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CHINESE TECHNOLOGY POLICY IN THE 1980s

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1. Introduction

This paper analyses some elements in science and technology policy which influence the environment for technological innovation as distinct from scientific advance in China. In a socialist economy the innovation process is mainly set in motion by agencies generating and utilising technological knowledge in terms of planned allocation and coordination of research and development (R&D) and industrial resources by the State. Analytical issues concerning Chinese technology policy may, therefore, have to be tackled at the levels of planning, organisation and management of R&D institutions. However, China today is in the tempo of restructuring the national economy so as to develop the forces of production including technology for socialist modernisation by establishing "correct" relations of production. The reform of the economic structure is aimed at correcting some imbalances created by the "left errors" of the earlier periods and at developing commodity productions and exchange, and opening to the outside world. The approach is to integrate the law of value, regulatory role of market, and promotion of individual economy with socialist planning. In view of these changes technological innovation will be increasingly influenced by market forces such as competition, private (institutional) ownership of knowledge, and profits. The central policy issue for analysis will accordingly be the State's technology strategy for influencing the environment for innovations.

The significance of a strategy for technological transformation and its close correspondence with the more general development strategy is too obvious to be underlined here. The historiograph of economic development in China can be read in terms of a "policy cycle" swinging with shifts in development strategy. In the literature[1] four distinct phases in economic development in New China have been identified, viz. (a) socialist transformation until 1956, (b) socialist construction between 1956 and 1966, (c) the cultural revolution between 1966 and 1967, and (d) socialist modernisation thereafter. To the extent that there is an intimate inter-relationship between economic institutions and technological development,[2] the above period can also said to have seen corresponding changes in technology policy marked by

(a) technological progress based on large-scale capital construction with technical assistance from the Soviet Union, (b) multi-layer development of technological structure based on "walking on two legs" strategy, (c) radicalisation of science and technology (S&T) management with an emphasis on mass participation aimed at an autonomous and self-reliant development of technology, and (d) modernisation of technology within a multi-layer structure but with reemphasis on professionalism and sophistication through opening the door to the outside world for technology import.

Thus, there has been a shift in the general development strategy in China in the 1980s. Correspondingly, there has been a shift in the technology strategy as well. The shift may have, *inter alia*, changed characteristics

[1] Seema Hong, New Strategy for Chinese Economy, New World Press, Beijing, 1983, pp.12-19.

[2] The casual relationship between economic growth and technological development is not yet clearly brought out in the literature. There is a view that "S & T are not independent variables in the development process; they are pathetically dependent on the nature of political and economic institutions and on the appreciation of the top political leadership which in practice means the appreciation of one, two or three men or women" (See Ashok Parthasarathy, "Technological Bridgeheads for Self-reliant Development" in Michale Gibbon, et al. (eds), Science Technology Policy in the 1980s and Beyond, Longman, London, 1984, p.226.

of two basic components of the strategy viz., (i) optimum combination among alternative technologies, and (ii) the choice between technology import and indigenous technology development. The focus of this paper is on outlining some features of these two strategy-aspects of Chinese technology policy in the 1980s by drawing a comparative picture relative to the Indian situation.

2. Multi-layer technological structure

Both China and India are characterised by relative scarcity of capital and abundance of labour and hence have been concerned with the questions of choice of technique and output-mix in industrial investment in order to match the growth of income and employment. Attempts have been made in both countries to evolve rational technological structure for this purpose. There is co-existence of capital-intensive large scale along with labour-intensive small scale production and advanced automative techniques with semi-automated and traditional handicraft operation.[1/] This has resulted in a multi-layer technological structure.

Despite the existance of technological-dualism, China has been relatively more successful than India in establishing interdependence between different scales of production. China's strategy of "walking on two legs" has no close parallel in any other developing country. The co-ordinate relationship between the two, in terms of what Ishikawa called "investment

1/ In terms of capital-labour ratios Chinese heavy industrial enterprise today on an average would need a fixed asset of 11,000 yuan per worker whereas the corresponding ratio is 4500 yuan in light industrial enterprise, 1250 yuan in handicrafts, and 1000 yuan in commune and brigade run enterprises. In India, too, there are variations in capital-labour ratios as between enterprises in organised and unorganised and large scale and small scale sectors. The similarity between the two countries, however, ends here.

inducement mechanism[1] has ensured that technological innovations in the capital-intensive large-scale sector lead to productivity increase of the labour-intensive small scale sector. The rationalised implementation of the "walking on two legs" strategy has meant that the rise in the overall capital intensity in China has been moderate despite a capital deepening process in the large scale sector.[2] However, level of the capital-labour ratio was high during initial years of the current phase when the country resorted to indiscriminate import of technology (in terms of large scale complete plants on turn-key contract basis).

The recent reform for restructuring the economy can be expected to lead to a readjustment in the choice of techniques. In this context it may be noted that the proportion of capital construction in total fixed investment by state enterprises has been on the decline, whereas the investment in technical innovation and transformation is on the increase.[3] The stress now is on renovation and upgradation of key technologies in existing plants rather than setting up new plants. Further, investment allocation today is not based essentially on the consideration of raising the rate of saving and growth by applying the criterion of "coefficient of investment effectiveness" (or its inverse "the period of recoupment") a la Soviet style; it is in accordance with the need of raising living standards. The pattern of investment under the recent reform has tilted emphasis from heavy industry and capital accumulation in favour of light industry and consumption goods.

