Science and Technology in Contemporary China

Interrogating Policies and Progress

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To the five who are central to my life:
First, the one who gave me life;
Second, the two who brought me into the world;
Third, the one who shares my life;
Fourth, the two who will carry on my legacy;
Fifth, all those who contributed to my life, both directly and indirectly.

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Preface

Chinese science and technology (S&T) policy, as a subset of the Open Door Policy that Deng Xiaoping launched in 1978, marked the completion of three decades of reform in 2008. A three-decade evolution is substantial enough to review and assess the trajectory of S&T policy to understand the manner in which it has unfolded, shaping S&T progress. Liberal and flexible policies initiated and implemented effectively in different facets of S&T, such as organisational structure, S&T personnel, research and development (R&D), and technology acquisition are central to this process. The cumulative outcome of these gradual and yet fundamental reforms in S&T policy is a remarkable S&T progress. The following select data for 2010 gives us a glimpse into the Chinese accomplishments in S&T. China's Gross Expenditure on Research and Development (GERD), a key indicator of S&T development, was about 179 billion US dollars, trailing just behind the US. China published about 45,000 scientific research articles and, thus, figured among the top five. Though multinational companies (MNCs) play a key role, China is now the largest high-technology exporting country with a volume of about 350 billion US dollars. Moreover, some segments of its space, agricultural, and industrial technologies are approaching the levels of the ones in the advanced countries. These impressive indicators signify the unfolding of a new phenomenon of paradigm shift from 'made in China' to 'invented and innovated in China'. This is in line with the goal that China set for itself in 2006 to become a nation of innovation by 2020. However, there are a multitude of problems, such as lack of adequate academic freedom and indigenous innovation, rampant imitation, academic fraud, plagiarism, and intellectual property rights violations, that continue to fraught the Chinese S&T system.

Despite some of these deficiencies, the end result of these policy changes has been the far-reaching transformation of the very structure and substance of S&T, facilitating their contribution to the economic development of China

with an average GDP growth rate of about nine per cent during this period. It may not be an exaggeration to posit that the economic development that China had been able to achieve in the last three decades hinged, to a considerable extent, on the reforms initiated in the S&T system. The central thesis of the study is that at the heart of this process is S&T policy coupled with effective implementation, resulting in remarkable progress. Therefore, this study aims at delineating this key component with an eye on S&T progress.

A number of studies have been published in the recent past, highlighting some of these dimensions of S&T, including the notable role of policy and progress in contemporary China's development. The main theme of these studies is that the Chinese government, the scientific community, and the advanced technology that China acquired – all contributed to this progress in a short span. There are other studies that discuss the shortcomings of the Chinese S&T policy and progress.

In the context of these divergent processes, problems, and perspectives, there is an imperative need to revisit and interrogate the nature and scope of Chinese S&T policy and progress. This study, therefore, in delineating the role of state in S&T policy formulation and development, vis-à-vis scientific community, and in technology acquisition, makes a major departure from these studies and perspectives. Some of the critical issues that need probing are the nature and scope of Chinese S&T policy and the place of the poor in the Chinese S&T policy architecture. In other words, how are S&T policies crafted with an eye on the impacts these will have on the lives of those on the periphery, particularly those in the central and western provinces in China? While examining these pivotal issues, the study interrogates S&T from the prism of the marginalised and the underprivileged, whose interests and concerns are required to be factored into the formulation of S&T policy. One of the key questions, therefore, is where exactly do the poorest of the poor and the marginalised communities are in the framework and gamut of Chinese S&T policy? Some sections of Science and Technology Studies (STS) scholars might question the logic of this proposition stating: Is it possible to factor the poor in the broad framework of S&T policy? The study, however, assumes that it is not only possible but also most certainly vital for the future of both the poor and S&T, particularly in the context of the increasing corporatisation of not only R&D but also S&T. While corporatisation of R&D and S&T has some substantial benefits, there is a great need to harness S&T for the good of the majority. It is in this realm where the corporate houses do not venture, that the governments must endeavour to push the envelope of S&T policy and progress in the direction of hitherto uncharted terrains.

In addition, participatory development paradigm that Robert Chambers so lucidly articulated in his path-breaking work *Whose Reality Counts? Putting the Last First* will also be used, as this paradigm is wider in scope, bringing those on the margins to the centre of policy-making, thus making S&T policy and progress truly representative of all sections of the society, factoring their voices and their concerns. From the perspective of Social Studies of Science (SSS), the progress of science presupposes progress in our understanding of the conditions, nature, and development of not only science but also S&T policy and the poor.

Structure of the Study

In an attempt towards delineating the Chinese S&T policy, this study is divided into three major parts. The first part considers both the macro and the micro issues pertaining to S&T policy in general and S&T policy in China in particular. The second part highlights the historical narrative of Chinese S&T policy, as it has a key role in the evolution of contemporary S&T architecture. The third part discusses three focal components of Chinese S&T system, each representing state, society, and international system. The organisational structure representing the state, research system representing the society, and technology acquisition representing the international system, with serious implications for China, form a substantial part of the study.

