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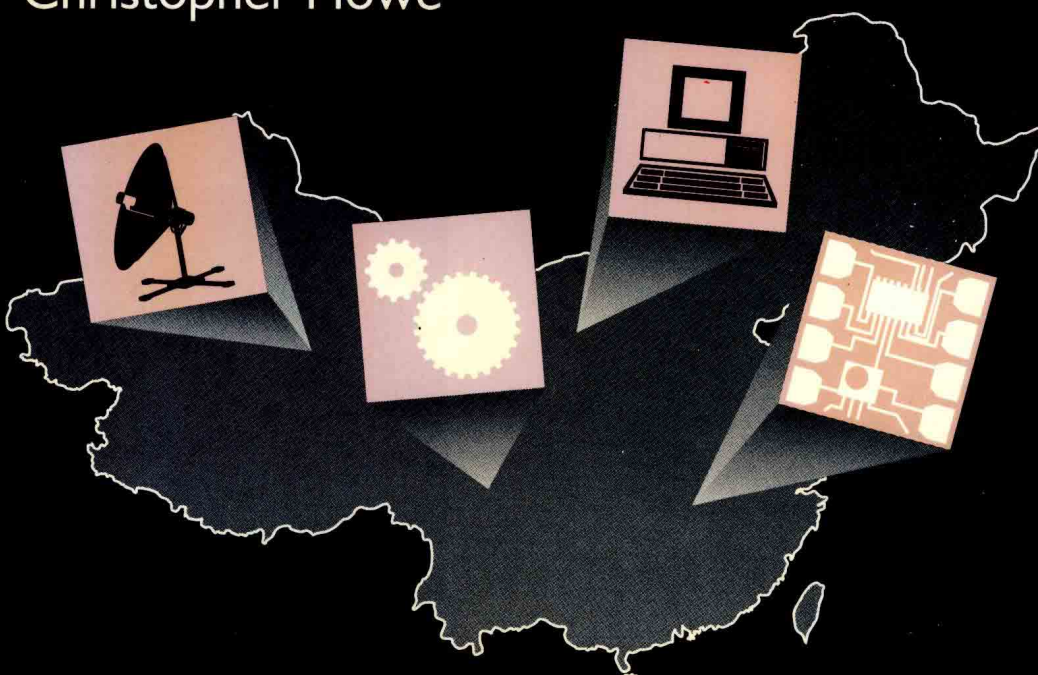
Chinese Technology Transfer in the 1990s

CURRENT EXPERIENCE, HISTORICAL PROBLEMS AND INTERNATIONAL PERSPECTIVES

Edited by
Charles Feinstein and
Christopher Howe



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Edward Elgar
Cheltenham, UK • Lyme, US

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Published by
Edward Elgar Publishing Limited
8 Lansdown Place
Cheltenham
Glos GL50 2HU
UK

Edward Elgar Publishing, Inc.
1 Pinnacle Hill Road
Lyme
NH 03768
US

A catalogue record for this book is available from the British Library

Library of Congress Cataloguing in Publication Data

Chinese technology transfer in the 1990's : current experience, historical problems, and international perspectives / edited by Charles Feinstein, Christopher Howe.
Includes bibliographical references and index.
1. Technology transfer—Economic aspects—China. 2. Technological innovations—Economic aspects—China. 3. Technology and state—China. 4. Competition, International. I. Feinstein, C. H. II. Howe, Christopher.
HC430.T4C465 1997
338.951'06—dc21 96–39590
CIP

ISBN 1 85898 245 6

Typeset by Manton Typesetters, 5–7 Eastfield Road, Louth, Lincolnshire LN11 7AJ, UK.
Printed and bound in Great Britain by
Biddles Ltd, Guildford and King's Lynn

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Preface

In 1993 a delegation of social scientists from the British Academy visited China as guests of the Chinese Academy of Social Sciences (CASS). One of the purposes of the visit was to discuss the operation of the reciprocal exchange agreement between the Academy (working jointly with the Economic and Social Research Council) and CASS. In the course of the discussions it was suggested that it would be valuable to supplement the visits of individual scholars by a joint seminar. It was agreed that the issue of technology transfer was a topic of great importance and mutual interest, and that discussion of both historical and contemporary aspects would provide a very suitable theme for such a seminar. As a member of the British delegation, Charles Feinstein undertook to carry forward the proposal and to invite the British participants.