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[1] S. Ishikawa, "A Note on the Choice of Technology in China," Journal of Development Studies, Vol.9, No.1, October 1972.

[2] Value (original purchase value) of fixed capital per worker is estimated at 3157 yuan in 1952, 4502 yuan in 1957, 9090 yuan in 1965, 9512 yuan in 1975 and 11485 yuan in 1979. (See S. Ishikawa, "China's Economic Growth in PRC period - An Assessment," China Quarterly, No.94, June 1983. On the basis of data made available in the statistical year book, the ratio of fixed investment per worker in State enterprises in 1983 works out to 8267 yuan.

[3] The proportion of investment on technology innovation in the total investment increased from 17 per cent in 1965 to 25 per cent in 1978 and to 37 per cent in 1983.

All these would have a favourable impact on raising employment and consumption though it cannot be said that choice of technology in China is now used as an explicit instrument of meeting the objective of employment generation. Overall, the multi-layer technology structure strategy in China has been able to match the twin objectives of industrial growth and employment generation in a better way than India's.

3. Technology-import

The second aspect of technology strategy under consideration is the choice between technology import and indigenous alternatives. This issue may be examined in the context of "self-reliance" as it has consistently been the formal strategy for technological development in China.

The Chinese word for self-reliance is zili gengshen, which literally means "standing on one's own to change a new life". The concept originated within a revolutionary matrix of thought, which integrated Mao's nationalism with Lenin's theory of imperialism, was set in as a development policy in the 1950s. In policy terms, however, self-reliance has never meant self-imposed autarky. At the same time as an integral part of a multi-layer structure strategy, which gives priority to the use of domestic resources, the technological self-reliance precludes massive foreign investment and unqualified import and assimilation of foreign technological inputs in the socialist modernisation of the national economy. A relevant question arises: Has there been a shift in the meaning and practical implications of the "self-reliance" policy with the reforms for economic restructuring in the 1980s[1/]

[1/] For a detailed discussion of this question, see Ronald C. Keith, "China's Modernisation and the Policy of Self-reliance", China Report, March-April 1983.

Taking a leaf out of the "three foundations" of Mao's thoughts and his oft-stated argument that China's modernisation cannot take place in isolation from external technological development,[1] the present leadership has repudiated the closed door policy followed during the earlier periods (viz., the Great Leap Forward and the Cultural Revolution). It has now established an open door policy for importing advanced technology and expanding economic and technological exchanges with capitalist countries. The modernization of China's industry, agriculture, national defence and science & technology requires the utilization of latest scientific and technological achievements emerging on a global scale. The present policy is to draw the world's advanced technology and methods of management including those of capitalist countries. A strategic measure for accelerating modernization is seen in opening the economy to the outside world. In terms of "Four Modernisations" foreign capital and foreign technology are today given a greater role than in the past within the old multilayer-structure technology strategy. This has led to contradiction between the need to create an attractive environment for external economic relations and the need to maintain the continuity of self-reliance.

The point may be illustrated. In the rhetoric of modernisation and open door policy a trend was set for indiscriminate import of technology in the late 1970's.[2] That in turn began to tell upon the budgetary and

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[1] It may be mentioned here that Mao had also qualified his support to the idea of learning the strong points of all nations by saying that "we must firmly reject and criticise all the decadent bourgeois system, ideological and ways of life of foreign countries" (See "On the Ten Major Relations" in Selected Works, Vol. V, Foreign Language Press, Beijing, 1977.

[2] This is reflected in the trend of machinery import which as a proportion in the total import rose from 15.2 per cent in 1977 to 17 percent in 1978 and further to 26 percent in 1979. During the period large scale turn-key contracts (e.g. Baoshan steel and Najing petrochemicals) were signed. In 1978 alone contracts worth U.S. $6400 million were signed with foreign enterprises.

trade deficits and the limit of indigenous technology for assimilation. A readjustment policy was soon introduced to correct the imbalance by emphasising the expansion and renovation of existing plants in preference to setting up new modern plants, import of key technology instead of turn-key contracts for complete plants, and integration of imports with exports. Foreign business however misread the readjustment as a negative retreat of the open door policy. To dispel the doubt and attract foreign business, the government initiated a number of legislative measures, strengthened the organisational set-up, and extended tax concessions and other incentives. Today, China is in a wave of perfecting economic legislation and providing liberal and preferential treatment (with regard to taxes, prices, domestic sales, wages, credit, etc.) to improve upon the climate for attracting foreign investments and technology import.

The legislative measures introduced so far present a long list of more than 40 laws and decrees[1/] such as Law on Chinese-Foreign Joint-ventures, Income Tax Law concerning Joint-ventures, and Foreign Enterprise Tax Law. In more recent days, China has introduced the Patent and Trade Mark Law; and has taken the decision to join the Paris Convention of Industrial Property and the Madrid Agreement on International Registration of Trade Marks. Attempts are on the anvil towards codification and publication of commercial laws and practices concerning foreign investment, technology import and trade. Along with the legislative measures, efforts have also been made to simplify administrative procedures, to decentralise administrative power by granting autonomy to the Governments of Provinces and City Municipalities, and to establish institutional structure to deal with

[1/] For a detailed listing see, "China's Foreign Economic Legislation", Foreign Language Press, Beijing, 1984.

external economic relations.[1] All these are intended to foster China's policy of opening to the outside world, to expand external economic and technological exchanges, and to speed up import of advanced technology from the developed market economy countries.

