products that can be acquired,and the absorption ability. The cause-effect relationship of foreign BR products acquisition and absorption is described in Fig 4.

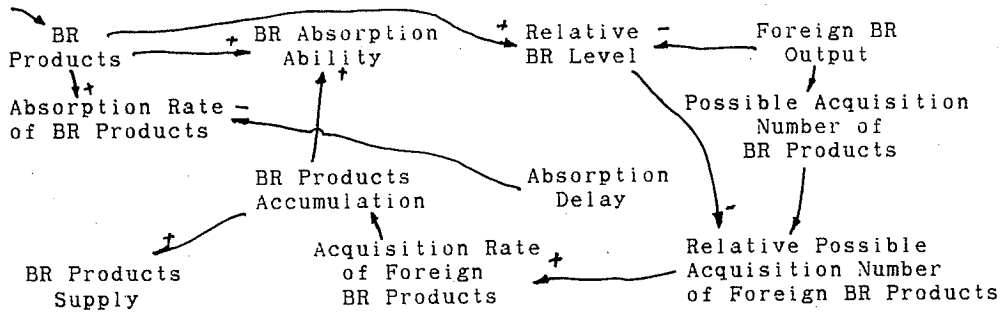

Fig 4 The Cause-Effect Relationship of Foreign BR Products Acquisition and Absorption

The acquisition cost of designing & manufacturing technology and loboratory products is relatively high.So the acquisition of designing & manufacturing technology and laboratory products is not only confined by the number that can be acquired, but also decided,to a marked degree,by the defrayable foreign exchange.Especially in China,the desirable investment of tech-acquisition are always far more than the defrayable foreign exchange supply.So in theory the acquisition of designing & manufacturing technology and laboratory products is not decided by demand,but by supply.

In terms of the acquired technology ,to be used effectively,it needs a process called the absorption cycle of the acquired technology .The absorption cycle depands on the research cycle of the relative kinds of self-development research .In addition,it is closely related to the absorption ability and absorption investment.The cause-effect relationship of designing & manufacturing technology acquisition and absorption is described in Fig 5.

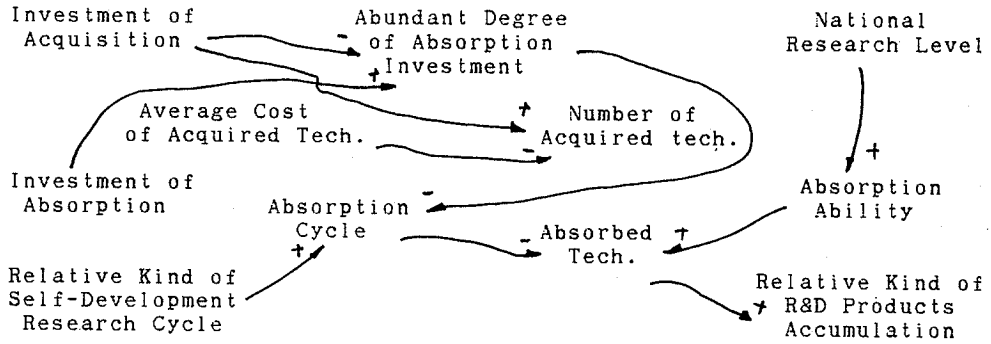

Fig 5 The Cause-Effect Relationship of Designing & Manufacturing Tech. Acquisition and Absorption

3.The subsystem of the economy

The key point of this paper is the coordinative development between R&D and tech-acquisition,which focuses on promoting economic growth and the development of science and technology.So some internal structure of economic subsystem is simplified. The macroeconomic level of the country is reflected mainly by the GNP and the import & export trade value.The cause-effect relactionship of the economic subsystym is described in Fig 6.

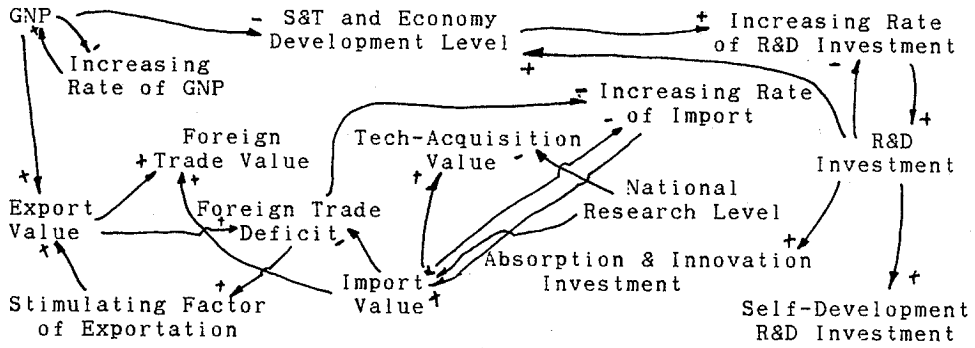

Fig 6 The Cause-Effect Relationship of the Economy Subsystem

According to international business theory,both import and export value have some relationship with the nation's GNP.For a particular country ,the proportion of export value comprising the GNP is relatively steady over a certain period of time.Of course,in the long-run,the proportion will be changed by some other factors such as the development of S&T etc.Similarly,there is also a relationship between