The papers included in this volume were originally presented at the resulting seminar, which was held in Beijing in April 1995. The arrangements in China were made with great efficiency by the Institute of Industrial Economics on behalf of CASS, and the success of the meeting owes a great deal to the contribution made by Professor Ding Jingping, Deputy Director of the Institute, and by Mrs Ding Yi, Chief of the Scientific Research Division. It is also very appropriate to record the valuable support for this initiative given initially by Mrs Wu Lingmei, who was at that time Chief of the European Division of the Foreign Affairs Bureau of CASS.

We hope that this collection of papers will both make a useful contribution to better knowledge and understanding of the problems of technology transfer with which China will be dealing in the 1990s, and also convey something of the stimulating character of the seminar in Beijing.

C.H.F.
C.H.

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Introduction

Christopher Howe

TECHNOLOGY TRANSFER IN TWO SYSTEMS

The efficiency of technology transfer and innovation has long been regarded as the touchstone of the quality of an economic system. In market-based societies, as Paul David shows here in Chapter 1, the character of innovations and trade secrets has called for special arrangements (patents, apprenticeship traditions, etc.) designed on the one hand to reward innovation and, on the other, to ensure its controlled diffusion. In the period before the Second World War, however, technology was at the forefront of western debates about the relative merits of capitalism and socialism.

On one side of this debate was Joseph Schumpeter, who first made the crucial link between theories of innovation and development and who later came to the view that both activities were necessarily and beneficially related to monopolistic industrial structures, at least in the short run.[1] Against this, critics of capitalism, including economists such as Paul Sweezy and Maurice Dobb and scientists such as J.D. Bernal, argued that monopoly and concentration were the main reasons for capitalism's failure to exploit the discoveries of science in the broad social interest.[2] For them, the unused patent for the ever-burning electric light bulb was a defining symbol of capitalist waste. Dobb also argued that the inability of market systems to cope with problems of excess capacity and 'technological unemployment' made technology a drag on economic progress.[3] Later, even such a relatively dispassionate analyst as Edith Penrose was concerned that the international monopolization of the combination of patents and trade 'know-how' posed a serious threat to world economic efficiency.[4]

Early apologists for socialism believed that the dilemmas posed by innovation could be resolved in socialist systems: systems where public ownership would predominate and where planners rather than profit-driven capitalists would allocate resources. The planners, it was believed, would invest in human capital, shoulder the risks inherent in innovation, take account of all linkages and positive external effects, and make investments using time horizons far longer and closer to social optimality than those of the private

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businessman.[5] But as Charles Feinstein shows in Chapter 3, the experience of the Soviet Union proved disappointing. For in spite of some spectacular successes (space technology, for example), major Soviet innovation was rare and industry in general was technologically backward and lacking in the incremental improvement of processes of the kind achieved by firms in market economies described by John Enos (Chapter 6) and Christopher Howe (Chapter 2).

The analysis of the Soviet problems, however, was not conclusive, even in the west, until the 1960s and 1970s – some thirty to forty years after the beginning of the Soviet experiment. To China, therefore, embarking on its own institutional revolution in the early 1950s, the Soviet model was the dominant, natural influence; and whereas the Chinese were aware from the outset of the errors of Soviet agricultural collectivization and their implications for China, they had no reason to doubt the superiority of Soviet industrial and technological systems and policies.

