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THE TECHNOLOGICAL TRANSFORMATION OF CHINA AND ITS SOCIAL IMPACT: AN AGENDA FOR POLICY RESEARCH

Summary of an SSTC-IFIAS Roundtable

Beijing, May 1984

Under the joint sponsorship of the State Committee on Science and Technology (SSTC) of China, and of the International Federation of Institutes Advanced Studies (IFIAS), a Roundtable was held in May 1984 to examine the need for science and technology (S&T) policy research and to explore the scope for international cooperation in this field.

Twenty-five specialists from developed and developing countries joined the same number of Chinese policy-makers and researchers to explore the interactions between science, technology and society in the Chinese setting and to identify opportunities or joint S&T policy research.

The Roundtable was chaired by Wu Mingyu, Director of the Chinese National Research Center for Science and Technology for Development, and by Alexander King, Chairman of IFIAS. Francisco Sagasti, Executive Director of the Group of Analysis for Development (GRADE) in Lima, Peru, was asked to present a summary of the discussions at the end of the meeting. His views on the themes and issues covered at the Roundtable are presented herewith.

Introduction

The Roundtable discussions recognized that the capacity to generate, disseminate and utilize scientific and technological knowledge are the main determinants of social and economic development, particularly as the 20th Century draws to a close.

The effectiveness of the process whereby S&T knowledge is generated, transferred and applied depends on the formulation of adequate policies and on their implementation to guide decision-making at enterprises, research centers, engineering firms, rural households and many other organizations involved in the process of S&T development.

It is also increasingly accepted that the interactions between science, technology and society are most complex and that the application of S&T to achieve specific national, regional and local objectives is a difficult proposition. Good and effective policies depend on those complexities being understood, and this is why policy research aimed at providing this understanding has become so important in recent years. The Roundtable has provided ample evidence of the value and usefulness of policy research and has shown how international cooperation may lead to particularly valuable results and insights.

Several policy research topics have been identified at the Roundtable discussions and an effort has been made to organize them around five several themes that refer to a particular aspect of the current situation of S&T in China. Particular attention was paid to the identification of possibilities for international cooperation in studies or empirical research projects, joint monitoring and analyses of evolving situations, and workshops or meetings to exchange views and experiences.

1. Managerial reforms and the organization of production

The accelerated process of institutional transformation that China has experienced in the last five years has brought unprecedented challenges to the capabilities of policy-makers, managers and administrators, and have also led to the restructuring of a major portion of agricultural, industrial and service activities. The issues referring to managerial reforms and the organization of production were highlighted during the discussions.

a. Managerial reforms and entrepreneurship

A process of transition from a centrally planned economy to a mixed economy, in which the market is beginning to play a certain role, is taking place in the different sectors and regions of the Chinese economy. The scope of autonomous decision-making has been enlarged considerably for state enterprises, collective production units and individual households through the introduction of the "responsibility system," the establishment of Special Economic zones, and the opening of the Chinese economy to international trade.

The increased autonomy and responsibility given to managers and entrepreneurs covers different aspects of the managerial function such as pricing, marketing, investment and personnel, and the degree of autonomy varies in each of these aspects according to the size of production unit, type of product and location of the enterprise. The influence of these varying degrees of autonomy on the process of innovation and technical change is a difficult but important subject of study.

The use of management science methods in business planning and operations is a recent phenomenon in China. Their effective use in functions such as marketing, finance, production, and organization requires that they be adapted to local conditions, particularly in the case of R&D management. Many developing countries have experiences in this regard, which may prove valuable to China.

In addition to managerial skills, the importance of entrepreneurship for responding to the new challenges faced by Chinese production units, particularly to the challenges involved in technical innovations, was recognized at the Roundtable. This applies not only to industrial enterprises, but also to rural households, collective units, R&D institutes, and similar organizations. The process of fostering entrepreneurship and of identifying and encouraging entrepreneurs is crucial if the reforms are to succeed. The experience of other countries, both developed and developing, should shed light on this issue and suggest policies and measures such as reward systems, support to small enterprises, and provision of risk capital.

b. Market structure, organization of production and innovation

The way in which industrial and agricultural production is organized was considered as a key factor for technological innovation and the development of S&T capabilities. This applies equally to the rural areas, where networks of mutually supporting specialized households and small industries are being established in the transition from self-sufficient to commodity production; and to advanced industries, where closely interacting networks of suppliers, producers, customers and support organizations are necessary for the development and utilization of new technologies.