A comparative listing of incentives in China and India (Table 1) underlines the relatively flexible policy framework and liberal incentives in China to attract foreign investment and technology import. In China foreign firms can operate through diverse modalities such as, (1) technology contract, (2) processing/assembling of imported materials and compensation trade, (3) cooperative production, (4) equity joint-ventures, and (5) wholly owned independent foreign enterprises. Amongst these, the most preferred modality has been the compensation trade/cooperative production. (See Table 2). Under this form Chinese partner provides land, buildings, materials (in the case of compensation trade) and labour, and foreign collaborator provides machinery and technology (which becomes Chinese property). The end-product is bought back by the foreign side until the original outlay is amortized. In these forms of foreign operation the major gain for China is the access to simple assembly/processing technology, though the arrangement ensures foreign exchange for buying the machinery analogous to a defferred-payment sale. However there is a large scope for technology supplying firms to follow transfer pricing and other restrictive practices.

As for fields of operation, Chinese policy in principle limits foreign investment and technology import to preferred areas and where national efforts are inadequately developed. In practice, however, a

1/ To illustrate, organisational back-up such as Foreign Investment Control Commission, China International Trust and Investment Corporation, Industrial Product Corporation of Ministries etc. have been added. The Provincial governments have been delegated powers to directly negotiate with foreign firms and approve case up to a value of 30 million yuan.

significant proportion of joint ventures is approved (or is being contemplated) in light industries and consumer goods (Table 3). This may be in conformity with the macro economic reform like the shift from capital accumulation to consumption. A policy with self-reliance as the cardinal point, however, would have regulated the inflow of foreign capital and technology import in accordance with the need of strengthening the domestic technological base. In contrast, a more inward-looking technology policy of protecting domestic technology development by a "selective" import of technology has been followed in India.

It is also significant to note that a large proportion of foreign investment in China has been in the Special Economic Zones (Table 4) which provide more attractive terms and more comprehensive scopes for operation as compared to the Export Processing Zones (EPZ) in India. To illustrate, foreign investment is not only approved but also encouraged in agriculture and allied activities in the Zomes and a part of the production is allowed (in individual cases) to be sold in the domestic market. It is obvious that foreign investors would take advantage of the cheap labour, rich material base, and growing domestic market r consumer goods in China in return for transfer of assembly/processing technology embodied in machinery and equipment. Yet, the Special Economic Zones in China are more in number as compared to EPZs in India. Very recently, the Government of the Peoples Republic in China has opened 14 coastal cities and the Hainan island for foreign investment offering similar concessions as in the SEZs.

Sourcewise (Table 5), much of foreign investment flow into China seemingly originates from Hong Kong (mainly overseas Chinese). The origin of technology import is more evenly spread. In the case of India the pattern is slightly different with a much larger participation by the

United States, West Germany and U.K. The collaboration of the Soviet Union and East European countries in China is at a low-key, whereas their collaboration with India is noteworthy. Also, it seems, a relatively cautious 'step-up' approach is adopted by the Western business in making long-term commitment in a socialist system. The cultural differences compounded by the long time taken in reaching negotiated settlement of contracts with Chinese partners are also plausible explanations.[1/] In general, the response of MNCs of the West to liberal policies is relatively "slow" in China as compared to India. A comparative listing (Table 6) of the number of joint-ventures approved in China and India in the recent past (except in 1983) lends support to this inference.

A striking feature emerging from the comparison is the Indian rigidity as compared to the Chinese flexibility in policy approaches towards foreign ownership/technical control. India is cautious and guarded in its approach to foreign-majority participation. Indian policy generally limits the size of foreign investment to the approved value of imported equipment and machinery in individual cases. China, on the other hand, is not only charitable but even insists on a foreign share of not less than 25 percent of the registered capital in a joint-venture. Investment can be made in cash, kind or industrial property rights. Even when the majority ownership is with Chinese, there is the practice of making foreign partner's representative as the Managing Director/Chairman or the posts alternatively manned by foreign and Chinese nationals. On the whole, there is an apparent preference in Chinese policy and practice for foreign investment (joint-venture) as a

[1/] For a discussion on the negotiation bottlenecks in China, see A.E.I.Rao, "Talking Business in China", China Quarterly, No.90, June 1982.

modality of acquiring advanced technology. This is difficult to comprehend since China has now a fairly comfortable position as regards foreign exchange reserves.[1/]

It appears that China is increasingly looking to developed market economy countries for acquiring advanced technology, modern management practices and investment funds for carrying out the modernization programme and its drive for export promotion. The number of technology contracts, joint ventures and other modalities of external economic relations is on the increase.[2/] Does this implies a shift in the meaning of self-reliance as a cardinal point in technology-strategy?