The first chapter considers two central issues. First, it delineates the nature and evolution of S&T policy by situating it within the framework of policy studies, which is witnessing a major paradigm shift in its evolution, contributing in developing a number of conceptual and analytical tools that could be applied to S&T policy in general and Chinese S&T policy in particular. This is necessitated because of the critical gap that exists between policy studies and S&T policy. In fact, S&T policy can benefit from the analytical tools developed within the policy studies over the years. Second, the chapter focuses on how S&T has been evolving over the last few decades and in the process becoming more variegated and complex. The complex nature of S&T policy is directly related to the expansion of various new technologies and their increasing impact on society, economy, and polity. In the last three decades, with a number of byproducts and a new phenomenon of maturation in the developing countries, S&T policy has become much more complex, thus necessitating a novel approach. This is done in the light of Robert Chamber's framework of whose reality counts underscoring the fact that the reality of all those who are affected by the growth of the present S&T architecture must find a credible place.

The second chapter examines the trajectory of S&T policy in China since 1978, focusing on the changing contours. It analyses the Chinese perceptions of policy in promoting the development of S&T. The central theme of the chapter is how the Chinese state provided an innovative ideological base and gave unflinching support to the S&T system in order to make it more effective and use it for the overall development of China. The role that Deng Xiaoping played is central to this process. He envisioned a new path for the development of S&T by decoupling it from the control of the Party. Consequenty, the Chinese S&T policy went through various phases and pathbreaking reforms, which have transformed the substance and structure of Chinese S&T policy and progress. However, the Chinese state neglected to factor the poor, the marginalised, and the central and western regions into the S&T policy framework. In fact, it moved away from Mao's version of people-centred science to professionals-centred science, which resembles the Western science in style and yet in substance continues to retain some authoritarian vestiges.

The S&T policy changes in contemporary China cannot be fully appreciated without a historical narrative and analysis of S&T in its *pre-policy* (prior to 1850) and *policy* (since 1850 when Qing rulers began to promote S&T with fragmented policies) periods. Therefore, the third chapter places the discussion in the historical context of the development of S&T in China. It brings to light the glorious past that China carved over the centuries thus adding to the global S&T with its inventions of paper, movable printing press, compass and gunpowder, besides several others prior to the fifteenth century. This was followed by some sort of technological inertia and inward-looking policy during the mid-fifteenth to the mid-nineteenth centuries, which deeply affected the growth of S&T, thus leading to the conceptualisation of the famous Needhamian puzzle, which poses the question that why China, with such a glorious past, could not experience Industrial Revolution much before Europe. Ever since the Opium War of late 1830s and early 1840s, and the consequent semi-colonisation of China, we notice China's insatiable quest for acquiring and using Western technology to catch up with and defeat the West, followed by the nationalist endeavours to strengthen S&T in China. Thereafter, Mao Zedong, with his deep understanding of S&T, attempted to make science serve the state, the Party and the socialist movement by calling for mass-science. What emerges from this discussion is the various vicissitudes of S&T policy impacting its architecture and trajectory.

In the third chapter, organisational structure of the S&T system, as a representative of the state, is examined. The many institutions established and

different reforms initiated during Deng's period form part of this chapter. The first thing the state did under Deng Xiaoping was to revive the S&T system and establish a number of bodies and R&D institutes. The Science and Technology Leading Group (STLG) was one such high level body. The organisational structure was made more flexible with the devolution of decision-making power to the research institutes. Some of the reforms introduced in the S&T organisational structure are so radical that they transformed the very nature and functioning of S&T and began to strip the socialist elements, thereby transforming the Chinese S&T institutions.

The fourth chapter looks at the reforms initiated in the research system, as a representative of the society, in S&T personnel, R&D, and S&T programmes. In the post-Mao period, S&T personnel have been given a new status and identity following the ideological departures that Deng Xiaoping made. They are now accepted as part of working class and called 'brain workers'. This process has boosted their morale and opened new vistas for them to interact with their counterparts across the globe and to articulate liberal views vis-à-vis science, society, and polity. In the area of R&D, an attempt was made to strike a balance between basic, applied, and development research, though the scale continues to tilt towards development research. To use the R&D results, a number of science plans and programmes were introduced, which have been transforming the economic and social fabric of China.

The fifth chapter elucidates how technology acquisition, as a representative of the international system, has been contributing to the development of not only Chinese S&T but also its economy. Changes in the way China acquired advanced technology, the increase in the quantum of technology imported, and several other related facets are discussed in this chapter. The mode and content of technology transfer from countries that could offer some of the most advanced technologies saw major changes. These have provided a number of sources for China to acquire sophisticated technology and expedite the process of reducing the gap between China and the developed countries. There is also an element of techno-nationalism underpinning Chinese S&T policy, particularly in China's pursuit of acquiring state-of-the-art technologies from countries like US and Japan. China's preoccupation with acquiring sophisticated technologies from the developed countries was such that both the leadership as well as the scientific community overlooked the need to invest their resources to develop indigenous technology. Of late some efforts are being made to address these lacunae.