An issue that merits special attention refers to the characteristics of the "systems" or "clusters" of productive and service units that are required for efficient production and for innovation in high technology fields such as electronics, biotechnology and agricultural production. These characteristics and the performance associated with them could be derived from field studies and international comparisons.

It also appears important to conduct studies of the behavior of productive and service units in specific sectors such as consumer electronics, offshore oil exploration, machine tool production, and telecommunications equipment, considering the roles played by competitive pressures and cooperative ventures, and by enterprise strategies for vertical integration and diversification. The responses of enterprises to the transition from a centrally planned economy to one in which market signals also play a role needs to be carefully studied, as well as the effect of these responses on innovation and on the development of in-house technological capabilities.

c. Educational reform and innovation

The role of education to provide the necessary skills and to foster receptive attitudes towards innovation was also recognized at the Roundtable. Some issues to be examined include the education of managers and entrepreneurs, of scientists and engineers, of technicians and support staff, and of workers and the general public, so as to release and promote creativity, as well as to develop response capacities to deal with a rapidly changing socioeconomic and technical environment. The experience of other countries, and especially the contrast with Japan and Europe, may be of particular interest in this regard.

2. Policy design and implementation

The importance of the policy environment and of the process of policy formulation for innovation and technological development was emphasized repeatedly in the discussions. The policy environment must be adequate to the local situation, capable of adapting to changes and conductive to innovative behavior.

The reforms being put into effect to increase decision autonomy and responsibility may run contrary to the established centralized but fragmented structure of government policy-making. Different administrative jurisdictions, government ministries and departments make decisions on the allocation of

investment resources, industrial priorities, manpower development and the use of energy resources. In addition, policies are made and decisions are taken by national, regional and local government agencies and enterprises. This raises the issue of coordination of policies and decisions at various levels and between different governmental entities, so as to structure a coherent policy environment, especially at a time of rapid change. The experience of other large countries that have faced similar coordination problems would be relevant in this regard.

Science, technology and innovation policies must be formulated in accordance with the specific features of the productive units, research centers, universities, engineering firms, and other actors in the innovation process that the policies are intended to influence. Characteristics such as selectivity, concentration, specificity and scope need to be considered. The range of policy instruments available for attaining policy aims is rather broad, although only a few of them may be appropriate and effective in a particular situation. There is a need for continued research to assess the performance of policy instruments, comparing their effectiveness under different conditions, and exchanging information on this matter.

In particular, it is necessary to examine these factors in relation to policies for innovation and technological development in rural areas, with special reference to agricultural, production, post-harvest activities, agroindustry, and small and medium-scale manufacturing. Similarly, the special requirements of the high technology fields, such as microelectronics and biotechnology, should also be analyzed. Considering the changes that Chinese S&T policies are undergoing, and the large experience accumulated in other developed and developing countries, this is an area of particular interest for international comparative research.

3. Technology transfer and local research and development (R&D) efforts

The opening up of the Chinese economy, the increased influx of foreign technology, and the need to expand significantly local R&D efforts create special problems for policy making. Of particular interest are the strategies, priorities and capabilities required to make effective use of technology transfer and for employing imported technology as a base for local R&D efforts. Along this line, the organization of R&D efforts merits special attention.

a. Technology transfer and the development of R&D capabilities

The balance and complementarity between the transfer of technology and domestic research capabilities is a complex issue that must be examined in relation to a specific sector, geographical location and set of productive units. The importation, adaptation and absorption of foreign technology must be harmonized with research, development and engineering activities to generate local technologies. This requires the definition of a strategy for technology transfer, covering aspects such as the pre-investment phase of industrial projects, technology assessment, the sequence of technology assimilation and absorption activities in different sectors, the appropriate levels for decision making, and the relative weight given to indigenous research, development and engineering in the transfer process.

The various channels available for technology transfer —exchange of information, engineering services, imports of equipment, technical assistance, and joint ventures, among others— should be examined to determine the more suitable mix for a particular sector, set of local conditions and policy objectives. In addition, the different mechanisms for acquiring technical information, evaluating technological options, and selecting technologies need to be considered against the background of a rapidly changing and more competitive international economic and technological environment.