It can well be argued that foreign aid and investment constitute a very small proportion of the total investment in China. Foreign trade also accounts for a small proportion of its national income. With socialist (public) ownership of the means of production Chinese have faith in their ability to avoid the dangers of technological dependence. At the formal policy level, economic and technological exchanges with foreign countries are to be carried out on the principle of equality and mutual benefit. In relation to technology, Zhou Enlai's four points ("First use, second criticize, third improve and fourth make it our own") would imply a process of selective importation, local adaptation, and improvement of technology whereby it becomes Chinese technology and strengthens the domestic

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[1/] China's foreign exchange reserve reached the figure of U.S. $ 11.3 billion by 1983 and the gold reserves are worth U.S. $ 3.4 billion.

[2/] By the end of 1983, as many as 190 equity joint-ventures were established as well as more than 1,000 contractual projects under co-operative production, assimilating over U.S. $ 3 billion of foreign capital. Between 1979 and 1983 more than 350 contracts for technology-import with an investment of U.S. $ 1.8 billion are reported to have been approved. Chinese foreign trade has grown from U.S. $ 35.5 billion in 1978 to $ 86 billion in 1983. Its share in the world export increased from 0.75 per cent in 1978 to 1.25 per cent in 1983.

technology-base. It is difficult to say (without a detailed analysis of the micro behaviour of enterprises and R & D institutions) how far these principles in fact, are being practised in an environment of rushing with foreign investment and technology-import.

There are very few studies (available in English) which have examined in detail the working of joint-ventures in China. A recent study[1] prepared by a Chinese scholar on technological issues in the Chinese capital goods sector, *inter alia*, underline certain undesirable features of technology import in general and joint-ventures in particular. The survey revealed the following: (1) technology import through contractual arrangement has been on the increase, (2) the secrecy clause in the contract meant multiplicity of contract for the same technology leading to "excess" import of technology, (3) technology contracts encompassed mainly detailed designs and assistance in manufacturing and training but very few cases included basic design transfer, and (4) technology transferred in most cases is more than six years old. The survey further revealed that there was no significant difference between wholly domestic enterprises and those with foreign collaboration in regard to the type of technology used (as reflected in the age of machinery and equipment) and in relation to productivity. However, foreign-collaborated enterprises' contribution to exports and addition of new products was found relatively low as compared to wholly domestic enterprises. A summary view of these characteristics (reproduced in Table 7) thus raises doubts on the effectiveness of Chinese policy in making best use of imported technology and in warding off the consequences of technological dependence.

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[1] UNCTAD, *Technology Issues in the Capital Goods Sector, the experience of the Peoples Republic of China*, United Nations, 1984 (UNCTAD TT/57).

The impression the author could form from a recent visit to a few joint-ventures in China also did not suggest that serious attempts were now being made towards unpackaging, local adaptation, assimilation and upgradation of imported technology. On the other hand, some wholly domestic firms which have modernised their production by simple purchase of key technology-embodying machinery and equipment were successful in duplicating imported equipment through local R&D efforts. The point for emphasis is the capability demonstrated by wholly-owned Chinese enterprises in modernisation without establishing a "dependence" relationship in some cases. The indifference towards foreign ownership/technical control, which could dampen domestic initiatives for building up indigenous technological capacity, is a perplexing aspect of the Chinese technology policy in the 1980s.

4. Innovation Process

It is obvious that there is a contradiction between technological self-reliance and technology-import. To what extent unity among these opposites can be brought about? This will depend upon the strength of national scientific and technological (S&T) infrastructure in carrying out autonomous innovation process.

China has, over time, built up a fairly well-coordinated S & T infrastructure by strengthening scientific and technical personnel, R&D institutions, and S&T policy planning and implementing structures at various levels, though the progress in this area did fluctuate with the "swings" in the technology policy in different time periods. Today, China has over 6 million S&T personnel, more than 110 research institutions under the Chinese Academy of Science, more than 4300 research institutions under the Ministries of Central and Provincial governments and a number of independent

R&D institutions of key production-enterprises. In the countryside, country-level research organisations have established several combinations of S&T stations/groups in communes and townships. There is also the State Science and Technology Commission for overall planning, coordination, organisation and administration of the country's scientific and technological research work.

India also has made similar efforts towards institution-building under the auspices of the State in order to strengthen autonomous capacity in science and technology development.[1/] As a result of the emphasis given and investment made in it, a fairly large infrastructure has developed in India. In terms of R&D expenditure, however, data available from scattered sources suggest that China is increasingly spending a high proportion of its social product (GDP) on R&D as compared to India, though Chinese R&D expenditure is still low relative to industrially advanced countries.[2/] Overall, China has developed, as in India, a fairly large research system, which has the potential capacity to carry out technological innovation and modernisation with self-reliance.

[1/] For an interesting account of India's efforts in institution-building, see Ashok Parthasarathy, "India's Efforts to Build an Autonomous Capacity in Science and Technology for Development, "Development Dialogue, 1979, p.46.

[2/] Consistent set of data on R&D expenditure for China are not available. According to Chinese Government sources, national R&D expenditure for 1979 was around 5.6 billion Yuan which works out to about 1 per cent of GDP. An estimate for 1973 puts the national R&D expenditure at 4.5 billion yuan. (See Sigurdson and Billgren, An Estimate of Research and Development Expenditure in PRC in 1973. Occasional paper No.16, OECD Development Centre (Industrial Technology), Paris.