THE SOVIET PHASE OF TECHNOLOGY POLICY: 1953–60

The main task for China in this period was to secure efficient transfer of known, foreign techniques and to adapt and improve these in the light of Chinese characteristics, including labour abundance, raw material configurations, and existing resources in the modern and traditional sectors. Two aspects of the early programme stand out: the dominant role of the Soviet Union as the single supplier of new technologies; and the priority accorded to the defence-related industries.

Overall, what is striking about the technology transfer in this phase is how successful it was. Important new process technologies were introduced, especially in the metallurgy and chemical sectors, and new products appearing in these years included vehicles, machinery of all kinds, man-made fibres and chemical products. Moreover, improved management of existing resources and some incremental improvements led to productivity gains (including gains in total factor productivity) both in industry as a whole and in individual industrial sectors such as steel, where progress mainly took the form of the modernization and enlargement of facilities left by the Japanese.[6]

What factors explain these successes? First, we should not ignore the skills and capabilities accumulated in industry before the Anti-Japanese War. In Shanghai, in particular, machinery, shipbuilding and textiles all made important transfers of western and Japanese technologies, in part as spill-overs from foreign direct investment (FDI) in the city.[7] Second, during the First Five-Year Plan (1953–57) choices were relatively simple and government priorities clear and coherent. This coherence reflected the advantage of hav-

ing one major supplier of new industrial technology since this ensured at least minimal standardization and integration.

Most interesting of all, however, was the fact that, whatever Soviet motives at the time, the underlying concept of technology transfer appears to have been a broad one –something, as Paul David (Chapter 1) argues, conspicuously lacking in western thinking about the problems of technology transfer to 'developing countries' during the 1950s. For the Soviet transfer included not only the 'hardware' of whole plant and other capital goods imports to China, but also the blueprints, technical literature, training programmes and personnel exchanges required for a full transmission of 'know-how' and tacit information. Soviet assistance also extended to the upgrading of higher education and the establishment of a Soviet-style network of research and design institutions, as well as to the practice of formulating long-range science and technology plans.

In spite of its successes, these programmes were in serious difficulty by the late 1950s. This reflected not only China's macroeconomic mismanagement and the Sino-Soviet political rift (which led directly to the abrupt withdrawal of all Soviet technicians from China), but also more narrowly technological factors as well. One of these was that the speed of technology transfer embodied in the fifteen-year perspective plan (1953–67) and the Five-Year Plans within this was over-ambitious, allowing insufficient time for full transfer and absorption of skills to take place.[8] Indeed, some of the plants planned in the mid-1950s did not come on-stream until 1969–70 – ten years behind schedule. Further, unlike the Soviet Union, China's low level of economic development required the continuation of small-scale, semi-mechanized productive and service sectors and the Sino-Soviet strategies for technology transfer and improvement did little or nothing for this important element of the economy.

Apart from these specific problems, China also began to report evidence of the systemic shortcomings common to Soviet-type systems, including lack of continuous productivity growth and innovation in existing enterprises. The key dysfunctional features of the system were reported to be the gulf between quasi-autonomous research and development (R&D) facilities and industrial enterprises; the unwillingness of managers to take risks in a system that provided rewards and punishments reflecting success in plan fulfilment and physical indicators; and the problems created by planning based on physical norms. Productivity norms governing basic processes (e.g. coal per unit of electricity, raw cotton per metre of yarn, etc.) are the essence of a physical planning system since, without them, planning is reduced to *ad hoc* bargaining between the planners and individual enterprises. Yet precisely by predetermining these relationships and rewarding plan fulfilment based on them, the rationale and incentive for *improvement* in them is lost.[9]

Thus the Soviet relationship and system provided an effective mechanism for achieving an heroic, once-for-all transfer of a limited number of technologies and in enabling the Chinese to acquire much of the codified, tacit and contextual knowledge associated with these. What they did not do was to implant a system for discovering and diffusing the incremental gains to be had from learning by using and learning by doing, or to impart to the Chinese a sense of the complex, routine, day-to-day relationships required for successful innovation and productivity growth in the long run.[10]