There is a considerable experience in this regard in many industrialized and developing countries, and China may benefit from an exchange of experiences on concrete and specific cases. At the same time, the large-scale process of technology transfer in which China has embarked should be closely monitored, not only to modify policies as the need arises, but also to transmit the experience to other developing countries.

b. Organization of R&D efforts

The local generation of technology should cover the whole spectrum of activities from research and development to utilization and dissemination. This implies the need of designing integrated R&D and delivery systems that respond to the specific characteristics of the users, may they be rural households or industrial firms; that take into account the different types of technologies, from simple agro-industrial techniques to high technology; and that consider the characteristics of the institutions involved in the R&D process, whether they are universities, research associations, or national laboratories.

The division of labor between R&D institutions should be defined as a matter of policy. The linkages between these organizations and their clients, including extension services, engineering firms, industrial liaison services, development banks, and venture capital funds, also merit particular attention. There is considerable experience in this field in developed and developing countries that have experimented with a variety of organizational models during the last thirty years, and that are continuously searching for new ways of organizing their R&D efforts to make them more effective.

4. New technologies and their impact on development and innovation

The last three decades, and particularly the last five years, have witnessed the emergence of new science-based technologies that have spread with great speed and are drastically changing producing activities, introducing new products, altering the international economic environment, and modifying international power relations. These have been precisely the same years during which China has undergone a major transformation, experienced upheavals and embarked on a process of accelerated development. Advances in microelectronics, informatics, mechatronics, biotechnology, new energy sources, new materials, space technologies, and many other fields are creating new opportunities, threats and challenges for industrialized and developing countries alike. Many of these technologies have the potential to support a process of decentralized development and to increase the efficiency of traditional activities, while at the same time they

could generate unemployment, displace cultural values, and disrupt the social fabric of developing countries.

a. Strategies for responding to the challenge of new technologies

There are many possible strategic options for developing countries to face the challenge of emerging technologies and, given the impossibility of mastering each and every one of these technologies, the first problem is to define the priorities and select fields for concentration. The sequences and steps involved in acquiring high-technology capabilities, including the possibility of advancing to the technological frontier skipping intermediate stages, the roles played by leading high-technology sectors in raising the general level of technological capabilities and inducing innovation; and the possible synergistic effect of the interactions among the various emerging technologies, all need to be considered in the design of technological strategies. There is considerable scope for policy research and international cooperation in this field.

b. Blending emerging and traditional technologies

One particular component of the strategy to deal with new technologies is the integration of emerging with traditional technologies, so as to improve the efficiency of the latter without disrupting the social and cultural environment. This is of particular importance for China, where traditional technologies still account for a major share of productive activities and have done so for a very long time.

There is a need to focus on new problem areas and on specific technological advances to initiate a learning process to assess and capitalize on the blending of emerging and traditional technologies. The problems related to rural households, agro-industries, rural energy supply, and small scale manufacturing may be amenable to the adoption of "blended" technologies and should be covered in a review of possibilities to implement this approach. The experience of other countries in the design of specific technologies and in institutional innovations for organizing delivery systems would be of particular importance.

5. Socioeconomic impact of technological transformations

The large-scale technological transformations that China is undergoing at present, which will accelerate in the future, will have profound social effects. There will be educational, institutional, and major organizational changes necessary to absorb new technologies and to cope with a faster pace of innovation; the uneven level of development in different regions is likely to become accentuated; and the impact of the process of decentralization, of economic and managerial reforms, and of the introduction of market mechanisms, will create a more competitive environment for productive units. These changes must be examined in contrast with the resilience of the Chinese society, with many centuries of conservative administrative traditions, and with the inertia associated with a very large population.

In addition, the increased standards of living will have an impact on the use of material resources, energy demand and on the environment. While China may have the social capabilities, cultural attitudes and institutional frameworks for

dealing with these changes and the tensions they will generate, a period of turbulence and instability may be anticipated in the not too distant future.

From a science and technology policy research perspective, it becomes imperative to monitor these changes, assess them continuously, and attempt to anticipate their effect on the development of the scientific and technological capabilities that are essential for China to face the future it is designing for itself. For this reason, China should complement its growing capability for S&T policy research with a capacity for prospective assessment of the economic, social and political consequences of these transformations.

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