However, some differences in Chinese S&T infrastructure relative to India are noteworthy. Statistics on the stock of S&T personnel in the State-owned units in China (see Table 8) underscore certain disturbing features: The rate of growth of the stock is not very high. The proportion of S&T personnel engaged in research is also low with the figure not exceeding 5 per cent of the total in 1983. Significantly, the share of the research sector in the total S&T personnel is on the decline. The educational profile of S&T personnel in China is also low with more than 57 percent of them not having attended college or university. In contrast, postgraduates represent the greatest increase in S&T personnel in India and an important component of S&T personnel is engaged in research.

There is a shortage in both quality and quantity of S&T personnel in China. The shortage gets compounded due to rigidity in labour mobility and low level of enrolment in institutions of higher learning. The recent reform has recognised the serious import of these constraints as reflected in the relaxation in migration policies of scientific and technical personnel and in sending scholars abroad for advanced education and training. A policy change is on the anvil now to induce mobility of scientific manpower by providing autonomy to enterprises in recruitment and introducing "floating wages". Various measures have also been introduced in recent years to upgrade educational level of cadres and workers in production enterprises as well as research institutions.

The shortage of S&T personnel and their low educational profile would indeed have adverse effect on the types of indigenous innovations and the very innovation process itself. The legacy of the open-door research approach pursued during the Cultural Revolution which placed greater emphasis on mass participation instead of professional orientation.

in research adds to the complexity. Shop-floor innovations and mass participation lack scientific temper and technological sophistication. The strategy of self-reliance carried out in an ideological orthodoxy may have stimulated innovation process, but at the same time it has limited scientific level of technological innovations and their economic efficiency.

However, the open-door research approach contributed to establishing links between R&D institutions and the production sector. The practice of "sending out" researchers to production settings, and "inviting-in" workers to research institutions linked experiments in R&D institutions and activities of the workers and peasants. Over time, new methods and systems for technology transfer between R&D institutions at various levels and with production units have been worked out. These include technology-contract system, compensated technology transfer, technical services and advisory contracts. Besides, the vertically organised hierarchical structure ensured coordination of institutions at various levels. This integration ensured that scientists chose their research topics according to productive needs and worked on problems to which society needed solutions. Innovations thus became more relevant to the needs of society.

Another noteworthy feature of Chinese policy has been its attention on technology-diffusion. China has a well-established institutional structure for technology diffusion. A number of central, provincial, county and commune level institutions are engaged in disseminating technical information to end-users. There are, for instance, more than 70 scientific and technological information research institutes, more than 3000 national and regional specialised S&T information centres or stations, and more than 370 scientific and technical journals. There is a conscious policy of encouraging technology transfer functionally between large and small enterprises and geographically between rural and urban areas and between coastal and inland regions. The diffusion takes place more by vertical integration rather than horizontal exchange of knowhow and information. R&D institutions sign agreements for transferring their accomplishments to enterprises and depute their staff members to work in production enterprises. There is an emphasis on transferring technology from laboratories to enterprises, from advanced to backward regions and from military to civilian use.

India's technology policy in relation to innovation and diffusion stands in contrast with China. Technology diffusion in India is a slow process. The links between R&D organisations so also between R&D organisations and production sector are very weak. Much of R&D results originating in R&D laboratories remain unutilised whereas the production sector looks to the international market for technological innovations. The national S&T infrastructure is said to have had a marginal effect in bringing about a coordinated development of science, technology and economic growth. Research activities carried out in the R&D sector are said to be irrelevant to the needs of the production sector. Overall, India's technology policy is often criticised on account of its failure to integrate R&D activities with the needs of the production sector whereas China is often cited in the international literature as an example of successful linking of indigenous innovation process with the production sector.

However, recent Chinese literature holds the view that the objective of the integration of research with production has not been fully achieved. The data now released by Chinese sources show that while a large number of major achievements have been made in scientific and technical research, the number of inventions approved by the State and popularised has been small (see Table 9). The inadequate linking of science and technology with economic development is attributed to the legacy of centralisation in planning, organisation and management of S & T practiced during the Cultural Revolution.

5. Planning, organisation and management of R&D

New principles and policy directions have, therefore, been initiated during the 1980s for developing science and technology in China. These principles recognise scientists and technologists as indispensible forces in modernisation and rehabilitate the dominant role of expertise, elitism, professionalism and foreign influence, rather than the 'wisdom of masses', in the development of science and technology. A new interpretation is given to the Marxist "practice-theory-practice" principle of epistemology. A series of institutional reforms affecting the planning, organisation and management of R&D activities and interaction with world science and technology in conformity with the changes introduced since 1979 in the economic development strategy have been, therefore, introduced.

The National Plan for Science and Technology Development (1978-79) formulated in 1978 has been modified. The emphasis in research priorities in the Plan has been shifted from basic research and advanced technology towards applied techniques and development studies, and the popularisation of productive innovation, Agriculture, light industry and consumer products are now the priority sectors for R&D with emphasis on energy-saving technology material science and electronics and computer technology. The modification has been done to match S&T with investment priority in the Sixth Five Year Plan emphasising consumption rather than accumulation. According to the new policy guidelines basic research should be expanded steadily and gradually and foreign science and technological advance should be carefully studied and assimilated but the focus should be on key problems and projects urgently required for economic construction.