import value and tech-acquisition value .As the nation'research level improves and the difference between China and the developed countries lessens,the proportion of tech-acquisition value comprimising total import value increases and then declines. According to international convention,the limitation of a nation's foreign exchange accumulation is 3 month's import value.So in the model, the sum of foreign exchange deficit adding 3 month's import value is used as a feedback control variable.If the result is below zero,some special policies will be adopted to limit import and to stimulate export.This feedback control in the model is realized by means of a SWITCH function.

4.Some Results and Conclusions

In order to study the coordinative development between R&D and tech-acquisition,three kinds of investment policy variables have been set in the model.The first is the investment structure variable of tech-acquisition.The second is the investment structure variable of self-development R&D.The third is the allocation variable between absorption & innovation of acquired technoiogy and self-development R&D.The policies are given according to the theoretical reliability and practical possibility.

After the DYNAMO program has been adjusted repeatedly,the policy variable are fixed at a certain level,Then we obtain basic simulation results.

* GNP tends towards an exponential changing pattern. Its increasing rate follows a high-rate development period,a non-steady development period,and then tends towards a low-rate steady period.The steady increasing rate is about 3.2 percent.By the year 2000,the GNP in China will reach the level of $919 billion, i.e.¥3427.8 billion (converted according to the 1987 exchange rate)

* Import and export values tend towards an exponential changing pattern.Similar to the increasing rate of the GNP,the increasing rate of import value takes the three steps,and tends to be steady at last.The increasing rate of the export value is relatively steady.Meanwhile,the proportion of the total value of import and export trade comprising the GNP in 1987 was 17 percent.From now on,through 30 years of continual increase,the proportion will stabalize at 26 percent.

* Total R&D investment tends towards an exponential pattern.Its increasing rate will remain high in 20-30 years,and then will stabalize at 5 percent.In 1984,the proportion of the total R&D investment comprising the GNP was less than 1 percent.In 45 years, the proportion will reach the level of 3.3 percent.The increasing rate of tech-acquisition value will remain high in 15-25 years.Its average is about 8.7 percent.Correspondently,the average proportion of investment used for absorption and innovation of acquired technology comprising the total R&D investment is 12 percent.

Three kinds of policy variable consist of a number of investment policies.By means of analysig the effects of these policies on several major economic and scientific indeces,some conclusions can be drawn as follows:

1) Tech-acquisition will play an important role in the growth of the economy and the development of S&T in China,especially from now to the year 2010.At present,the proportiom of different kinds of tech-acquisition is described as follows: Operating Tech.:Designing & Manufacturing Tech.:Laboratory Products=0.7:0.28:0.02.By the year of 1995,the proportion will be 0.2:0.75:0.05.By the year of 2005 ,the

proportion will be 0.03:0.57:0.4.As the nation's research level improves,the direct effects of tech-acquisition on the economy will be weakened

2) National R&D will play a decisive role in increasing the nation's research level.The distribution of self-development research investment should take the policy that if resources(funds) are abundant then BR will be a priority,otherwise DR will be a priority.From now to the year 2000,national R&D should pay great attention to the absorption and innovation of acquired technology.In particular,investment in this domain should be raised greatly.From the results of the 1985 Chinese national scientific survey, the investment of absorption and innovation of acquired technology only comprised less than 3 percent of the total tech-acquisition value--$4.25 billion.This situation has become the second unfavourable factors follows the factor of technical suitability to the absorption and innovation of acquired technology.

3) In short,the successful way of improving the growth of the economy and the development of S&T in China must be as follows: From now to the year of 2000,on the basis of ensuring the R&D investment, tech-acquisition must be emphasized.This is a shortcut to catch up with the developed contries in a relative short period of time.But it doesn't mean that China needn't develop its own research system.Quite the opposite, from now on, China must pay great attention to basic research(BR) in order to lay a good foundation for the continuous development of S&T and the growth of the economy.

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