The study ends with a chapter on conclusions arrived at. The chapter critiques the structure and substance of S&T in post-contemporary China in the light of the policy studies framework and the ever-expanding horizons of S&T in the global context, besides highlighting some of the major foibles with it. The study concludes arguing that there are several issues pertaining to S&T policy and progress, which are on the periphery and which need to be brought forth to form the fulcrum of the debate. Among these issues, the bottom of the pyramid of the S&T system, the poor, the marginalised communities and their needs, and also the central and western regions and their concerns are some that must find a credible place in the Chinese S&T policy and progress architectures.

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time from their dad. It was a joy to have them around while doing research in China in 2004 and they also contributed their share.

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Abbreviations

ACADSTC	All China Association for Dissemination of S&T Knowledge
ACFSS	All China Federation of Scientific Societies
CAAS	Chinese Academy of Agricultural Sciences
CAE	Chinese Academy of Engineering
CAFS	Chinese Academy of Forestry Science
CAGS	Chinese Academy of Geological Science
CAMS	Chinese Academy of Medical Science
CAS	Chinese Academy of Sciences
CAST	China Association of Science and Technology
CCP	Chinese Communist Party
CIFST	Council of International Federation of Science and Technology
CNTIEC	China National Technology Import and Export Corporation
COCOM	Coordinating Committee on Multilateral Export Controls
COSTIND	Commission on Science, Technology and Industry for National Defence
CS	Contract System
CSE	Centre for Science and Environment
CTBT	Comprehensive Nuclear Test-Ban Treaty
CTER	Centre for Technical and Economic Research
DRS	Director Responsibility System
ERS	Engineers Responsibility System
ETDZ	Economic and Technology Development Zone
FBIS	Foreign Broadcast Information Service
FDI	Foreign Direct Investment
FOSAT	Forum on South-South Cooperation in Science and Technology
FSTD	Foundation of Science and Technology for Development
GCSTP	Guide to China's Science and Technology Policy

GLF	Great Leap Forward
HEI	Higher Education Institution
HTDZ	High Technology Development Zone
ICBC	Industrial and Commercial Bank of China
ICTs	Information and Communication Technologies
ING	International Non-governmental Organisation
IPRs	Intellectual Property Rights
ISTIC	Institution of Science and Technical Information of China
KIP	Knowledge Innovation Programme
LME	Large and Medium Enterprise
MDGs	Millennium Development Goals
MLP	Medium and Long Term Plan
MNC	Multinational Companies
MOFERT	Ministry of Foreign Economic Relations and Trade
MOFTEC	Ministry of Foreign Trade and Economic Cooperation
MOST	Ministry of Science and Technology
NDSTC	National Defence Science and Technology Commission
NHTDZ	New and High Technology Development Zone
NIEs	Newly Industrialised Economies
NDIO	National Defence Industry Office
NGO	Non-Governmental Organisation
NIS	National Innovation System
NPC	National People's Congress
NPT	Non-Proliferation Treaty
NRCSTD	National Research Centre for Science and Technology for Development
NRDC	National Reform Development Commission
NSF	National Science Foundation
NSFC	National Natural Science Foundation of China
NSORI	Non State-Owned Research Institute
NTDZ	New Technology Development Zone
OECD	Organisation for Economic Cooperation and Development
PLA	Participatory Learning and Action
PRA	Participatory Rural Appraisal
PSP	Participatory Science Policy
PM	Production Ministry
PRC	People's Republic of China
R&D	Research and Development
RI	Research Institute

RMB	*Renminbi*
RSFTE	Research Foundation for Science, Technology and Ecology
S&T	Science and Technology
SC	State Council
SEC	State Economic Commission
SEd.C	State Education Commission
SEZ	Special Economic Zone
SLGST	State Leading Group of Science and Technology
SOE	State-Owned Enterprise
SPC	State Planning Commission
SSS	Social Studies of Science
SSTC	State Science and Technology Commission
STC	Science and Technology Commission
STDZ	Science and Technology Development Zone
STIPs	Science and Technology Industrial Parks
STLG	Science and Technology Leading Group
STS	Science and Technology Studies
SWB	Summary of World Broadcast
TBI	Technology Business Incubator
TCS	Tata Consultancy Services
TERC	Technical and Economic Research Centre
TVE	Township and Village Enterprise
TWAS	Third World Academy of Science
TWOWS	Third World Organisation for Women in Science
UNESCO	United Nations Education, Scientific and Cultural Organization
WFEO	World Federation of Engineers Organisation
WFOE	Wholly Foreign Owned Enterprise
WTO	World Trade Organisation
ZTE	Zhongxing Telecom Equipment Ltd.