Administrative reorganisation in R&D institutions has been aimed to underplay the role of the Party ideology in S&T management as is reflected in the replacement of the "three-in-one" management team of the Cultural Revolution period. Instead, responsibility has been assigned to professionals. There is a move for decentralisation in decision making power and greater professional autonomy to enterprises in allocation of resources for technological renovations, implant R&D and other technological decisions. Similarly, there is greater autonomy in the mobilisation and administration of funds and determining research projects in R&D institutions after completing the State-assigned projects. In a sense, there is a move towards 'enterprisation' of R&D institutions to provide the scientists with economic autonomy. There has been reforms in the wage system that link wages to performance. S&T personnel are now provided with material incentives such as permission to accept advisory assignments or to do research for other units on remuneration and awards, and prize monies are given for meritorious work. Above all, the patent law which recognises the principle of proprietory right in knowledge has been enacted. On the whole, there is now a liberal policy approach in the organisation and management of R&D based on the contribution of individual creativity and competition rather than mass-participation and class-struggle.

New principles and policy directions in the planning, organisation and management of R&D activities are in consonance with the 'liberal' approach of the 1980s for developing commodity production. The possible contradiction of liberalisation with the need for controlling the direction of research and of coordinating them in a planned way with economic activities in a country, which is still largely based on socialist relations of production, is however a perplexing feature of the Chinese policy. For, there is no clear idea as to how market forces in a socialist economy stimulate technological innovation. The danger of competitive forces undermining the planned development of indigenous science and technology cannot be ruled out.

There is already some evidences which suggests that liberalisation has meant lack of coordination in a multi-layer technological structure resulting in the duplication and waste at all levels of research and duplication of technology import. The decentralisation in decision making (professional autonomy) is said to have led to technological blockades. Also with the expanding autonomy of enterprises and the 'enterprisation' of R&D institutions there is increasing competition for innovations with the result that secrecy of technological achievements has become omnious. In particular, enterprises possessing new technology are reluctant to share it with others. To gain prize money inventors often lock up invention and thereby impair the process of innovation and diffusion. The rush with liberalisation may, thus, adversely affect the rate and direction of indigenous development of science and technology and may create a state of technological stagnation. This in turn may accentuate rather than resolve the contradiction between technology import and technological self-reliance.

5. Conclusions

Does the overview of China's technology policy in the 1980s contrasted with that of India suggest any general conclusion? If at all, it is this: there is nothing like a "Chinese model" which a developing country can copy in relation to its technological transformation.

For technology unlike science, does not work in a socio-economic vacuum and can develop only in a given political framework. Besides, the process of industrial innovation as it occurs in a socialist economy cannot be judged and reformed (as the Chinese policy tends to do now) in the light of the known dynamics of the process in a capitalist economy. This is so notwithstanding the economic readjustments integrating law of value for developing socialist commodity production. Therefore, each country has to pursue a technology policy relevant to its own perspectives and changes in economic development and social needs. Some lessons, however, can be drawn that could suggest variations in the strategy.

There is a suggestion from the overview for making self-reliance as the kernel of technology policy. Technological autarky may hamper the development of forces of production and retard the progress in technological advance and modernisation. Yet, a tactical movement for internalisation and selective delinking in the initial phase is useful to lay the foundation of a strong endogenous S&T base. The specific form and timings of delinking will differ with the strategy of economic development.

The Indian approach for a long time has been to block and hold foreign ownership and foreign control, and to import technology selectively after careful evaluation of the terms and modalities under the framework of administrative regulations. In the case of China, which is known for its 'walking two steps forwards and one step backwards' the connotation of self-reliance in technology policy has been swinging with policy-cycles in relation to economic strategy and development. In particular, the apparent rush towards a liberal approach to foreign investment and technology import in the post-Mao period is too complex to comprehend because of its potential dampending effect on indigenous innovation and economy, autonomy. Nevertheless, if one looks back at both Chinese and Indian experience, there is a suggestion that but for an inward-looking technology policy neither country could have built up a domestic S&T capability which gives the self-confidence in 1980s to open out and shop for the latest technology in the international market.

A commitment to fast modernisation, an ambitious aim to catch up with industrialised countries, and a drive for rapid export promotion would make liberalisation in technology-import expedient. An attractive climate for foreign investment and technology import would call for such material incentives and liberal concession that may potentially conflict with the larger national interests. As the experience of China in the immediate post-Mao period suggests, indiscriminate technology-import poses serious adjustment problems despite the magnitude of foreign investment being proportionately marginal and the socialist (public) ownership of the means of production.

The Indian experience is instructive to the extent that it suggests the possibilities of "selective regulation" of foreign investment and technology import and its local adaptation, assimilation and indigenisation even in the phase of opening-out for technological upgradation and modernisation of the production sector within a self-reliance strategy. This, however, has to be accompanied by a process of planning for indigenous capacity for technological innovations. The Indian experience unfortunately underscores the fact that technology planning without a serious concern for the coordination of R&D activities between R&D institutions at various levels and with the production sector results in marginalisation of endogenous S&T. Here, the Chinese experiments with the "walking on two legs" strategy are worth emulating.