These comments are not simply a western-oriented, retrospective commentary on events. By 1958 Mao had himself become very critical of the industrial system; and while there was much that proved disastrous in Mao's thinking and policy in these years, he was correct in perceiving that because of its strong elements of centralization, bureaucracy and coercion, Soviet planning was destructive of a creativity that should be based on first-hand knowledge of local circumstances and on the incentives provided by local and individual empowerment. He also grasped the point that planning based on common technological norms could not work effectively in China where varying vintages of capital (with widely differing norms) were unavoidable.[11]

THE PROBLEMS OF RELATING TO THE MARKET ECONOMIES: 1960–78

When China began to rethink these problems in the mid-1960s it was faced with new issues and possibilities. In place of one major supplier, China could now shop for technology throughout western Europe and, increasingly, even in Japan, with whom tentative rapprochements were being made.

In this phase, anti-foreign politics, Maoist emphasis on decentralized, inspirational management, rejection of foreign investment and an explicit preference for self-sufficiency were all-important. The underlying philosophy for technology transfer appears to have been that while some foreign technologies remained essential for the large-scale sector, they could be acquired with minimal foreign contact and no respect for foreign intellectual property rights. Thus the technology import programme for 1964–66 consisted mainly of targeted whole-plant and other hardware imports, coupled with plans for copying and reverse engineering.[12]

Apart from the ideological and other restraints on technology transfer, a short-term attitude to it was reinforced by the prevailing trade system. For whereas in the 1950s trade plans (and contractual commitments) extended over several years, by the 1960s this had been abandoned in favour of year-to-year planning in which the composition and level of trade were, to an important extent, determined by the harvest in the previous autumn. None of

this worked well. The time period for planning was too short and by comparison with the 1950s, when 'know-how', contextual and codified knowledge came packaged together, the attempt to manage with minimal, arm's-length, market-based relationships failed to take account of the realities involved.

The Cultural Revolution

The first phase of the Cultural Revolution (1965–70) brought even these tentative experiments to an end. However, the seriousness and ever-widening character of the technology gap were well understood by Zhou Enlai and Liu Shaoqi. Zhou had played a major role in the Twelve-Year Programme for Technology and Science (1956) and, in December 1964, had made his historic call for the Four Modernizations – including that of technology. Liu, on the other hand, was reportedly particularly concerned about the development of the electronics revolution then gathering pace in the west and Japan; while both must have perceived the defence significance of gaps and the need for major technology acquisitions in oil and chemicals that would enable China to increase its supply of fertilizer and take advantage of the downstream possibilities created by exceptionally high growth rates in crude oil output.[13]

There thus followed a further spurt of whole-plant imports, in part taking advantage of China's resumption of normal relations with the United Sates and Japan (1972). This phase culminated in contracts for a huge steel complex at Baoshan (Shanghai) in 1978 which, in a completely new turn of policy, was designed to be fed by imported ore supplies.[14]

The effectiveness of this phase of technology transfer (1972–78) remains controversial. On the one hand, technology transfers were hampered by continued emphasis on whole-plant imports with insufficient attention to 'know-how' and the wider transfer of management and technical skills. Transfers were also affected by the collapse of China's educational and research systems during the Cultural Revolution; by politically ambiguous foreign-trade policies; and by the general disorder of planning and co-ordination that made it difficult to keep installation schedules and plans to bring technology imports and new plant on stream at reasonable capacity levels. While much of the blame for this lies on the Chinese side, western and Japanese exporters (many desperate for orders in the post-oil-shock recessions) were also at fault for signing contracts without fully acquainting themselves with Chinese conditions and absorptive capacity.[15]

However, an alternative view of this phase (from the Japanese whole-plant exporters) emphasizes that many of the problems of the 1970s were echoes of the 1950s, another period when Chinese impatience tended to outstrip reality. The Japanese point out that by the mid-1980s most of the problematic plants

were operating successfully, reflecting the eventual success of Chinese learning efforts and of the Japan–China knowledge transfer.[16]

Summary of the Pre-reform Period

Summing up the pre-reform experience, we may say that, whereas in the 1950s technology transfer between China and other planned economies was reasonably successful, the collapse of the Soviet connexion left China with unprecedented problems in relating to market economies. These were found to be insoluble without significant internal planning reform; without a revolutionary transformation in political and cultural attitudes to the outside world; and without some willingness to experiment with joint ventures and foreign investment.