Technology planning, however, has the danger of overcentralisation of decision making power in State administration which throttles individual initiative and creativity, so important in the innovation process especially in a market-determined situation. Rigidity and adhocism in administrative controls can lead to serious economic inefficiencies and wastes particularly in a market-oriented economy as is evidenced by the Indian experiments with a regime of quotas and controls. At the same time, relaxation of administrative controls and juxtaposing competitive forces and the law of value within a still largely planned economy, as the recent Chinese experience tends to suggest, sharpens contradiction between technological self-reliance and open-door strategies in the technology policy.

On the whole, a selective regulation of technology-import and planning of R&D activities to strengthen indigenous innovations are the key components in a technology-policy for any developing country. Whether the strategy could be implemented through direct administrative controls, or indirectly by monetary and fiscal instruments when a planned economy is integrated with market orientation remains an open question.

Table 1

Incentives for Foreign Investment, China and India

CHINA	INDIA
a) Corporate Tax Incentives	a) Corporate Tax Incentives
- Total Income Tax exemption in first profit making year and 50 percent in 2nd and 3rd years.	- Exemption from Income Tax upto 25 per cent in respect of enterprises outside Free Trade Zones (FTZ).
- Additional 15-30 percent tax reduction for low profit operation areas.	- Complete tax exemption for industries in FTZs for five years.
- Additional tax reduction of 15-30 per cent in economically backward areas for 10 years.	- Investment allowances for specified industries.
- Carry forward losses for t 5 years	- Special tax incentives for setting up industries in backward areas.
- Special privileges of tax reduction from preferred sources.	- Depreciation allowances on capital assets.
- 40 per cent refund of taxes on reinvested profits.	- Investment allowance to specified industries.
b). Tariff Incentives	b) Tariff Incentives
Reduction/Exemption from custom duty and integrated commercial and industrial tax.	Duty free imports, of raw materials capital goods or components for 100 per cent export oriented units:
80-90 per cent tax reduction in respect of import of raw materials etc. required for export production.	
c) Other Incentives	c) Other Incentives
Exemption from land charges from one to five years.	Deduction of expenditure on scientific research.
Discount rates are offered in backward areas.	Weighted deduction in expenditure on R&D.

Source: "Comparative Investment Incentives", China Economy & Trade, Vol.1, No. July 31, 1983, pp.3-4.

Table 2

Modalities of Foreign Investment in China: end 1983

Modalities	No. of units	Amount of foreign investment (in U.S. $ million)
1. Chinese Foreign joint venture	190 (7.7)	329 (32.2)
2. Chinese Foreign cooperative oil exploration projects	31 (1.2)	242 (23.7)
3. Chinese Foreign cooperative production enterprise	1129 (45.7)	323 (31.6)
4. Compensation Trade/Processing of imported materials	1067 (43.2)	86 (8.4)
5. Wholly owned foreign enterprises (Independent ventures)	53 (2.2)	42 (4.1)
Total	2470 (100.0)	1022 (100.0)

Figures in parentheses are percentages to total.

Source: Statistical Year Book, State Statistical Bureau, Beijing, 1984.

Table 3

Industrywise distribution of Investment Proposals made in 1982. China

Industry	No. of Projects	Total investment (US $ 10,000)	Value of foreign Investment (US $ 10,000)	Share of foreign investment in total (%)	No. of projects with foreign majority equity	Col.6 as per cent of col.2
1	2	3	4	5	6	7
Light industry	29 (22.3)	35702 (21.8)	19161 (21.4)	53.6	17 (33.3)	58.6
Textile industry	11 (8.5)	8419 (5.1)	3842 (4.3)	45.6	5 (9.8)	45.5
Chemical industry	11 (8.5)	25235 (15.4)	12466 (13.9)	49.4	4 (7.8)	36.4
Machine building industry	19 (14.6)	38821 (23.7)	26221 (29.3)	67.5	4 (7.8)	21.1
Building materials	21 (16.1)	23001 (14.0)	10363 (14.3)	45.0	6 (11.7)	28.6
Meters and instruments	4 (3.1)	1960 (1.0)	610 (0.7)	36.0	- -	- -
Medical apparatus	3 (2.3)	660 (0.4)	260 (0.3)	39.3	-	-
Metallurgy	11 (8.5)	9276 (5.6)	6267 (7.0)	67.5	7 (13.7)	63.6
Electronics	18 (13.8)	17758 (10.8)	8620 (9.5)	48.5	6 (11.7)	33.3
Forestry	3 (2.3)	3302 (2.0)	1780 (2.0)	53.9	2 (3.9)	66.7
Total	130 (100.0)	164134 (100.0)	89590 (100.0)	54.6	51 (100.0)	39.2

Note: Data relate to tentative investment project-proposals prepared by the Ministry of Foreign Economic Relations and Trade for negotiation at the Guangzshow Investment Promotion Meeting, 7-11 June 1982.

Source: Based on data reproduced in China Economy and Trade, Vol.1, No.6, July 15, 1983, pp.9-11.

Table 4

Location of Chinese-Foreign Joint Ventures: end 1983

Regions	No. of Joint Ventures	Value of Foreign Share (US $ 10,000)
a) Four Special Economic Zones	99 (52.1)	11479 (34.9)
[of which Shenzen	87	9213 (28.0)]
b) Beijing & other coastal areas	81 (42.6)	20657 (62.8)
c) Hinterland	10 (5.3)	769 (2.3)
Whole Country	190 (100.0)	32905 (100.0)

Figures in parenthesis percentage to total.

Source: as in Table 2.

Table 5

Technology Contracts and Foreign Investment in Joint Ventures approved in 1983

	CHINA		INDIA	
Country of origin	Value of foreign investment share (US $ 10,000)	No. of technology contracts	Value of foreign investment share (Rs. lakhs)	No. of technology contracts (foreign technical collaboration)
U.S.A.	3671 (19.5)	46 (21.7)	1389.21 (30.1)	135 (27.2)
U.K.	3602 (19.1)	18 (8.5)	980.18 (21.3)	119 (23.9)
West Germany	--	43 (20.3)	484.23 (10.5)	129 (26.0)
France	270 (1.4)	3 (1.4)	..	..
Italy	99 (0.5)	40 (18.8)	115.00 (2.5)	30 (6.1)
Belgium	3954 (21.0)	5 (2.3)	..	..
Sweden	..	5 (2.3)	..	..
Switzerland	..	2 (1.0)	..	..
Canada	..	1 (0.5)	35.60 (0.8)	6 (1.2)
Japan	989 (5.2)	44 (20.7)	1607.70 (34.8)	58 (11.7)
Hong Kong	6000 (31.9)	2 (1.0)	..	..
Australia	--	2 (1.0)	--	..
Newzeland	40 (0.2)	1 (0.5)	..	..
U.S.S.R.	--	..	..	4 (0.8)
East Germany	--	--	..	10 (2.0)
Others	212 (1.1)	..	..	5 (1.0)
Total	18837 (100.00)	212 (100.00)	4611.92 (100.00)	496 (100.00)

Source: Data for China from State Statistical Bureau, Beijing and for India from Indian Investment Centre, New Delhi.

Table 6

Forein Investment Approvals in China and India

Years	CHINA No. of Equity Joint Ventures	CHINA Value of foreign investors share (US $ 10,000)	INDIA No. of foreign collaboration (Joint Venture	INDIA Value of foreign investment share (Rs.10,000)
1979	10 (5.3)	1437 (4.4)	32 (11.1)	5640 (5.4)
1980	24 (12.6)	7629 (23.1)	54 (18.7)	4713 (4.5)
1981	29 (15.3)	2576 (7.8)	44 (15.2)	9122 (8.7)
1982	20 (10.5)	2419 (7.4)	72 (24.9)	39537 (37.6)
1983	107 (56.3)	18837 (57.3)	87 (30.1)	46119 (43.9)
Total	190 (100.0)	32898 (100.0)	289 (100.0)	105131 (100.0)

Source: as in Table 5.

Table 7

Some Characteristics of Technology Import in Capital Goods Sector in China

	Total sample	Wholly domestic firms	Domestic firms with foreign collaboration
1. No. of firms	19	11	8
2. Percentage value of equipment less than 5 years old	14.7	15.6	14.3
3. Output per worker on 1980 (thousand $US)	4.4	3.9	4.6
4. Export as percentage of sales (in 1980)	2.9	6.3	1.8
5. Average No. of new products in 3 years	9.3	10.7	5.6
6. Technical contents of Licensing agreements (as % of total)			
a) Basic design			84
b) Detailed design			97
c) Assistance in manufacturing			97
d) Training			100
7. Age of design (% total)			
a) Upto 5 year old			16
b) 6-9 year old			81
c) More than 9 year old			3

Adapted from tables 7, 8 and 10 from UNCTAD, Technology Issues in the Capital Goods Sector, the experience of the PRC, United Nations, 1984, UNCTAD/TT/57.

Table 8

S&T Personnel in State-owned Units: China

(Units: 1000)

Sectors \ Year	1978	1981		1982	1983
Engineering	1571 (36.1)	2077 (36.4)	(49.9)*	2356 (37.6)	2802 (40.9)
Agriculture	294 (6.7)	328 (5.7)	(35.1)*	362 (5.8)	404 (5.9)
Health	1276 (29.3)	1680 (29.4)	(25.7)*	1807 (28.8)	1934 (28.2)
Scientific research	310 (7.1)	338 (5.9)	(74.3)*	372 (5.9)	328 (4.8)
Teaching	894 (20.6)	1291 (36.3)	(51.1)*	1369 (21.8)	1382 (20.2)
Total	4345 (100.0)	5714 (100.0)	(43.7)*	62[illegible]6 (100.0)	6850 (100.0)

Figures in parenthesis percentage to vertical total.

* These figures indicate per cent of personnel who have attended college or universities.

Source: State Statistical Bureau, PRC. Beijing.

Table 9

Number of Major Achievements in Scientific and Technical Research: China

Year	Number of major achievements in creations and inventions	Number of creations and inventions approved by the State	Col. 3 as percentage of Col. 2
1	2	3	4
1979	2790	42	1.50
1980	2600	107	4.11
1981	3100	120	3.87
1982	4100	149	3.63
1983	5400	214	3.96

Source: State Statistical Bureau, PRC. Beijing.