It is true that some highly specific, state-led technology enterprises did succeed, even in the difficult years. One achievement was in nuclear fission, where the Soviets believed that their withdrawal from China would be fatal to Chinese ambitions.[17] China also succeeded beyond expectation in establishing the technology for China's oil extraction industry.[18] Against this, we must note some very high-priority technology transfers that failed badly. Prominent among these was the Spey engine contract with Rolls Royce. This was intended to enable China's Xian-based aircraft-manufacturing capabilities to jump from twenty to only ten years behind the contemporary technological frontier. But it proved far too ambitious a leap for the time, and revealed that China lacked the sophisticated, complementary technologies and skills (especially in metallurgy) that were needed for success.[19]

These judgements are made mainly on the evidence of case studies and Chinese self-analyses. Further evidence of the problem is to be found in estimates of long-run trends in total factor productivity and other indices. According to one uncontroversial estimate, the trends for the state-owned manufacturing sector as a whole were as shown in Table 0.1.

Table 0.1 Total factor productivity in state-owned industry, 1952–78 (average annual rates of growth, per cent per annum)

	1952–57	1957–65	1965–78
Series I	7.4	–1.4	0.8
Series II	9.3	0.3	1.2

Note: Series I and II represent weightings for labour and capital inputs of 0.4 and 0.6, and 0.6 and 0.4 respectively.

Source: Tidrick, (1986, p. 4).

Although the data for the First Five-Year Plan reflect some special factors, they generally confirm the overall pattern shown, made up of a successful Soviet phase, chaos during and after the Great Leap Forward, and weak technology transfer and domestic innovation during 1965–78.[20]

TECHNOLOGY TRANSFER AND INNOVATION IN THE CHINESE REFORM

The reform of the Chinese economy which began in later 1978 has been accompanied by a major effort to raise the level of research and development, and to accelerate both its application to the economy and the transfer of foreign technology to China. This is made clear in the chapters by Tang Shiguo and Jiang Xiaojuan, and has been confirmed by the State Council as recently as May 1995.[21]

In Chapter 4, Xu Jiangping identifies three phases in the technology transfer element of this programme: a rapid phase of state-led growth 1981–87; stagnation during 1988–91; and a final phase of accelerated transfer in which the driving forces have been the influx of foreign direct investment and the growing importance of enterprise-level decision-making.

Throughout the whole period, however, the government has retained a major role. It has done this by establishing the broad framework for science and technology policy and industrial innovation as well as detailed technology programmes – the latest of which extends to the year 2010. The state has also been active in raising the status of science and technology staff and in improving incentives through the establishment of new forms of intellectual property rights, prizes and the creation of a market for technology contracts. Particularly significant also has been the support for continuous, on-going technical progress to enhance the productivity and quality of output in old enterprises as distinct from earlier policies that concentrated on technology showpieces and new investments. Clearly, it is hoped that progress of this kind will be increased by the incentives generated by the general marketization of enterprises' activities but, in addition, the problem has been recognized by the provision of special funds for investment in technical renovation (Jiang Xiaojuan, Chapter 7 in this volume).

In the most recent phase, the role of foreign direct investment (and especially that by the Japanese) has been particularly striking. In Chapter 8 Tang Shiguo points out that in 1993 alone Japanese investment was almost as large as in the whole of the decade of the 1980s. While these flows are unlikely to continue to grow at such high rates, it is clear that a new era in Sino-Japanese economic relations is opening with consequences for technology transfer and enhancement on a scale of importance that matches the Soviet effort in the 1950s.

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